

## Estimation of Relationship Fixed Effects for Data from SRM Designs\*

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On page 210, Kenny, Kashy, and Cook (2006) discuss how Social Relations Model (SRM) relationship effect estimates can be used to estimate Actor-Partner Interdependence Models (APIM). Here I show how this can be accomplished using raw data with the correct degrees of freedom. I use SPSS and R as the estimation methods, but any multilevel modeling program could be used. I also provide the dataset, syntax, and output.

I use as an example a round-robin study that examines measurement of sociability at zero acquaintance and the effect of physical attractiveness from four women who are in 27 different groups (Kenny, Horner, Chu, & Kashy, 1992). (The example has complete round-robin data, but most any SRM design can be used and there may be missing data. However, it is not exactly certain how all of this works with missing data.) For each group, there are 6 dyads and 12 observations. To conduct an APIM analysis, pairwise dataset (see Chapter 1 of Kenny et al. ,2006) needs to be created from the original dataset; an app for doing so is available at <https://davidakenny.shinyapps.io/ItoP/>. The example dataset can be downloaded at <http://davidakenny.net/doc/chu.csv>. A pairwise dataset contains the data from the respondent, e.g., A's rating of B, as well as the other member of the dyad, e.g., B's rating of A. On each record would the following variables scores:

Sociable\_AB (how sociable A thinks B is)

Sociable\_BA (how sociable B thinks A is)

Attractive\_AB (how physically attractive A thinks B is)

Attractive\_BA (how physically attractive B thinks A is)

actorN (a unique actor number for person A)

partnerN (a unique partner number for person B)

dyadN (a unique number for the dyad containing persons A and B)

partnum (the AB record is given a 1 and BA record is given a 2)

For the example, there would be 324 scores, 162 different dyads, 108 different actors and partners, and partnum for 1 to 2. Note that if there are multiple groups, dyads, actors, and partners in different group need to be given a unique code. For the 45 dyads, the variable partnum would be 1 for one person and 2 for the other. To be clear in what follows, if the terms “ActorN” and “PartnerN” are used they refer to the set of dummy-coded variables. The example dataset has no missing data. It is not entirely clear if this procedure can be employed if there are missing data.

An APIM analysis (or other dyadic analysis) can now be conducted. However, before conducting the APIM, it may be useful first to estimate the empty model, a model with no predictors, except ActorN and PartnerN. First discussed is the SPSS syntax and then R.

For SPSS the syntax is as follows (upper case terms are SPSS terms and terms with some lower case depend on the names given by the user):

```
MIXED Sociable_AB BY actorN partnerN
  /FIXED= actorN partnerN
  /PRINT=SOLUTION TESTCOV
  /REPEATED=partnum | SUBJECT(DyadN) COVTYPE(CSR).
```

Of interest in this run are the “Estimates of Covariance Parameters.”

Parameter	Estimate	Std. Error	Wald Z	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Repeated Measures CSR diagonal	1.126543	.143571	7.847	.000	.877541	1.446201
	CSR rho	.104110	.122880	.847	.397	-.138102

a. Dependent Variable: Sociable\_AB.

Note that “CSR diagonal” is the value that would be obtained for relationship variance in a regular SRM analysis. The “CSR rho” value is the dyadic reciprocity correlation. It is noted for the example run it does not reach conventional statistical significance.

Also interesting from the empty model are the tests of ActorN and PartnerN effects. Note that the numerator *df* are 81 which is the number of persons in each group, less one, times the number of groups. In this instance, both are statistically significant. Such a result means that there is actor and partner variance in these data.

**Type III Tests of Fixed Effects<sup>a</sup>**

Source	Numerator df	Denominator df	F	Sig.
Intercept	1	54.000	2392.864	.000
ActorN	81	96.154	1.763	.004
PartnerN	81	96.154	1.770	.004

a. Dependent Variable: Sociable\_AB.

To perform an APIM analysis, the variables Attractive\_AB and Attractive\_BA are added as predictors:

```
MIXED Sociable_AB BY actorN partner WITH Attractive_AB Attractive_BA
/FIXED= Attractive_AB Attractive_BA actorN partnerN
/PRINT=SOLUTION TESTCOV
/REPEATED=partnum | SUBJECT(DyadN) COVTYPE(CSR).
```

To perform an APIM analysis, actor or intrapersonal predictor (i.e., Attractive\_AB) and partner or interpersonal predictor (i.e., Attractive\_BA) effects are estimated even if only one is predicted. The estimates of actor and partner effects show that only the actor effect is statistically significant.

**Estimates of Fixed Effects<sup>a</sup>**

Parameter	Estimate	Std. Error	df	t	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Intercept	2.842887	1.396343	53.000	2.036	.047	.042178	5.643597
Attractive_AB	.342910	.135812	108.973	2.525	.013	.073735	.612085
Attractive_BA	-.011700	.135812	108.973	-.086	.932	-.280875	.257475

a. Dependent Variable: Sociable\_AB.

Relationship effects are obtained of the controlling for ActorN and PartnerN variables which removes actor and partner variance from the outcome variable and corrects the degrees of freedom. The analysis

procedure can be viewed as a type of “group centering.” In multilevel modeling, you often center on the mean of the level 2 variable. With the SRM there are two level 2 variables, actor and partner. This method effectively centers on both of them.

Note also then even though ActorN and PartnerN are not random variables in this analysis, they are effectively treated as such in the tests of actor and partner relationship effects. It must, however, be assumed that Actor, Partner, and Group do not interact with the actor (Sociable\_AB) or partner (Sociable\_BA) variables. Depending on the group sizes, these effects can be tested. For instance, the interaction of the actor effect with random actor effect can be tested by adding Sociable\_AB\*ActorN to the fixed line to find a marginally significant  $p$  of .06. Finding, an actor (or partner) interaction with ActorN or PartnerN implies that the test of the “main effect” of actor (or partner) has too small a standard error and more complicated analyses should be undertaken. Finally, note that if Group interactions are to be model, Group simply interact with the actor or partner effects.

The syntax for R, which was jointly written with Avraham Kluger who has written more extended R code. The nlme package be loaded and a dataset, called MaDa is loaded that has in it the relevant variables. The following code is used to set up the run:

```
library(nlme)
MaDa$ActorN=as.factor(MaDa$ActorN)
MaDa$PartnerN=as.factor(MaDa$PartnerN)
MaDa$Adum = model.matrix(~MaDa$ActorN)
MaDa$Adum = MaDa$Adum[,-1]
MaDa$Pdum = model.matrix(~MaDa$PartnerN)
MaDa$Pdum = MaDa$Pdum[, c( FALSE, rep(TRUE,dim(MaDa$Pdum)[1]/dim(MaDa$Pdum)[2])) ]
```

Note the number of persons in groups is assumed to be a constant.

```
yyy=gls(Sociable_AB ~ Attractive_AB + Attractive_BA + Adum + Pdum, na.action=na.omit,
        method="REML",verbose=TRUE, correlation=corCompSymm (form=~1|DyadN), data=MaDa)
summary(yyy)$tTable[2:3,]
```

	Value	Std.Error	t-value	p-value
Attractive_AB	0.34291006	0.1358118	2.52489163	0.01274815
Attractive_BA	-0.01169987	0.1358118	-0.08614767	0.93147859

(Note value, standard error, and  $t$  value should be the same as SPSS. The  $p$  value is somewhat smaller as the degrees of freedom are infinite in size, a  $Z$  test.)

```
summary(yyy)$sigma
```

1.043935 (note the standard deviation not the variance)

```
coef(yyy$model$corStruct,unconstrained=FALSE)
```

Rho

0.1131712 (same as SPSS)

```
anova(yyy)
```

Term	Numdf	F	p
Pdum	81	1.5660	0.0109

The  $F$  value the same as SPSS, but because the  $df$  are different,  $p$  value is somewhat different. The anova test statement gives the proper test for actor variance. To get the proper tests for actor variance test, use the following code:

```
MaDa$ActorN=as.factor(MaDa$ActorN)
```

```
MaDa$PartnerN=as.factor(MaDa$PartnerN)
```

```
MaDa$Pdum = model.matrix(~MaDa$PartnerN)
```

```
MaDa$Pdum <- MaDa$Pdum[,-1]
```

```
MaDa$Adum = model.matrix(~MaDa$ActorN)
```

```
MaDa$Adum <- MaDa$Adum[, c( FALSE, rep(TRUE, dim(MaDa$Adum)[1]/dim(MaDa$Adum)[2])) ]
```

```
yyy=glS(Talkative_AB ~ Attractive_AB + Attractive_BA + Pdum + Adum, na.action=na.omit,
```

```
method="REML",verbose=TRUE, correlation=corCompSymm (form=~1|DyadN),data=MaDa)
```

```
anova(yyy)
```

Effect	df	F	p
Adum	81	1.3480	0.0635

(Note Adum is after Pdum in the equation.)

The reciprocity can be tested by the following code (assuming equal sized groups with no missing data):

```

ng = 27
np = 4
dfn = ((np-1)*(np-2)/2 - 1)* ng
dfd = (np - 1)*(np-2)*ng/2
F = (1+as.numeric(coef(yyy$model$corStruct,unconstrained=FALSE)))/
  (1-as.numeric(coef(yyy$model$corStruct,unconstrained=FALSE)))
plov=pf(F,dfn,dfd)
2 * min(plov, 1 - plov)

```

which equals 0.3502669, which does not appear to be statistically significant.

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## References

- Kenny, D. A., Horner, C., Kashy, D. A., & Chu, L. (1992). Consensus at zero acquaintance: Replication, behavioral cues, and stability. *Journal of Personality and Social Psychology*, *62*, 88-97.
- Kenny, D. A., Kashy, D. A., & Cook, W. L. (2006). *Analysis of dyadic data*. New York: Guilford.