

Online Supplemental Material C

Analyses Controlling for Task Order Rather Than Interdependence of the Round-Robin Design

In primary analyses, we accounted for the interdependence of round-robin data (each child appears as the child and the partner in three of the six dyads per group) by a) including all six dyads per group in one row with data in wide format (see Online Supplemental Material B for an illustration of the data set), b) constraining intercepts to be equal and variances to be equal for all 12 lagged variables (child's emotion and partner's emotion for all six dyads), c) setting autoregressions and cross-lagged relations to be equal across all 6 dyads, and d) setting covariances among all 12 lagged variables to 0.

This approach did not control for task order, which may be important. Children's emotions may change as they proceed through three sets of search and planning tasks with different partners, particularly if their negative emotions increases or their happiness decreases as they fail at multiple search tasks over time.

Our analytic approach prohibited controlling for interdependence of the round-robin data and task order simultaneously. When we included all six dyads per group in one row with data in wide format (as we needed to do to control for interdependence of the round-robin data), we could not add a task order covariate, because matching that covariate to dyads would require that the dyads be in long format in the data set.

As a compromise, in this online supplement, we repeated primary analyses, but this time, we controlled for task order by including it as a covariate (0 = first search or planning task, 1 = second search or planning task, 2 = third search or planning task). In these supplemental analyses, dyads were in long format, and we did not take the steps outlined in the first paragraph above to control for the interdependence of round-robin data. In other respects, these analyses mirrored those conducted in the main document.

The pattern of statistically significant findings for cross-lagged relations using the Bonferroni correction for familywise error rate was identical between the primary analyses and these supplemental analyses with one exception. That is, in the primary analyses, the $Sad_i \rightarrow Anxious_{i+1}$ cross-lagged relation for the planning tasks (the more sadness a child expresses in one interval, the more anxiety their partner expresses in the next interval) was significant at $p < .001$ (meeting the Bonferroni correction criterion). However, when controlling for task order rather than dyad interdependence, this relation was only significant at $p < .05$ (which did not meet the Bonferroni correction criterion).

Table 1
Descriptive Statistics

	Search Tasks						Planning Tasks						Task Difference
	Min	Max	<i>M</i>	<i>SD</i>	Skew	Kurt	Min	Max	<i>M</i>	<i>SD</i>	Skew	Kurt	<i>F</i>
Happy	0.00	100.00	8.12	15.96	2.93	9.99	0.00	100.00	14.46	20.37	1.84	3.28	88.41***
Sad	0.00	30.04	0.13	1.24	12.73	194.46	0.00	81.88	0.08	1.43	38.63	1996.29	1.78
Angry	0.00	76.62	1.29	4.70	6.28	57.56	0.00	58.30	0.44	2.53	10.17	143.97	49.83***
Anxious	0.00	100.00	1.04	5.35	8.88	105.63	0.00	100.00	0.84	5.19	10.41	137.37	1.61
Neutral	0.00	100.00	89.20	18.15	-2.43	6.52	0.00	100.00	83.89	21.48	-1.74	2.79	52.43***

Note: *N* = 6060 (202 children x 3 partners x 10 intervals); Min = minimum; Max = maximum; Kurt = kurtosis; *** *p* < .001

Table 2*Multi-Level Models of Cross-Lagged Relations Across Dyad Members Within Same Emotion*

	Search Tasks		Planning Tasks		Task Differences	
	Estimate	Posterior SD	Estimate	Posterior SD	Estimate	Posterior SD
Auto-Regressions Within Child						
Happy _{<i>i</i>} → Happy _{<i>i</i>+1}	0.50***	0.01	0.48***	0.01		
Sad _{<i>i</i>} → Sad _{<i>i</i>+1}	0.16***	0.01	0.15***	0.01		
Angry _{<i>i</i>} → Angry _{<i>i</i>+1}	0.27***	0.01	0.11***	0.01		
Anxious _{<i>i</i>} → Anxious _{<i>i</i>+1}	0.36***	0.01	0.38***	0.01		
Neutral _{<i>i</i>} → Neutral _{<i>i</i>+1}	0.50***	0.01	0.49***	0.01		
Lagged Relations Across Children						
Happy _{<i>i</i>} → Happy _{<i>i</i>+1}	0.02***	0.00	0.04***	0.01	-0.02	0.02
Sad _{<i>i</i>} → Sad _{<i>i</i>+1}	0.01	0.01	-0.01	0.01	0.02	0.02
Angry _{<i>i</i>} → Angry _{<i>i</i>+1}	0.07***	0.01	0.01	0.01	0.06***	0.02
Anxious _{<i>i</i>} → Anxious _{<i>i</i>+1}	0.03***	0.01	0.02*	0.01	0.02	0.02
Neutral _{<i>i</i>} → Neutral _{<i>i</i>+1}	0.04***	0.01	0.04***	0.01	-0.00	0.02
Task Order						
Happy	0.47*	0.20	-0.97***	0.27		
Sad	-0.04*	0.02	0.01	0.02		
Angry	0.14*	0.07	0.15***	0.04		
Anxious	-0.00	0.07	-0.03	0.07		
Neutral	-0.55***	0.24	0.72**	0.29		
Intercepts						
Happy	3.37***	0.27	7.79***	0.45		
Sad	0.15***	0.02	0.06*	0.03		
Angry	0.73***	0.09	0.26***	0.05		
Anxious	0.62***	0.09	0.53***	0.10		
Neutral	41.58***	1.16	38.50***	1.24		
Residual Variances						
Happy	175.18***	3.49	289.43***	4.61		
Sad	1.65***	0.03	1.79***	0.03		
Angry	20.84***	0.42	5.90***	0.09		
Anxious	23.37***	0.46	21.24***	0.34		
Neutral	224.50***	4.49	328.41***	5.15		

Note: This table represents five different models with one model per emotion. Estimates are unstandardized. Lagged relations across children are bolded if they are less than the Bonferroni-corrected α of .001. Task differences are bolded if they are less than the Bonferroni-corrected α of .002. $i = interval$. * $p < .05$; ** $p < .01$; *** $p < .001$.

Table 3*Multi-Level Models of Cross-Lagged Relations Across Dyad Members Across Different Emotions*

Model for Happy and Sad										
	Search Tasks		Lagged Relations Diff. for Search Tasks		Planning Tasks		Lagged Relations Diff. for Planning Tasks		Task Difference	
	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD
Auto-Regressions Within Child										
Happy _i → Happy _{i+1}	0.51***	0.01			0.50***	0.01				
Sad _i → Sad _{i+1}	0.16***	0.01			0.15***	0.01				
Lagged Relations Across Children										
Happy _i → Sad _{i+1}	-0.00	0.00	-0.16	0.13	-0.00	0.00	-0.03	0.17	0.00	0.00
Sad _i → Happy _{i+1}	-0.16	0.13			-0.03	0.17			-0.14	0.22
Task Order										
Happy	0.49*	0.20			-1.10***	0.27				
Sad	-0.04*	0.02			0.01	0.02				
Intercepts										
Happy	3.48***	0.27			8.27***	0.38				
Sad	0.16***	0.03			0.08**	0.03				
Residual Variances										
Happy	175.47***	3.09			289.99***	4.82				
Sad	1.65***	0.03			1.79***	0.03				
Model for Happy and Angry										
	Search Tasks		Lagged Relations Diff. for Search Tasks		Planning Tasks		Lagged Relations Diff. for Planning Tasks		Task Difference	
	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD
Auto-Regressions Within Child										
Happy _i → Happy _{i+1}	0.51***	0.01			0.49***	0.01				
Angry _i → Angry _{i+1}	0.28***	0.01			0.11***	0.01				
Lagged Relations Across Children										
Happy _i → Angry _{i+1}	0.01***	0.00	0.06*	0.04	0.00	0.00	0.19*	0.09	0.01***	.00
Angry _i → Happy _{i+1}	0.07**	0.04			0.19*	0.09			-0.12	.10
Task Order										
Happy	0.48*	0.20			-1.13***	0.27				
Angry	0.14*	0.07			0.16***	0.04				
Intercepts										
Happy	3.39***	0.27			8.22***	0.38				
Angry	0.70***	0.10			0.24***	0.06				
Residual Variances										
Happy	175.44***	3.09			289.52***	4.80				
Angry	20.93***	0.41			5.90***	0.10				

Model for Happy and Anxious									
	Search Tasks		Lagged Relations Diff. for Search Tasks		Planning Tasks		Lagged Relations Diff. for Planning Tasks		Task Difference
	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate SD
Auto-Regressions Within Child									
Happy _i → Happy _{i+1}	0.51***	0.01			0.50***	0.01			
Anxious _i → Anxious _{i+1}	0.37***	0.01			0.38***	0.01			
Lagged Relations Across Children			0.01	0.03			0.00	0.05	
Happy _i → Anxious _{i+1}	0.00	0.00			-0.00	0.00			0.01 0.01
Anxious _i → Happy _{i+1}	0.02	0.03			0.00	0.05			0.01 0.06
Task Order									
Happy	0.50*	0.20			-1.10***	0.27			
Anxious	-0.01	0.08			-0.05	0.07			
Intercepts									
Happy	3.44***	0.27			8.27***	0.38			
Anxious	0.64***	0.10			0.58***	0.11			
Residual Variances									
Happy	175.47***	3.08			289.77***	4.80			
Anxious	23.45***	0.46			21.25***	0.37			
Model for Happy and Neutral									
	Search Tasks		Lagged Relations Diff. for Search Tasks		Planning Tasks		Lagged Relations Diff. for Planning Tasks		Task Difference
	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate SD
Auto-Regressions Within Child									
Happy _i → Happy _{i+1}	0.50***	0.01			0.48***	0.01			
Neutral _i → Neutral _{i+1}	0.51***	0.01			0.50***	0.01			
Lagged Relations Across Children			0.01	0.02			0.00	0.02	
Happy _i → Neutral _{i+1}	-0.02***	0.00			-0.03***	0.01			0.00 0.02
Neutral _i → Happy _{i+1}	-0.02*	0.01			-0.03***	0.01			0.01 0.01
Task Order									
Happy	0.45*	0.20			-1.03***	0.28			
Neutral	-0.58*	0.24			0.68**	0.30			
Intercepts									
Happy	5.06***	0.95			10.83***	1.03			
Neutral	44.84***	1.05			41.63***	1.20			
Residual Variances									
Happy	175.71***	3.07			289.56***	5.04			
Neutral	225.85***	4.45			328.82***	5.72			

Model for Sad and Angry										
	Search Tasks		Lagged Relations Diff. for Search Tasks		Planning Tasks		Lagged Relations Diff. for Planning Tasks		Task Difference	
	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD
Auto-Regressions Within Child										
Sad _i → Sad _{i+1}	0.16***	0.01			0.15***	0.01				
Angry _i → Angry _{i+1}	0.28***	0.01			0.11***	0.01				
Lagged Relations Across Children			-0.02	0.04			-0.02	0.03		
Sad _i → Angry _{i+1}	0.01	0.04			0.02	0.02			-0.00	0.05
Angry _i → Sad _{i+1}	-0.00	0.00			-0.00	0.01			-0.00	0.01
Task Order										
Sad	-0.03	0.02			0.01	0.02				
Angry	0.15*	0.07			0.15***	0.04				
Intercepts										
Sad	0.15***	0.03			0.07*	0.03				
Angry	0.81***	0.09			0.26***	0.05				
Residual Variances										
Sad	1.65***	0.03			1.79***	0.03				
Angry	20.98***	0.41			5.90***	0.10				
Model for Sad and Anxious										
	Search Tasks		Lagged Relations Diff. for Search Tasks		Planning Tasks		Lagged Relations Diff. for Planning Tasks		Task Difference	
	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD
Auto-Regressions Within Child										
Sad _i → Sad _{i+1}	0.16***	0.01			0.15***	0.01				
Anxious _i → Anxious _{i+1}	0.37***	0.01			0.38***	0.01				
Lagged Relations Across Children			0.00	0.05			-0.08*	0.05		
Sad _i → Anxious _{i+1}	0.00	0.05			0.09*	0.05			-0.08	0.06
Anxious _i → Sad _{i+1}	0.00	0.00			0.01	0.00			-0.00	0.01
Task Order										
Sad	-0.03*	0.02			0.01	0.02				
Anxious	-0.01	0.08			-0.04	0.07				
Intercepts										
Sad	0.14***	0.03			0.06*	0.03				
Anxious	0.67***	0.10			0.54***	0.10				
Residual Variances										
Sad	1.65***	0.03			1.79***	0.03				
Anxious	23.45***	0.46			21.23***	0.37				

Model for Sad and Neutral										
	Search Tasks		Lagged Relations Diff. for Search Tasks		Planning Tasks		Lagged Relations Diff. for Planning Tasks		Task Difference	
	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD
Auto-Regressions Within Child										
Sad _i → Sad _{i+1}	0.16***	0.01			0.15***	0.01				
Neutral _i → Neutral _{i+1}	0.51***	0.01			0.51***	0.01				
Lagged Relations Across Children			-0.15	0.14			0.08	0.18		
Sad _i → Neutral _{i+1}	0.15	0.14			-0.08	0.18			0.23	0.22
Neutral _i → Sad _{i+1}	0.00	0.00			0.00	0.00			0.00	0.00
Task Order										
Sad	-0.04*	0.02			0.01	0.02				
Neutral	-0.59*	0.25			0.72***	0.28				
Intercepts										
Sad	0.09	0.08			0.01	0.07				
Neutral	43.96***	1.00			40.48***	1.02				
Residual Variances										
Sad	1.65***	0.03			1.79***	0.03				
Neutral	225.22***	4.43			328.71***	5.71				
Model for Angry and Anxious										
	Search Tasks		Lagged Relations Diff. for Search Tasks		Planning Tasks		Lagged Relations Diff. for Planning Tasks		Task Difference	
	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD
Auto-Regressions Within Child										
Angry _i → Angry _{i+1}	0.28***	0.01			0.11***	0.01				
Anxious _i → Anxious _{i+1}	0.37***	0.01			0.38***	0.01				
Lagged Relations Across Children			0.00	0.02			-0.01	0.03		
Angry _i → Anxious _{i+1}	0.01	0.01			0.00	0.03			0.01	0.03
Anxious _i → Angry _{i+1}	0.02	0.01			-0.00	0.01			0.02	0.01
Task Order										
Angry	0.16*	0.07			0.14***	0.04				
Anxious	-0.01	0.08			-0.04	0.07				
Intercepts										
Angry	0.77***	0.09			0.28***	0.05				
Anxious	0.65***	0.10			0.54***	0.10				
Residual Variances										
Angry	21.00***	0.37			5.90***	0.10				
Anxious	23.44***	0.46			21.25***	0.37				

Model for Angry and Neutral										
	Search Tasks		Lagged Relations Diff. for Search Tasks		Planning Tasks		Lagged Relations Diff. for Planning Tasks		Task Difference	
	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD
Auto-Regressions Within Child										
Angry _{<i>i</i>} → Angry _{<i>i</i>+1}	0.27***	0.01			0.11***	0.01				
Neutral _{<i>i</i>} → Neutral _{<i>i</i>+1}	0.51***	0.01			0.51***	0.01				
Lagged Relations Across Children			0.10**	0.04			0.26**	0.10		
Angry _{<i>i</i>} → Neutral _{<i>i</i>+1}	-0.12***	0.04			-0.26**	0.10			0.14	0.10
Neutral _{<i>i</i>} → Angry _{<i>i</i>+1}	-0.02***	0.00			-0.00	0.00			-0.02***	0.00
Task Order										
Angry	0.14*	0.07			0.15***	0.04				
Neutral	-0.57*	0.25			0.77***	0.29				
Intercepts										
Angry	2.30***	0.30			0.35***	0.13				
Neutral	44.47***	1.01			40.64***	1.03				
Residual Variances										
Angry	20.91***	0.36			5.90***	0.10				
Neutral	225.04***	4.43			328.35***	5.71				
Model for Anxious and Neutral										
	Search Tasks		Lagged Relations Diff. for Search Tasks		Planning Tasks		Lagged Relations Diff. for Planning Tasks		Task Difference	
	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD	Estimate	SD
Auto-Regressions Within Child										
Anxious _{<i>i</i>} → Anxious _{<i>i</i>+1}	0.36***	0.01			0.38***	0.01				
Neutral _{<i>i</i>} → Neutral _{<i>i</i>+1}	0.51***	0.01			0.51***	0.01				
Lagged Relations Across Children			0.04	0.04			0.01	0.05		
Anxious _{<i>i</i>} → Neutral _{<i>i</i>+1}	-0.05	0.04			-0.01	0.05			-0.03	0.06
Neutral _{<i>i</i>} → Anxious _{<i>i</i>+1}	-0.01*	0.00			0.00	0.00			-0.01	0.00
Task Order										
Anxious	-0.01	0.07			-0.04	0.08				
Neutral	-0.60*	0.25			0.73***	0.29				
Intercepts										
Anxious	1.17***	0.31			0.52*	0.24				
Neutral	44.09***	1.01			40.50***	1.03				
Residual Variances										
Anxious	23.45***	0.40			21.25***	0.35				
Neutral	225.25***	4.43			328.70***	5.71				

Note: Estimates are unstandardized. Lagged relations across children are bolded if they are less than the Bonferroni-corrected α of .001. Lagged relations differences are bolded if they are less than the Bonferroni-corrected α of .0025. Task differences are bolded if they are less than the Bonferroni-corrected α of .002. SD = posterior standard deviation; Diff. = Difference; *i* = interval.

* $p < .05$; ** $p < .01$; *** $p < .001$.

Table 4*Interpretation of Cross-Lagged Relations in Multi-level Models of Emotion Transmission in Peer Dyads*

	Search Tasks		
	Cross-Lagged Relations	Direction	Interpretation
Escalation of Positive Emotion	$\text{Happy}_i \rightarrow \text{Happy}_{i+1}$	+	The more happiness a child expresses in one interval, the more happiness and the less neutral emotion their partner expresses in the next interval
	$\text{Happy}_i \rightarrow \text{Neutral}_{i+1}$	-	
Escalation of Negative Emotion	$\text{Angry}_i \rightarrow \text{Angry}_{i+1}$	+	The more anger a child expresses in one interval, the more anger and the less neutral emotion their partner expresses in the next interval
	$\text{Angry}_i \rightarrow \text{Neutral}_{i+1}$	-	
	$\text{Anxious}_i \rightarrow \text{Anxious}_{i+1}$	+	The more anxiety a child expresses in one interval, the more anxiety their partner expresses in the next interval
De-Escalation of Negative Emotion	$\text{Neutral}_i \rightarrow \text{Angry}_{i+1}$	-	The more neutral emotion a child expresses in one interval, the less anger and the more neutral emotion their partner expresses in the next interval
	$\text{Neutral}_i \rightarrow \text{Neutral}_{i+1}$	+	
Unexpected Findings	$\text{Happy}_i \rightarrow \text{Angry}_{i+1}$	+	The more happiness a child expresses in one interval, the more anger their partner expresses in the next interval
	Planning Tasks		
	Cross-Lagged Relations	Direction	Interpretation
Escalation of Positive Emotion	$\text{Happy}_i \rightarrow \text{Happy}_{i+1}$	+	The more happiness a child expresses in one interval, the more happiness and the less neutral emotion their partner expresses in the next interval
	$\text{Happy}_i \rightarrow \text{Neutral}_{i+1}$	-	
De-Escalation of Positive Emotion	$\text{Neutral}_i \rightarrow \text{Happy}_{i+1}$	-	The more neutral emotion a child expresses in one interval, the less happiness and the more neutral emotion their partner expresses in the next interval
	$\text{Neutral}_i \rightarrow \text{Neutral}_{i+1}$	+	

Note: This table only includes lagged relations across children below the Bonferroni-corrected α of .001.