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Detecting, Measuring, and Testing Dyadic Patterns in the Actor–Partner Interdependence Model

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Family researchers have used the actor–partner interdependence model (APIM) to study romantic couples, parent–child dyads, and siblings. We discuss a new method to detect, measure, and test different theoretically important patterns in the APIM: equal actor and partner effect (couple pattern); same size, but different signs of actor and partner effects (contrast pattern); and zero partner effects (actor-only pattern). To measure these different patterns, as well as others, we propose the estimation of the parameter *k*, which equals the partner effect divided by the actor effect. For both indistinguishable dyad members (e.g., twins) and distinguishable dyad members (e.g., heterosexual couples), we propose strategies for estimating and testing different models. We illustrate our new approach with four data sets.

Keywords: dyadic data, actor–partner effects, phantom variables, structural equation modeling, bootstrapping

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The actor–partner interdependence model (APIM; Kashy & Kenny, 2000; Kenny, 1996; Kenny & Cook, 1999) is increasingly used to analyze dyadic data from families. It has been used in studies of interactions between parent and child (Pesonen, Räikkönen, & Heinonen, 2006), romantic partners (Peterson, Pirritano, Christensen, & Schmidt, 2008), and siblings (Kenny & Cook, 1999). Researchers have found the APIM to be very useful in the study of dyadic relationships. The appeal of the APIM is that allows for the study of the influence of a person's own causal variable on his or her own outcome variable, which is called the *actor effect*, and on the outcome variable of the partner, which is called the *partner effect*. These two effects can be measured while proper statistical allowances are made for the nonindependence in the two persons' responses.

Using interdependence theory (Kelley et al., 2003), Kenny and Cook (1999) discussed four general APIM patterns: the actor-only, the partner-only, the couple, and the contrast patterns.[1] The actor-only pattern is indicated by a nonzero actor effect, but the partner effect is zero. That is, a person's causal variable has an effect on his or her outcome variable but not on the partner's outcome variable. The partner-only pattern occurs if the partner effect is nonzero, but the actor effect is zero. The partner-only pattern is relatively rare, and so the new approach developed in this article does not initially consider this possibility, although we do return to this pattern later in the article. The couple pattern is indicated if actor and partner effects are equal. That is, a person's outcome variable is equally affected by his or her causal variable and by the causal variable of the partner. For instance, Campbell, Simpson, Boldry, and Kashy (2005) found that negative behaviors were affected by one's own anxious attachment style and one's partner. The contrast pattern occurs if actor and partner effects are equal in size but have opposite signs. For example, a person's outcome variable is positively affected by his or her causal variable and negatively affected by the partner's causal variable. One example of this pattern was found by Klumb, Hoppmann, and Staats (2006): More housework leads to higher levels of one's own cortisol, but housework done by the spouse leads to lower levels of cortisol.

These different patterns imply very different processes in the dyadic relationships. If the dyadic relationship obscured the boundary between self and other, then we would find the

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[1] Kenny and Cook (1999) use the term *social comparison* for what we call *contrast* effects in this article.

couple pattern. The couple pattern implies that the operative causal variable is the sum of the two variables. Alternatively, if there was no dyadic relationship, then we would find an actor-only pattern. The operative causal variable is the person's own score. The contrast pattern implies a dyadic relationship, but one that is either compensatory (the more you do, the less I need to do) or in other cases very competitive (I just want to have more than you). The operative causal variable might then be the person's score minus his or her partner's score.

Although Kenny and Cook (1999) presented these idealized models, they are hardly ever explicitly tested. For instance, Campbell et al. (2005) found a couple-level effect of anxious attachment style to negative interaction behaviors and Klumb et al. (2006) found a contrast pattern for the effect of housework on cortisol levels, but these findings were never explicitly tested. We were unable to find a single report in which the authors tested for any of the specific patterns suggested by Kenny and Cook (1999). Likely the major reason for this is that there does not currently exist a general statistical framework to estimate and compare these patterns. We think that not having the statistical tools leads to missing important insights. The major purpose of this article is to remedy this deficiency.

Consider the following example: A researcher seeks to examine the effect of attachment style on conflict in gay men, and the expectation is for a couple pattern. Say that the actor and partner effects are each tested with 50% power, then all four possibilities—both actor and partner effects are significant, neither is significant, actor is significant and partner is not, and partner is significant and actor is not—are about equally likely. Thus, about 50% of the time the researcher would find one significant effect, either actor or partner, but the other effect would not be significant. The researcher would mistakenly conclude that the pattern is either actor only or partner only. If, however, the researcher were to use the techniques described below, he or she would conclude most of the time that a couple pattern was indeed the correct model. Even more problematic, the researcher might find that neither actor nor partner effect is statistically significant but that the data would still be consistent with the couple pattern. Just testing actor and partner effects individually for statistical significance might well yield a very misleading picture of what is the important result.

The key idea in this article is to introduce a new parameter, called k, which is defined as the ratio of the partner effect to the actor effect. (We call this parameter k in honor of Larry Kurdek, a pioneer in the study of dyadic relationships.) Note that for k to be defined, the actor effect must be nonzero to avoid division by zero. The range of possible k values is from negative to positive infinity, but three values are of particular interest to family researchers. If we have the couple pattern, then k is equal to 1; if we have the contrast pattern, then k equals –1; and finally, if we have the actor-only pattern, then k is equal to 0. Sometimes, we might find "none of the above." For instance, we might find a k of 0.5, the actor effect being twice as large as the partner effect, indicating something in between the couple and the actor-only pattern.

There are several advantages to estimating k. First, by estimating k, we have a quantitative index of the relative size of the partner effect, not a qualitative measure. Second, as we shall show, we can compute a confidence interval (CI) for k, and that way we can determine what the range is of plausible values for k. Third, we can statistically evaluate the hypothesis that k takes on a particular value (e.g., –1). Fourth, when dyads are distinguishable, such as heterosexual couples, we can compare k for both (e.g., husbands and wives), and we might find that they differ. Fifth, by using k, interesting patterns (e.g., couple or contrast) can be detected that might be missed by just significance testing actor and partner effects individually. Sixth, by having a quantitative measure, we can compare k across different studies.

Before we explain how k can be directly estimated by using structural equation modeling (SEM), we discuss the important issue of distinguishability in dyadic analysis and the estimation of the standard APIM using SEM.

Distinguishable and Indistinguishable Dyad Members

Whether dyad members are distinguishable or indistinguishable is an important consideration in dyadic analysis (Kenny, Kashy, & Cook, 2006). Some dyads are said to be indistinguishable (or exchangeable or interchangeable) when there is no way to order the two members. Examples of indistinguishable dyads are same-gender romantic partners and identical twins.

For dyad members to be treated as distinguishable, two conditions need to be satisfied. First, there needs to be some dichotomous variable that differentiates the two members of all dyads. For instance, the two members are mother and daughter or physician and patient. Second, that dichotomous variable must make some sort of an empirical difference. That is, by including the distinguishing variable in the analysis, the model does a better job reproducing the data than when dyad members are treated as indistinguishable.

However, there might be some situations in which the researcher may need to a priori assume distinguishability. In some literatures, it may be totally implausible to pool results across the two types of persons. In other cases, there may be many analyses that are being conducted, and in some, the results clearly show distinguishability. To make results more easily comparable, it may be beneficial to treat dyad members as distinguishable across all analyses. Theory and conventional practice in the research area should be used to help make the decision of distinguishability.

Estimation of the APIM Using SEM

For reasons that will be clearer later, we employ SEM, as opposed to multilevel modeling, in estimation of the APIM. We begin with the APIM for distinguishable members.

Distinguishable Members

The standard APIM, shown in Figure 1, consists of four measured variables (represented by rectangles) and two latent error terms (represented by circles). In this model, the

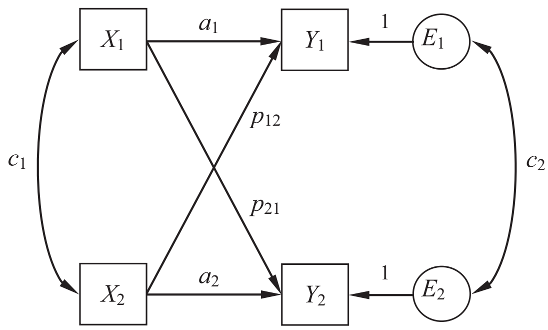

Figure 1. The actor–partner interdependence model. Variables X_1, X_2, Y_1, and Y_2 indicate measured variables; E_1 and E_2 denote errors.

measured variables vary between and within dyads and are termed *mixed variables* (Kashy & Kenny, 2000; Kenny, 1996). The variables X_1 and X_2 represent the causal or predictor variables of Persons 1 and 2 of a dyad, respectively, and Y_1 and Y_2 represent the outcome variables for the two members. The model contains two actor effects, a_1 and a_2, represented by horizontal arrows, and two partner effects, p_{12} and p_{21}, represented by diagonal arrows. The curved, double-headed arrow on the left represents the covariance between the two causal variables, and the one on the right represents the correlation between the two error terms. The latter indicates that the errors covary between dyad members because of unmeasured common causes.

The standard APIM is characterized by 14 parameters: one mean and variance for each causal variable, one intercept for each outcome variable, one variance for each error, two actor effects and two partner effects, one covariance between the independent variable, and one covariance between the error terms. When estimating all 14 parameters, the model is said to be *saturated* (or just-identified); therefore, there is perfect fit. When using SEM, researchers sometimes do not estimate the means and intercepts because they analyze only the variance–covariance matrix. When dyad members are distinguishable, by including the means and testing whether the intercepts on the two Y variables are different, we can test whether there is a mean difference due to the distinguishing variable. For instance, in Campbell et al. (2005), we wanted to know whether males and females exhibit the same level of negative behaviors, after controlling for theirs and their partners' attachment style. Thus, we advise including the means, as well as variances and covariances, in the model and the analysis whenever possible.

Of key relevance to this article are the actor and partner effects. We suggest simultaneously fixing the two actor and the two partner effects as equal and using a liberal alpha of .20 for this test. (Of course, if the sample size were large, we would not need to use such a liberal alpha value.) If there were no difference, we would treat actor and partner effects as the dyad members were indistinguishable.[2] If, however, there were a difference, we would treat them as distinguishable.

Indistinguishable Members

When dyad members are indistinguishable, a method developed by Olsen and Kenny (2006) can be used to estimate the APIM using SEM. For the basic APIM, the following six equality constraints are imposed on the model: equal means and variances of the causal variables, equal intercepts of the outcome variables, equal error variances, equal actor effects, and equal partner effects. Olsen and Kenny called the model with these six equality constraints the *ISAT* (or "interchangeable and saturated") model, which is used to compare other models instead of the standard saturated model with 0 degrees of freedom. The adjusted chi-square value is the difference between the chi square of the specified model for indistinguishable members and the chi square of the ISAT. That is, $\chi^2_{\mathrm{a}} = \chi^2_{\mathrm{Spec}} - \chi^2_{\mathrm{ISAT}}$, where χ^2_{a} is the adjusted chi square, χ^2_{Spec} is the chi square of the specified model, and χ^2_{ISAT} is the chi square of the saturated model for indistinguishable members. The adjusted degrees of freedom (df_{a}) can be obtained by calculating the difference between the degrees of freedom for the specified model and the degrees of freedom for the saturated model for indistinguishable members. That is, $df_{\mathrm{a}} = df_{\mathrm{Spec}} - df_{\mathrm{ISAT}}$, where df_{ISAT} equals 6 in the case of the basic APIM or 2 in the case of distinguishable dyads with equal actor and equal partner effects (see above). Any fit index that uses the chi-square statistic (e.g., the root mean square error of approximation or the comparative fit index) should use the adjusted and not the raw chi-square value.

Estimation of *k* Using SEM

The basic approach developed here presumes that the actor effects are relatively substantial. If a_1 or a_2 were small, estimates of k_1 and k_2 would be highly unstable. Before undertaking the procedures that we suggest, the researcher should first estimate the saturated model and determine that the actor effects are nontrivial. Although it is impossible to state a universal rule, a simple rule of thumb is to avoid computing k if the absolute standardized value of the actor effect is less than .10.

Distinguishable Dyads

Dyad members are distinguishable and we denote one member as "1" and the other as "2." There are two k values,

[2] Some might think it would be more appropriate to compare standardized instead of unstandardized coefficients. Almost everyone who has studied this problem (e.g., Tukey, 1954) has recommended that the appropriate null hypothesis to be evaluated is that the two regression coefficients are equal. If we want to determine whether X has a stronger effect on Y for husbands than for wives, we want to know that if we increase a husband's X score by 1 unit, do we get a bigger increase in Y than when we increase a wife's X score by 1 unit? This is what the difference in unstandardized regression coefficients evaluates. If we standardize within the two groups, then we have lost metric equivalence, and we are no longer comparing the same thing.

one for each of the two members of the dyad. Returning to Figure 1, we define the two k values as follows:

$$k_1 = p_{12}/a_1, \text{ and}$$

$$k_2 = p_{21}/a_2.$$

We refer to k_1 as the ratio for the 1s and k_2 as the ratio for the 2s. As we stated earlier, if the k ratio is near zero, the actor-only pattern is indicated; if k is near 1, we have the couple pattern; and if near –1, we have the contrast pattern. So, for instance, if the 1s are husbands and k_1 equals 0.1 and if the 2s are wives and k_2 is equal to 0.9, then the data suggest that wives are couple oriented and the husbands are actor only.

The ratios can directly be estimated within SEM by using phantom variables. *Phantom variables*, which were introduced by Rindskopf (1984), are latent variables that have no substantive meaning and no disturbance. This class of variables has been used as auxiliary variables in SEM to impose a wide variety of constraints on factor loadings and structural parameters (Rindskopf, 1984). The use of such variables does not affect parameter estimations or the implied variances and covariances and, thus, does not affect the fit statistics of a specific SEM. The APIM that allows a direct estimation of the k_1 and k_2 is presented in Figure 2. In this model, the two phantom variables, labeled P_1 and P_2, are included in the paths of the two partner effects. Consider the path from X_2 to Y_1. That effect is "mediated" by the phantom variable P_1. The effect of X_2 on P_1 is fixed to a_1, the actor effect from X_1 to Y_1, the path from P_1 to Y_1 estimates k_1. The "indirect effect" from X_2 to Y_1 is a_1k_1, which equals p_{12} because k_1 is defined as p_{12}/a_1. In a parallel fashion, P_2 "mediates" the effect of X_1 on Y_2. We note that the models in Figures 1 and 2 are statistically equivalent models (MacCallum, Wegener, Uchiono, & Fabrigar, 1993); therefore, the model in Figure 2 is also saturated and would have a chi square equal to zero with zero degrees of freedom.

It is advisable to compute for k a bootstrap CI and not to use the standard error. Especially because k is a ratio, its distribution would likely be skewed, which is a violation of normal theory, and so critical ratio tests of k might be misleading. We, thus, recommend computing a bootstrap CI for both k_1 and k_2, and we evaluate if 1, 0, or –1 is in the

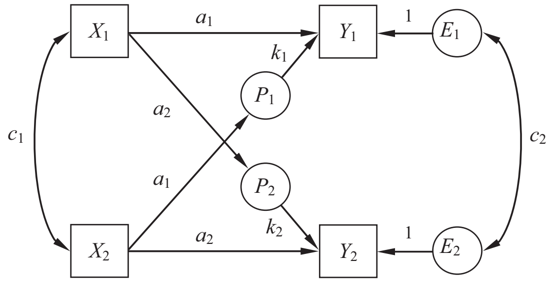

Figure 2. Phantom variables, P_1 and P_2, used to estimate k_1 and k_2. Variables X_1, X_2, Y_1, and Y_2 indicate measured variables; E_1 and E_2 denote errors.

interval. If 1 is in the CI, and 0 and –1 are not, we reestimate the model constraining k to 1; because the model is now overidentified, we can determine whether the model is a good-fitting model.

In addition, we can test whether $k_1 = k_2$. If they are equal, then we could estimate a model with a single k. If such a model has a good fit and better fit than a model with two ks, we can then compute a bootstrap CI for that common value of k. We can then statistically evaluate whether the value of k is statistically different from 1, 0, or –1 (or, for that matter, any value that makes theoretical or empirical sense). So, for instance, we might expect that both members of a married couple are operating at the couple level. We find that $k_1 = k_2$ and that the average value of k equals 0.86. If 1.00 is in its CI and 0.00 is not and the fit of the model does not worsen if we fix k to 1, then we have learned that the couple pattern is appropriate.

In sum, for distinguishable dyads, we recommend the following steps. First, we estimate the saturated model (see Figure 1). Second, we test to see whether the two actor effects and the two partner effects are equal. If they are both equal, we follow the strategy for indistinguishable dyads described in the next section. If they are equal and both the actor effects are nontrivial, we proceed to estimate the model with phantom variables to provide estimates of the two ks (see Figure 1). We then test whether the two ks are equal; if they are not different, we use a single k value. Finally, we compute the CIs for the ks (or single k) and determine the relative fit of the model in which k is fixed to 1, 0, and –1.

Indistinguishable Members

If dyad members are indistinguishable, we recommend the following three steps. We begin by estimating the saturated indistinguishable model (i.e., ISAT model), which has 6 degrees of freedom. Assuming that the actor effect is nontrivial, we then estimate the phantom variable model using the ratio APIM shown in Figure 2 with $k_1 = k_2$ (in addition to the six other constraints for indistinguishable members). This second APIM is statistically equivalent to the standard APIM estimated in the first step and has 6 degrees of freedom. For this model, we recommend computing the bootstrap CI for k and determine whether 1, 0, or –1 is contained in the CI for k. Next, we estimate a model in which we place a constraint on k, setting it to either 1, 0, or -1. This model has 7 degrees of freedom, 1 more than the APIM estimated in Steps 1 and 2. We subtract the chi square for the ISAT model to determine whether the constraint on the parameter is consistent with the data. (If dyad members are distinguishable, but the two actor effects and two partner effects are equal, the degrees of freedom of the ISAT model are equal to 2.)

We suggest the following reporting strategy. We report k and its CI and pay special attention as to whether 1, 0, and –1 are contained in that CI. If none is (e.g., we find $k = 0.51$ with a CI from 0.33 to 0.77), we conclude that none of the three dyadic patterns takes place. Alternatively, if say we find that k is 0.83 with a CI from 0.52 to 1.13, then we say that the data are consistent with the couple pattern. Then, we fix k to 1.0 and we should find a good fit.

Illustrations

We present analyses from four different data sets. Because we used Amos with bootstrapping, we had to use complete data for all the dyads.[3] (Other SEM programs do allow bootstrapping with missing data.) With one exception, we used the 95% CI. We present unstandardized and standardized (in parentheses) actor and partner effects. When dyad members are distinguishable, we used the entire sample of persons to standardize the variables (see p. 179 in Kenny et al., 2006).

Indistinguishable Dyad Members: Gay Men From American Couples

The data used for the first example are part of the well-known American Couples Study conducted by Blumstein and Schwartz (1983). This large study investigated differences in the relationships of heterosexual, gay, and lesbian couples. Here, we used questionnaire data from 930 complete gay couples, and we used own and partner's income to predict the degree to which the person thinks that it is important that the partner in the relationship provides financial security. Individuals' income was measured in thousands of dollars per year, and the importance of financial security provided by the partner indicated on a 9-point scale (1 = *not at all important* and 9 = *extremely important*).

The results of the APIM set up for indistinguishable members revealed a negative actor effect, –0.028 (–.139), and a positive partner effect, 0.037 (.179), that were both statistically significant. Thus, if a man has a high income, he does not value financial security. However, if he has a partner with a high income, he does value financial security. These two effects result in k that equals –1.283. The fact that k is absolutely greater than 1 indicates that the estimated partner effect is absolutely greater in size than the estimated actor effect. The 95% CI of the k is from −2.074 to −0.865 and includes −1, which supports the contrast pattern. Financial security provided by the partner is more important the lower a person's own income and the higher the partner's income. When k is constrained to –1, the model has a good fit, $\chi^2(1) = 1.661$, $p = .197$, thus, providing additional support for the contrast pattern. Models in which k is set either to 1 or 0 result in poor fit (ps $<$ .001). Thus, the data support a contrast pattern: How much a person values financial security in the partner is negatively predicted by the difference between the person's own income and the income of the partner. The relative difference in income predicts how much one values financial security.

Distinguishable Dyad Members: Heterosexuals From American Couples

We also examine the same model using heterosexual couples of the American Couples Study (Blumstein & Schwartz, 1983). There were 4,144 heterosexual couples and we used income, own and partner's, to predict the importance of the financial security provided by the partner. Because of the very large sample size, we set alpha to .01 and used a 99% CI for k.

The results of the standard APIM revealed negative actor effects for men, −0.027 (–.134), and for women, −0.053 (–.262), and positive partner effects from women to men, 0.035 (.172), and from men to women, 0.044 (.217), that were all statistically significant. When we tested whether the two actor effects and the two partner effects were equal, we found that they were not, $\chi^2(2) = 32.127$, $p < .001$. Thus, we treat the dyad members as distinguishable.

The k for men is equal to –1.282 (99% CI [1.840, −0.876]) and the k for women is −0.828 (99% CI [–1.079, −0.639]). For both men and women, the 99% CI of k includes –1, which suggests a contrast pattern. When we test a model with both ks set to –1, the model has a reasonably good fit given the large sample size, $\chi^2(2) = 7.075$, $p =$ .029. Finally, when we test whether the two ks are equal, the model shows a slightly poor fit, $\chi^2(1) = 6.873$, $p = .009$, with the common k equal to −0.961 (99% CI [–1.250, −0.748]). In sum, the higher the partner's income and the lower a person's own income, the more important is the financial security provided by the partner. Thus, as we found with the gay men, it is the relative difference in income that predicts how much one values financial security.[4]

Distinguishable Members: Acitelli Study of Heterosexual Couples

For next example, we use complete data from 233 heterosexual couples surveyed by Acitelli (1997). The causal variable used here was "our relationship is best described as two separate people" (coded 0) "versus a couple" (coded 1), the outcome variable was relationship happiness rated on a 4-point scale (1 = *not happy*, 4 = *very happy*).

The results of the standard APIM reveal actor effects for men, 0.785 (.443), and for women, 0.355 (.200), and partner effects from women to men, 0.162 (.092), and from men to women, 0.371 (.209), that are all statistically significant, except the partner effect from women to men. A model that sets the two actor effects and the two partner effects equal yields $\chi^2(2) = 7.412$, $p = .025$, and so has poor fit. The k for men is estimated to be 0.207; for women, it is 1.044. The 95% CI of k for men includes 0 and ranges from –0.049 to 0.536, which provides support for the actor-only pattern for the men. However, for women, the CI ranges from 0.328 to 3.151 and includes 1 but excludes 0, which supports the couple pattern for women's outcome variable. That is,

[3] The setups for Mplus are available in the online supplementary information. In addition, the Amos setups are available at http://davidakenny.net/k_apim.htm.

[4] The reader might wonder what result we obtained for lesbian couples from the American Couples Study. For this group, we found that the standardized actor effect was less than .10 in absolute value (–.093), and so we do not report the results for that group.

women's relationship happiness is affected by both her own and the partner's description of the relationship, whereas men's relationship happiness is only influenced by his own description of the relationship. We fit a model where the k for women equals 1 and the k for males equals 0. The model shows an excellent fit, with $\chi^2(2) = 2.869$, $p = .238$. Although a model that sets the two ks equal may also reasonable, $\chi^2(1) = 3.802$, $p = .051$, its fit is relatively worse than a model in which k is equal to 1 for wives and 0 for husbands. In sum, women are happier if both members perceive their intimate relationship as a couple, whereas men's happiness is not affected by how the partner describes the relationship.

Distinguishable Dyad Members: Bradbury Study of Relationship Satisfaction

The data used here are part of Bradbury's longitudinal intervention study on heterosexual married couples (Rogge et al., 2006). We use data from 171 heterosexual couples and examine whether a person's own and partner's depression predict general marital satisfaction. Depression was measured using the Beck Depression Inventory, and global satisfaction with the marriage was assessed using the semantic differential. The results of the standard APIM reveal actor effects for husbands, −0.037 (–.224), and for wives, −0.046 (–.281), both of which are statistically significant. The partner effects from wives to husbands equal −0.039 (–.241) and from husbands to wives equal −0.041 (–.253), and both are statistically significant. A model that sets the two actor effects and the two partner effects equal yields $\chi^2(2) = 0.445$, $p = .800$. Even with a liberal alpha of .20, we cannot reject the null hypothesis that the actor and partner effects are equal. In subsequent models, the only parameters that we force to be equal are the two actor effects and k_1 and k_2.

The results of the APIM reveal an actor effect, −0.042 (–.266), and a partner effect, −0.041 (–.248), that are both statistically significant. Depression leads to lower marital satisfaction for both self and partner. These two effects result in a k equaling 0.968, indicating that the actor and partner effects are nearly the same value. The 95% CI of the k is from 0.456 to 1.993 and includes 1, which supports the couple pattern. When k was constrained to 1, the model, after subtracting the ISAT model with 2 degrees of freedom, has a good model fit, $\chi^2(1) = 0.017$, $p = .898$, again providing additional support for the couple pattern. Models in which k is set to either 0 or –1 results in poor fit (ps $<$ .001). Thus, the data support a couple pattern: Marital satisfaction is predicted by the combined depression of the couple.

Advantages of *k*

The current standard practice for the APIM is to estimate and test individually the actor and partner effects. Such a strategy is problematic for several reasons. It does not explicitly test for specific patterns, and second it can fail to find theory-relevant patterns. By estimating k, we have a quantitative index that summarizes the relationship between the actor and partner effects. By quantifying the measure, we can test, relatively easily, several important hypotheses about the underlying dyadic process.

As we saw with the examples, we were able to find the couple pattern (Bradbury), the contrast pattern (American Couples), and the couple pattern for women and the actor-only pattern for men (Acitelli). Moreover, by computing k, we can sometimes simplify the results. For instance, in our analysis from the American Couples Study, we found statistically significant actor and partner effects and the two actor and two partner effects differed from each other. However, we found that there was a single value for k of –1, which indicated the contrast pattern for both men and women.

We can compute a CI for k, and that way we can determine what is the range of plausible values for k. Consider a study that found that k equals 0.7. We might find that 1 is in the CI and 0 is not, suggesting the couple pattern; alternatively, we might find that both 1 and 0 are in the CI, and so we are very uncertain as to what the pattern is; finally, we might find that neither 1 or 0 is the CI, and so we have something in between the two idealized patterns. The CI greatly clarifies the meaning of the actor and partner effects.

With distinguishable dyads, we can compare k for both, and we might find that they differ. For instance, consider the Acitelli example. We found that the one partner effect was statistically significant and the other one was not. That might suggest different patterns for men and women, but it does not statistically test such. By computing k for both men and women, we were able to test for such a difference.

We believe that in the long run, the main use of k will be in meta-analyses. Because we now have a quantitative measure of dyadic processes, we can compare k across different studies. We would expect that k would be relatively more invariant across studies than the absolute value of actor and partner effects.

Limitations and Future Directions

Earlier in the article, we mentioned that Kenny and Cook (1999) discussed the possibility of partner-only patterns. Consider a study of randomly paired couples on their first date, where X is physical attractiveness and Y is liking. Almost certainly, partner effects (if Person 2 is an attractive, Person 1 will like Person 2) will be much stronger than actor effects. If we were to define k as the ratio of partner to actor effects, there could be problems in the estimation. However, there is a simple fix: We define k as the ratio of actor to partner effects. We might in this case denote k as k^{-1}.

A second complication was initially pointed out to one of us by Joseph Olsen. With distinguishable dyads, the couple and contrast patterns can be defined in terms of either X or Y. Previously, k was defined in terms of Y. As an example of the couple pattern, the effects of X_1 and X_2 on Y_1 are the same. Alternatively, we could have defined them in terms of X: The effect of X_1 on Y_1 and Y_2 are the same. This alternative formulation is illustrated in Figure 3, and we denote k in this case as k_Y. Note again that this distinction

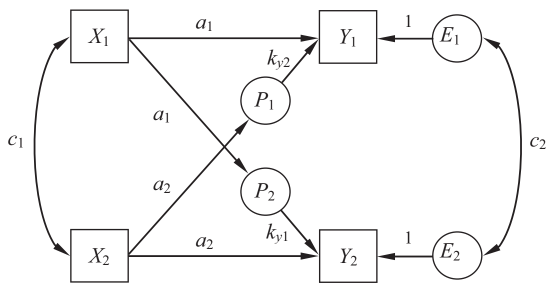

Figure 3. Model with "*X*" instead of "*Y*" *k* effects. Variables X_1, X_2, Y_1, and Y_2 indicate measured variables; E_1 and E_2 denote errors.

only arises when considering distinguishable dyads. When working with distinguishable dyads, the researcher should consider the possibility of defining *k* in this alterative fashion, especially in situations when it is plausible that we might want to consider computing either the mean of *Y* or the difference in *Y*.

We have used SEM in this article because it gives an estimate of *k* and its CI. However, we can use multilevel modeling. If we do so, we can compute *k* indirectly by computing the ratio of the partner to the actor effect. Kenny et al. (2006) discuss how the couple and contrast pattern can be estimated and deviance difference tests can be used to compare various models. However, standard multilevel modeling packages do not appear to currently be able to estimate *k* and its bootstrap CI.[5]

We have assumed that the APIM is correctly specified. There are several key ways in which the model can be misspecified. First, the causal pattern might be different. For example, Woody and Sadler (2005) have investigated a mutual feedback model in which there are no partner effects but rather Y_1 and Y_2 mutually cause each other. An alternative model is the common fate model (Griffin & Gonzalez, 1995; Kenny & La Voie, 1985) in which the two *X* measures are assumed to be caused by a single latent variable. Even if the basic structure of the APIM is correct, the estimates might likely be biased because of measurement errors in the *X* and *Y* variables. That is, the correct specification of the APIM is with both *X* and *Y* as latent variables.

One often unrecognized assumption of the APIM is metric equivalence. When working with distinguishable dyads, it must be assumed that *X* and *Y* are the same variables for both members. Just by using the same measure for both does not ensure that in fact the measure has the same meaning for both members. Differences between actor effects and between partner effects can sometimes be interpreted as differences in the meaning of the measures for the two members (e.g., when the variances of X_1 and X_2 differ substantially).

We considered only the basic APIM without the addition of any covariates. Such variables can be added to the model. For instance, in the Acitelli example, we have the covariate whether the couples are dating or married. We could have added that variable to the model by correlating it with both *X* variables and drawing a path from it to the two *Y* variables.

We have also ignored actor–partner interactions. Basically, we have presumed that none exist, but it is very often the case that they do. If such is the case, *k* is a variable. Note that if we find

$$Y_1 = b_1 + a_1X_1 + p_{12}X_2 + cX_1X_2 + E_1,$$

we can rewrite as

$$Y_1 = b_1 + a_1X_1 + (p_{12} + cX_1)X_2 + E_1.$$

The value of k_1 becomes $(p_{12} + cX_1)/a_1$ and so varies with the level of X_1. We can then use this equation to solve for the values of X_1 for k_1 to equal 1, 0, and –1. That may then assist us in understanding the meaning of the actor–partner interaction.

Conclusion

The APIM has proved to be a useful model for family researchers to study romantic couples, parent and child, and siblings. However, one of the main uses of the model, the ability to measure and confirm various dyadic patterns, has not been fully exploited. In this article, we proposed to remedy that problem. We developed the measure *k*, which is the ratio of partner to the actor effect. Various dyadic models imply different values of *k*. For instance, the couple pattern presumes that *k* equals 1. By being able to measure and test *k*, we can directly test which model is the more appropriate one.

We think that *k* has potential uses beyond the simple APIM. In particular, we think that APIM models with either mediation or moderation or both would benefit by considering *k*. For instance, if the mediator is a mixed variable that has actor and partner effects and dyad members are distinguishable, there are eight possible indirect effects. If we use *k*, it should be possible to reduce the number of indirect effects. We plan to explore this issue in a subsequent report. We suspect that there are other uses of *k* that we have not yet considered (e.g., latent class analysis), and we invite the reader to explore them.

[5] It appears that the xtmixed routine in Stata could be used to estimate the APIM model and the nlcom (nonlinear combination) function to compute *k* and its bootstrap CI. Also available in the online supplementary material is the description of a method for determining the standard error of *k* if bootstrapping cannot be used.

References

Acitelli, L. K. (1997). Sampling couples to understand them: Mixing the theoretical with the practical. *Journal of Social and Personal Relationships, 14,* 243–261.

Blumstein, P., & Schwartz, P. (1983). *American couples: Money, work, sex.* New York: William Morrow.

Campbell, L., Simpson, J. A., Boldry, J. G., & Kashy, D. (2005). Perceptions of conflict and support in romantic relationships: The role of attachment anxiety. *Journal of Personality and Social Psychology, 88,* 510–531.

Griffin, D. W., & Gonzalez, R. (1995). Correlational analysis of dyad-level data in the exchangeable case. *Psychological Bulletin, 118,* 430–439.

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 psychology* (pp. 451–477). New York: Cambridge University Press.

Kelley, H. H., Holmes, J. G., Kerr, N. L., Reis, H. T., Rusbult, C. E., & Van Lange, P. A. (2003). *An atlas of interpersonal situations.* New York: Cambridge University Press.

Kenny, D. A. (1996). Models of non-independence in dyadic research. *Journal of Social and Personal Relationships, 13,* 279–294.

Kenny, D. A., & Cook, W. L. (1999). Partner effects in relationship research: Conceptual issues, analytic difficulties, and illustrations. *Personal Relationships, 6,* 433–448.

Kenny, D. A., Kashy, D. A., & Cook, W. L. (2006). *Dyadic data analysis.* New York: Guilford Press.

Kenny, D. A., & La Voie, L. (1985). Separating individual and group effects. *Journal of Personality and Social Psychology, 48,* 339–348.

Klumb, P., Hoppmann, C., & Staats, M. (2006). Work hours affect spouse's cortisol secretion—for better and for worse. *Psychosomatic Medicine, 68,* 742–746.

MacCallum, R. C., Wegener, D. T., Uchiono, B. N., & Fabrigar, L. R. (1993). The problem of equivalent models in applications of covariance structure analysis. *Psychological Bulletin, 114,* 185–199.

Olsen, J. A., & Kenny, D. A. (2006). Structural equation modeling with interchangeable dyads. *Psychological Methods, 11,* 127–141.

Pesonen, A., Räikkönen, K., & Heinonen, K. (2006). Depressive vulnerability in parents and their 5-year-old child's temperament: A family system perspective. *Journal of Family Psychology, 20,* 648–655.

Peterson, B. D., Pirritano, M., Christensen, U., & Schmidt, L. (2008). The impact of partner coping in couples experiencing infertility. *Human Reproduction, 23,* 1128–1137.

Rindskopf, D. (1984). Using phantom and imaginary latent variables to parameterize constraints in linear structural models. *Psychometrika, 49,* 37–47.

Rogge, R. D., Cobb, R. J., Story, L. B., Johnson, M. D., Lawrence, E. E., Rothman, A. D., & Bradbury, T. N. (2006). Recruitment and selection of couples for intervention research: Achieving developmental homogeneity at the cost of demographic diversity. *Journal of Consulting and Clinical Psychology, 74,* 774–784.

Tukey, J. W. (1954). Causation, regression and path analysis. In O. Kempthorne, T. A. Bancroft, J. W. Gowen, & J. L. Lush (Eds.), *Statistics and mathematics in biology* (pp. 35–66). Ames: Iowa State College Press.

Woody, E., & Sadler, P. (2005). Structural equation models for interchangeable dyads: Being the same makes a difference. *Psychological Methods, 10,* 139–158.

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