Validating empirical power estimates obtained from PowerLAPIM

To validate the results obtained with PowerLAPIM, we compare two modeling approaches to analyze the L-APIM with linear effects: the multilevel approach using the application and structural equation modeling (SEM; Hong & Kim, 2019; Ledermann & Kenny, 2017).

We applied Model 1: L-APIM with linear effect only to the Dyadic Interaction data to estimate actor and partner effects of partners' enacted responsiveness on their happiness. For each participant, we select the first 10 time points, and we estimate Model 1 using SEM. We set the correlation between the partners' enacted responsiveness to zero. We also assume that the correlation between the Level 1 errors is zero. Table 1 shows the estimated parameter values using the 'sem' function from the lavaan package (Rosseel, 2012) in R. On the OSF project page, we include the R syntax to reproduce the analysis.

Taking the estimated parameters of Model 1 based on the Dyadic Interaction data, we use the lavaan function 'simulateData' to generate 1000 data sets considering the following number of dyads: 60, 80, 100, 160, 200, and 300. For each of these data sets we estimate the L-APIM using structural equation modeling. Empirical power is then calculated as the proportion of replications in which the parameters of interest were estimated as significantly different from zero (at a specified α level of .05).

Next, we use the application PowerLAPIM to conduct the simulation-based power analysis. We select the population model of interest (i.e., Model 1). We indicate that we want to consider the following values for the number of dyads: 60, 80, 100, 160, 200, and 300. We set the number of measurements within each participant to 10. We fill in values for the model parameters and we indicate that the predictors (i.e., enacted response) should be person-mean centered. We set the Type I error, α, to .05 and the number of Monte Carlo replicates to 1,000, and we choose the *Maximizing the restricted log-likelihood* option when specifying the estimation method. Finally, we click on *Compute Power*.

Table 2 displays the average estimates of the fixed effects, empirical power, and their standard errors across the 1000 Monte Carlo replicates. We observe that PowerLAPIM and SEM perform similarly in term of estimation accuracy. Also, power estimates across the two procedures are comparable. Table 3 and 4 show the estimates of the variance components. The simulation results indicate that both procedures yield similar estimates.

Table 1

Model parameters L-APIM with linear effects.

	Value	Std. Error	p-value
Intercept for partner A (women)	39.24	4.50	0.00
Intercept for partner B (men)	40.68	4.72	0.00
Linear actor effect for partner A	0.28	0.04	0.00
Linear partner effect for partner A	0.06	0.04	0.13
Linear actor effect for partner B	0.28	0.04	0.00
Linear partner effect for partner B	0.07	0.04	0.07
Variance of the Level 1 error for partner A	223.11	15.68	0.00
Variance of the Level 1 error for partner B	257.40	18.09	0.00
Covariance between the Level 1 errors of partner A and B	0.00	-	-
Variance of the random intercept of partner A	101.54	26.16	0.00
Variance of the random intercept of partner B	76.36	21.60	0.00
Covariance between the random intercepts of partners A and B	30.68	17.38	0.08
Mean of the predictor of partner A	74.92	0.90	0.00
Mean of the predictor of partner B	74.69	0.86	0.00
Variance of the predictor of partner A	360.09	24.01	0.00
Variance of the predictor of partner B	331.52	22.10	0.00
Covariance between the predictor of partners A and B	0.00	-	-

Table 2

Average of the estimated fixed effects and empirical power (standard errors in parentheses) using PowerLAPIM and a structural equations model (SEM) for L-APIM with linear effects only.

	Number of Dyads	True Value	PowerLAPIM		SEM	
			Mean	Power	Mean	Power
Intercept for partner A	60	39.24	39.25 (0.04)	1.00 (0.00)	39.23 (0.12)	1.00 (0.00)
	80	39.24	39.16 (0.04)	1.00 (0.00)	39.23 (0.11)	1.00 (0.00)
	100	39.24	39.19 (0.03)	1.00 (0.00)	39.28 (0.10)	1.00 (0.00)
	160	39.24	39.23 (0.03)	1.00 (0.00)	39.19 (0.07)	1.00 (0.00)
	200	39.24	39.17 (0.03)	1.00 (0.00)	39.25 (0.07)	1.00 (0.00)
	300	39.24	39.18 (0.02)	1.00 (0.00)	39.24 (0.05)	1.00 (0.00)
Intercept for partner B	60	40.68	40.71 (0.04)	1.00 (0.00)	40.70 (0.13)	1.00 (0.00)
	80	40.68	40.67 (0.04)	1.00 (0.00)	40.62 (0.11)	1.00 (0.00)
	100	40.68	40.74 (0.03)	1.00 (0.00)	40.62 (0.10)	1.00 (0.00)
	160	40.68	40.72 (0.03)	1.00 (0.00)	40.63 (0.08)	1.00 (0.00)
	200	40.68	40.69 (0.02)	1.00 (0.00)	40.68 (0.07)	1.00 (0.00)
	300	40.68	40.71 (0.02)	1.00 (0.00)	40.58 (0.06)	1.00 (0.00)
Actor effect for partner A	60	0.28	0.28 (0.00)	1.00 (0.00)	0.28 (0.00)	1.00 (0.00)
	80	0.28	0.28 (0.00)	1.00 (0.00)	0.28 (0.00)	1.00 (0.00)
	100	0.28	0.28 (0.00)	1.00 (0.00)	0.28 (0.00)	1.00 (0.00)
	160	0.28	0.28 (0.00)	1.00 (0.00)	0.28 (0.00)	1.00 (0.00)
	200	0.28	0.28 (0.00)	1.00 (0.00)	0.28 (0.00)	1.00 (0.00)
	300	0.28	0.28 (0.00)	1.00 (0.00)	0.28 (0.00)	1.00 (0.00)
Partner effect for partner A	60	0.06	0.06 (0.00)	0.41 (0.02)	0.06 (0.00)	0.42 (0.02)
	80	0.06	0.06 (0.00)	0.51 (0.02)	0.06 (0.00)	0.52 (0.02)
	100	0.06	0.06 (0.00)	0.63 (0.02)	0.06 (0.00)	0.61 (0.02)
	160	0.06	0.06 (0.00)	0.82 (0.01)	0.06 (0.00)	0.79 (0.01)
	200	0.06	0.06 (0.00)	0.89 (0.01)	0.06 (0.00)	0.90 (0.01)
	300	0.06	0.06 (0.00)	0.98 (0.00)	0.06 (0.00)	0.97 (0.01)
Actor effect for partner B	60	0.28	0.28 (0.00)	1.00 (0.00)	0.28 (0.00)	1.00 (0.00)
	80	0.28	0.28 (0.00)	1.00 (0.00)	0.28 (0.00)	1.00 (0.00)
	100	0.28	0.28 (0.00)	1.00 (0.00)	0.28 (0.00)	1.00 (0.00)
	160	0.28	0.28 (0.00)	1.00 (0.00)	0.28 (0.00)	1.00 (0.00)
	200	0.28	0.28 (0.00)	1.00 (0.00)	0.28 (0.00)	1.00 (0.00)
	300	0.28	0.28 (0.00)	1.00 (0.00)	0.28 (0.00)	1.00 (0.00)
Partner effect for partner B	60	0.07	0.07 (0.00)	0.54 (0.02)	0.07 (0.00)	0.53 (0.02)
	80	0.07	0.08 (0.00)	0.67 (0.01)	0.07 (0.00)	0.66 (0.01)
	100	0.07	0.07 (0.00)	0.75 (0.01)	0.08 (0.00)	0.77 (0.01)
	160	0.07	0.07 (0.00)	0.92 (0.01)	0.07 (0.00)	0.92 (0.01)
	200	0.07	0.08 (0.00)	0.97 (0.01)	0.07 (0.00)	0.98 (0.00)
	300	0.07	0.07 (0.00)	1.00 (0.00)	0.07 (0.00)	1.00 (0.00)

Table 3

Average of the estimated variance components (standard errors in parentheses)

using PowerLAPIM for L-APIM with linear effects only.

	Number of Dyads	True value	Mean
Standard deviation Level 1 errors for partner A	60	14.94	14.89 (0.01)
	80	14.94	14.91 (0.01)
	100	14.94	14.91 (0.01)
	160	14.94	14.94 (0.01)
	200	14.94	14.94 (0.01)
	300	14.94	14.92 (0.01)
Standard deviation Level 1 errors for partner B	60	16.04	16.04 (0.02)
	80	16.04	16.04 (0.01)
	100	16.04	16.04 (0.01)
	160	16.04	16.04 (0.01)
	200	16.04	16.04 (0.01)
	300	16.04	16.05 (0.01)
Correlation between Level 1 errors for partners A and B	60	0.00	0.00 (0.00)
	80	0.00	0.00 (0.00)
	100	0.00	0.00 (0.00)
	160	0.00	0.00 (0.00)
	200	0.00	0.00 (0.00)
	300	0.00	0.00 (0.00)
Standard deviation random intercept for partner A	60	10.08	9.93 (0.04)
	80	10.08	9.93 (0.03)
	100	10.08	9.99 (0.03)
	160	10.08	10.00 (0.02)
	200	10.08	10.02 (0.02)
	300	10.08	10.06 (0.02)
Standard deviation random intercept for partner B	60	8.74	8.56 (0.03)
	80	8.74	8.63 (0.03)
	100	8.74	8.61 (0.03)
	160	8.74	8.70 (0.02)
	200	8.74	8.66 (0.02)
	300	8.74	8.69 (0.02)
Correlation between random intercepts for partners A and B	60	0.13	0.13 (0.01)
	80	0.13	0.14 (0.00)
	100	0.13	0.13 (0.00)
	160	0.13	0.13 (0.00)
	200	0.13	0.13 (0.00)
	300	0.13	0.13 (0.00)

Table 4

Average of the estimated variance components (standard errors in parentheses)

using SEM for L-APIM with linear effects only.

	Number of Dyads	True value	Mean
Variance Level 1 errors for partner A	60	223.11	222.80 (0.42)
	80	223.11	222.69 (0.38)
	100	223.11	222.72 (0.33)
	160	223.11	222.66 (0.27)
	200	223.11	222.67 (0.24)
	300	223.11	222.72 (0.20)
Variance Level 1 errors for partner B	60	257.40	256.77 (0.52)
	80	257.40	257.24 (0.42)
	100	257.40	257.32 (0.38)
	160	257.40	257.10 (0.30)
	200	257.40	257.19 (0.27)
	300	257.40	257.60 (0.22)
Covariance between Level 1 errors for partners A and B	60	0.00	-
	80	0.00	-
	100	0.00	-
	160	0.00	-
	200	0.00	-
	300	0.00	-
Variance random intercept for partner A	60	101.54	99.74 (0.72)
	80	101.54	100.80 (0.62)
	100	101.54	100.72 (0.58)
	160	101.54	101.50 (0.45)
	200	101.54	101.63 (0.39)
	300	101.54	101.56 (0.32)
Variance random intercept for partner B	60	76.36	75.91 (0.59)
	80	76.36	75.17 (0.51)
	100	76.36	75.68 (0.44)
	160	76.36	76.22 (0.36)
	200	76.36	75.99 (0.33)
	300	76.36	76.24 (0.27)
Covariance between random intercepts for partners A and B	60	30.68	30.98 (0.48)
	80	30.68	30.36 (0.41)
	100	30.68	31.31 (0.37)
	160	30.68	30.62 (0.29)
	200	30.68	30.27 (0.27)
	300	30.68	30.62 (0.22)