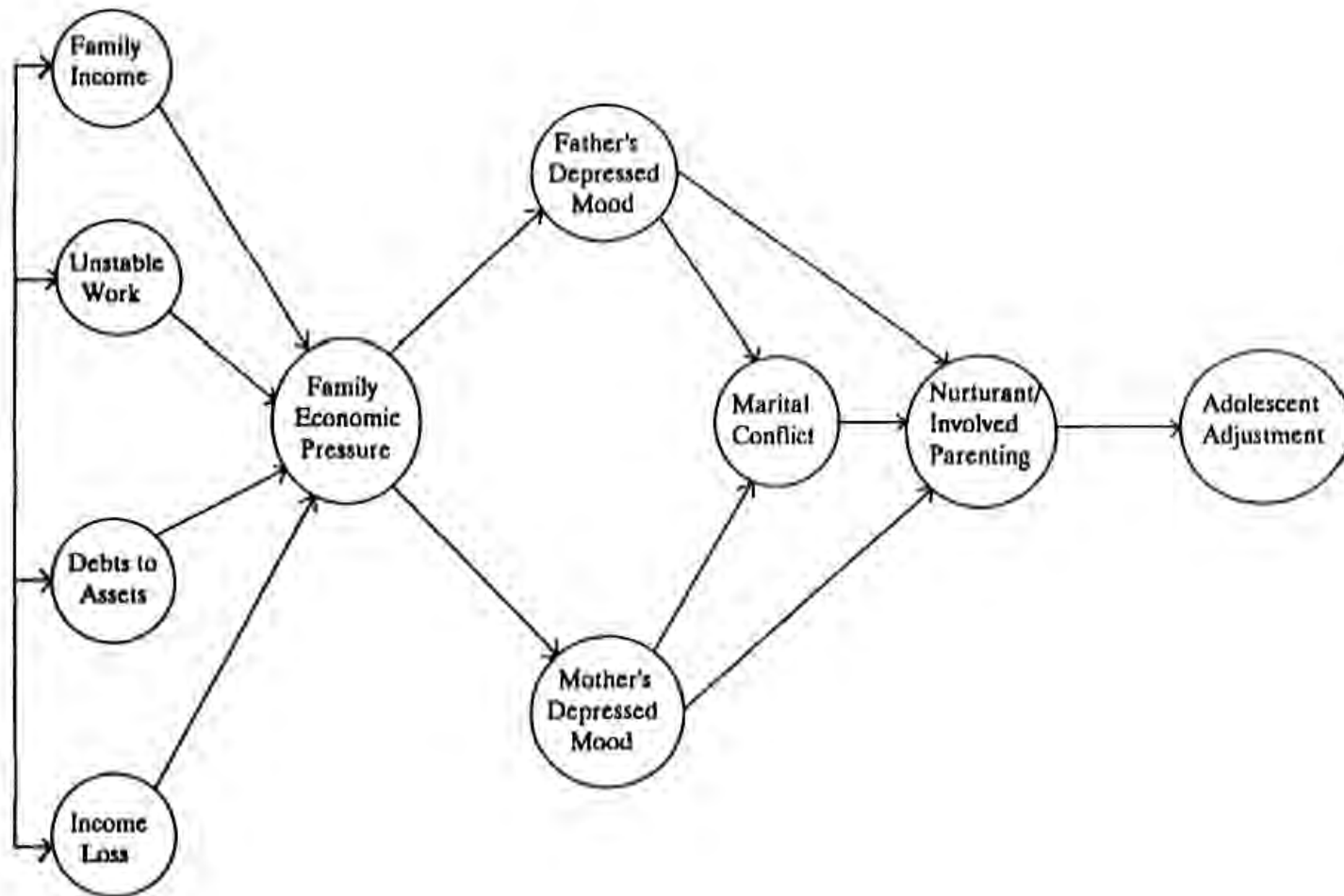Purdue University
Center for Families
Research on Dyads and Families
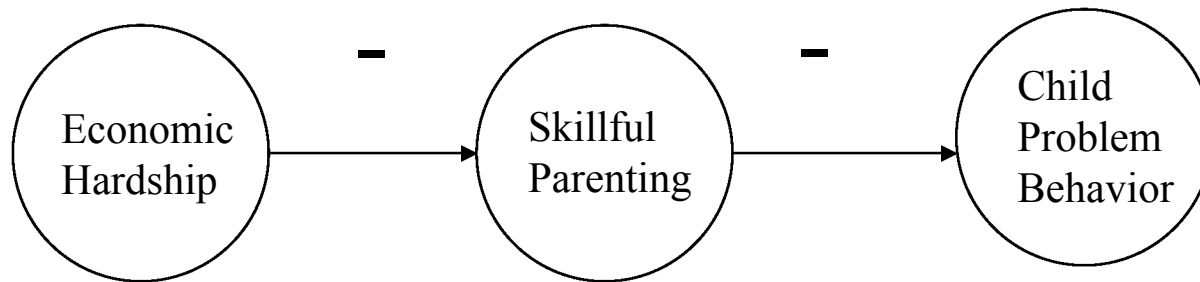May 18-19, 2010

Niall Bolger

Columbia University

Day 1:

Design and Analysis of Daily Diaries

Example: Economic Stress and Child Wellbeing (Conger et al., 1993)

Simplified Version

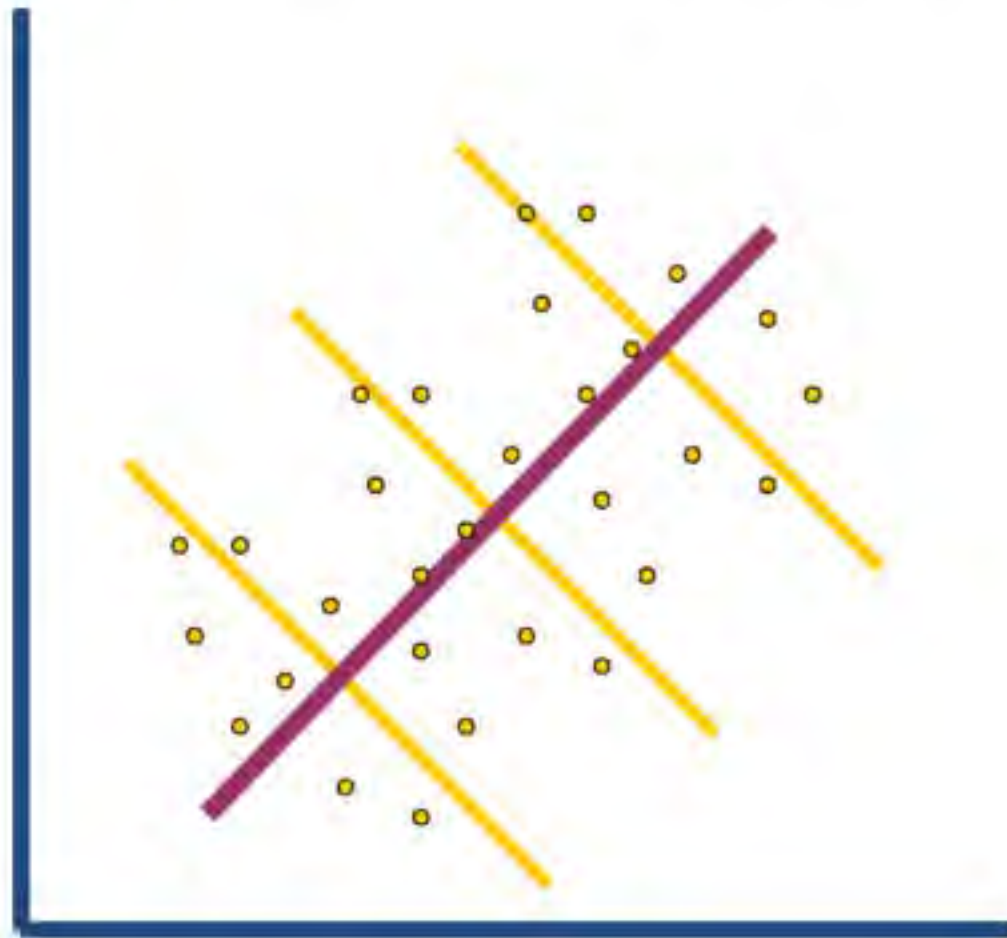# Different Levels, Different Questions

- **Between-subjects question**:
  - Are **families** who experience economic hardship more likely than **those who do not** to show unskillful parenting? Irrespective of economic hardship, are those **families** who show unskillful parenting more likely than **those who do not** to have children who show problem behaviors?

Different Levels, Different Questions

- **Within-subjects question**:
  - On **occasions when a family** experiences economic hardship, are the parents more likely to show unskillful parenting than on **occasions when they do not?**. Irrespective of their current economic hardship, **on occasions when families** show unskillful parenting, are their children more likely to show problem behaviors than **on occasions when they do not**?

Negative Within-person; Positive Between-person

Different Slopes, Different Folks
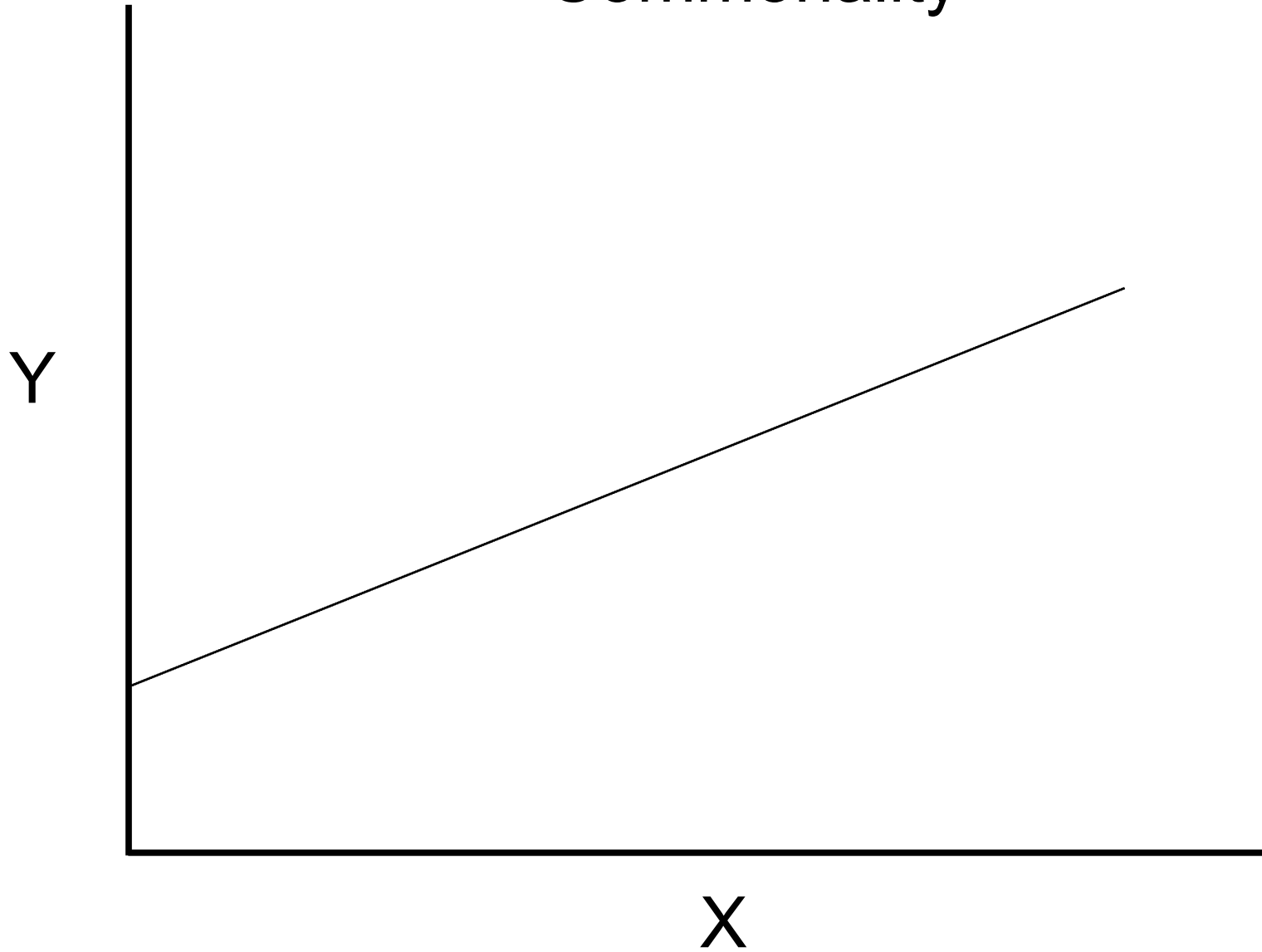
- **Commonality question**: What is the effect of economic hardship on child problem behavior, e.g., Cohen's d = .5 *SD* units?

- **Heterogeneity question**: How much do families (Level-2 units) differ in the extent to which economic hardship affects child problem behavior, e.g., is it d = 1.0 for half the sample and d=0.0 for the other half?

Commonality

Heterogeneity
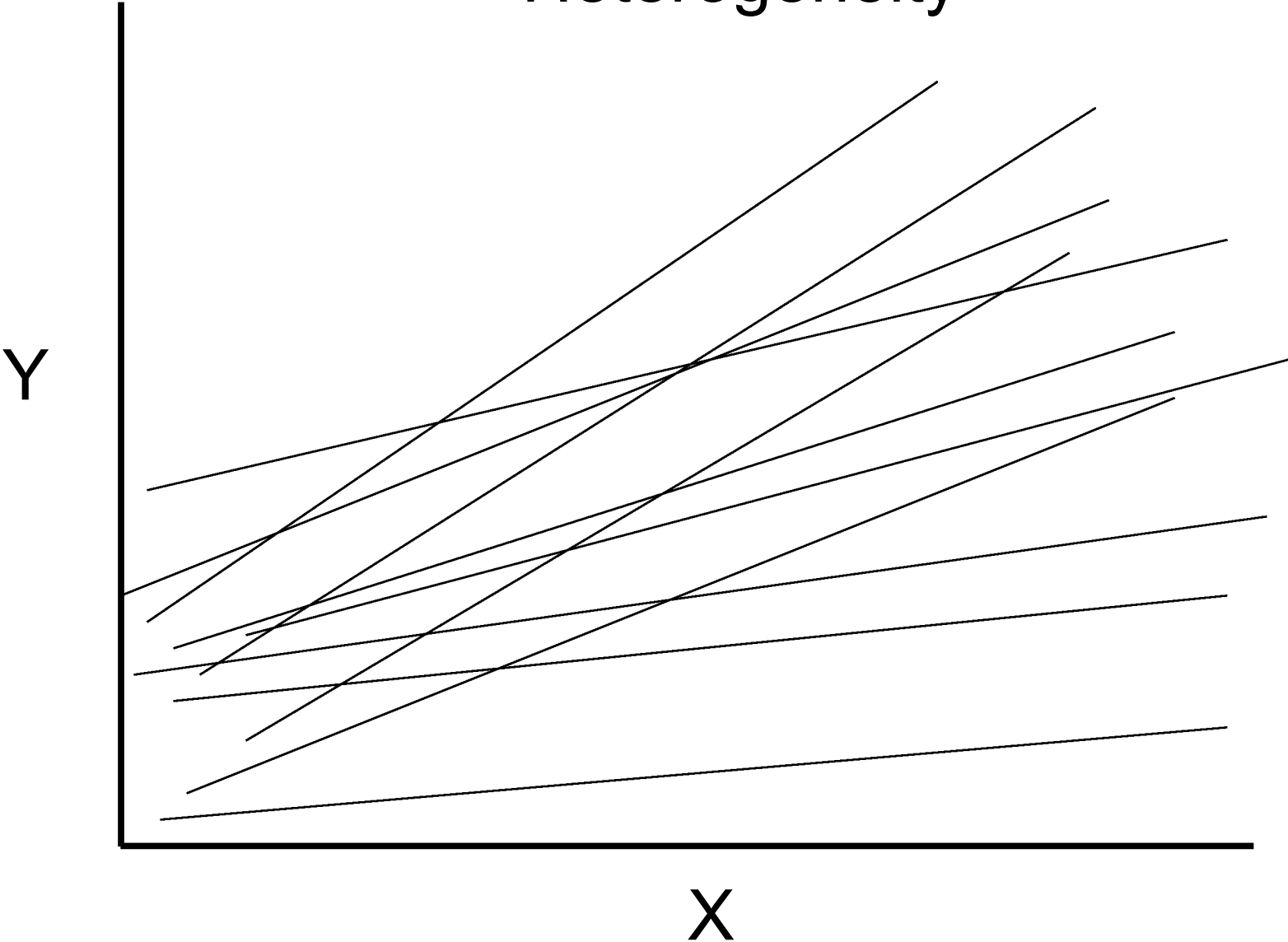
Mediating Processes
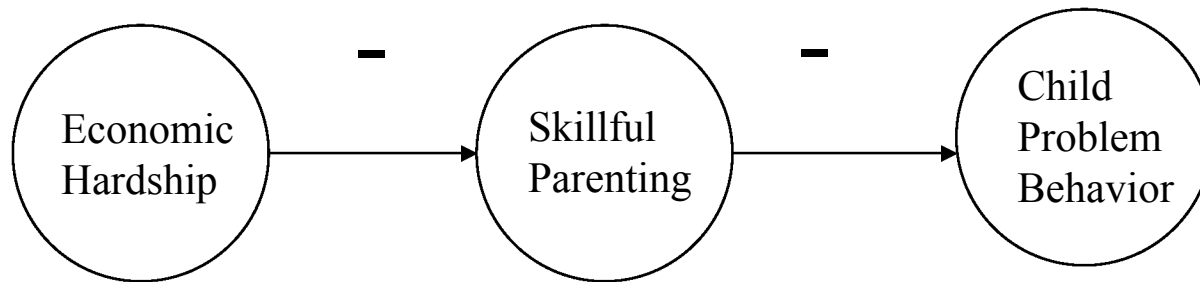
Mediating Processes

- **Commonality question**: How much does (un-) skillful parenting mediate the economic hardship → child problem behavior relationship, e.g. 50%?

- **Heterogeneity question**: How much do families vary in the extent to which (un-)skillful parenting mediates the relationship, e.g., is there complete mediation for half the sample, and no mediation for the other half?

Diary Designs

- Especially fixed-interval designs (daily, weekly, monthly)

- Where the X and Y vary over the intervals

- Can distinguish
  - Between vs. Within subjects relationships
  - Commonality vs. heterogeneity of relationships

Example Diary Study

- 66 Couples
- 28 consecutive days (4 weeks)
- Female partners' data only (for today's presentation)
- Daily measures of
  – Relationship conflict
  – Emotional intimacy
- Research Question: To what do daily conflict affect intimacy and does this differ depending on the quality of the relationship

First things first: Time course of DV: Daily emotional intimacy
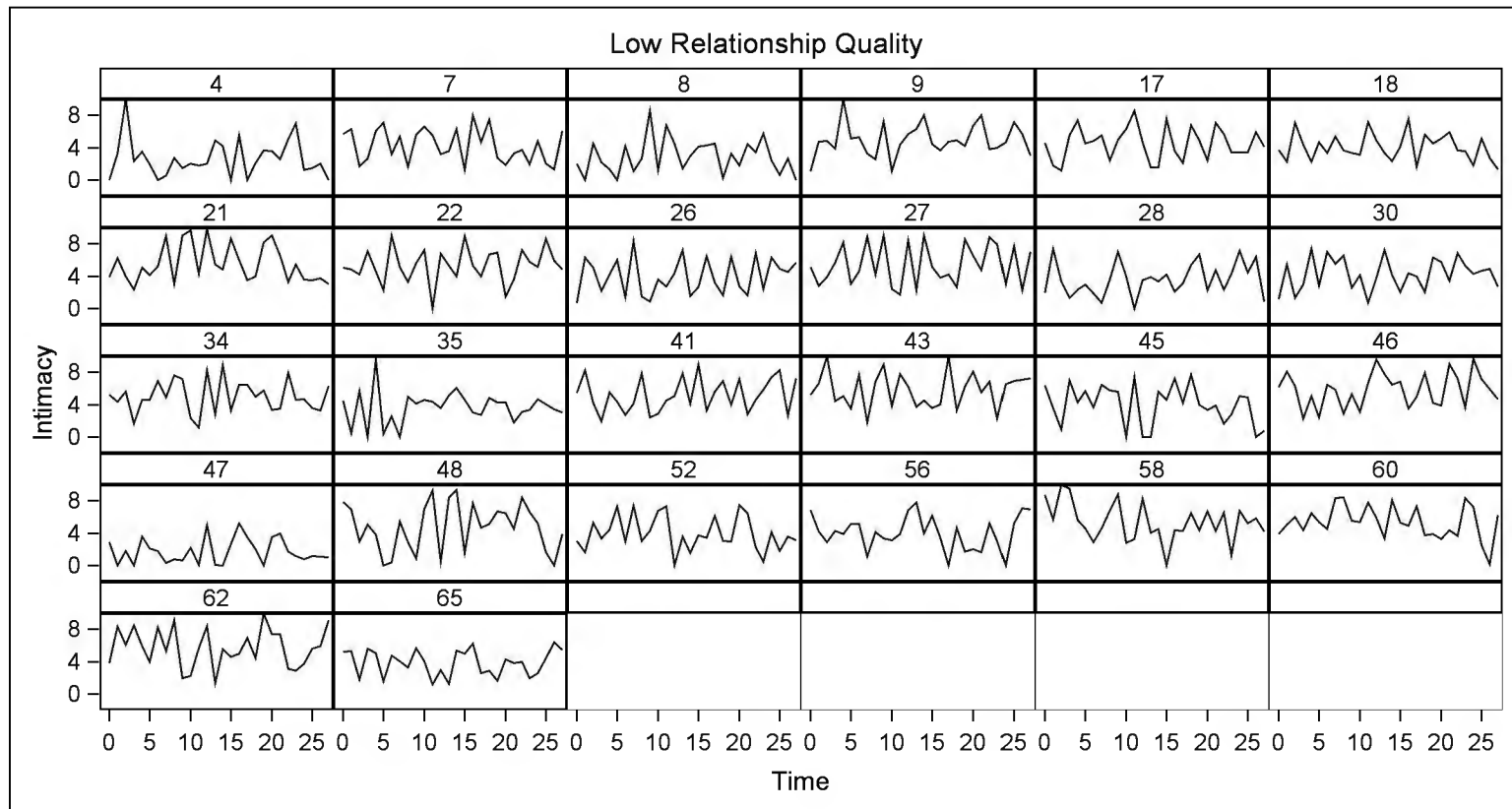
SAS Commands

```
proc sgpanel data=lowrq NOAUTOLEGEND;
 panelby id/columns=6 rows=5 novarname;
 series x = time y = y /LINEATTRS = (pattern = 1 color = black);
```

First things first: Time course of DV
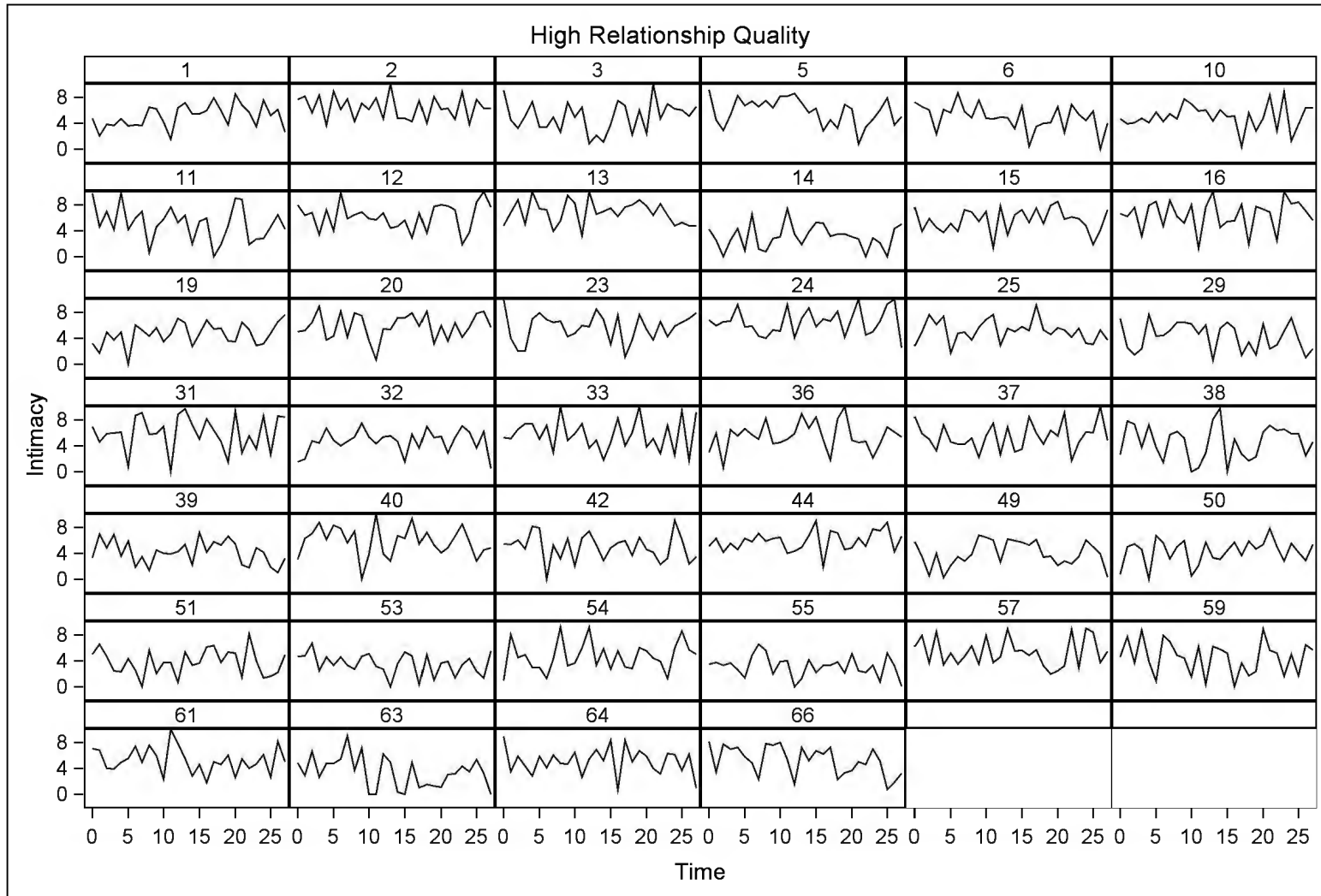
Time course of IV:
Daily relationship conflicts
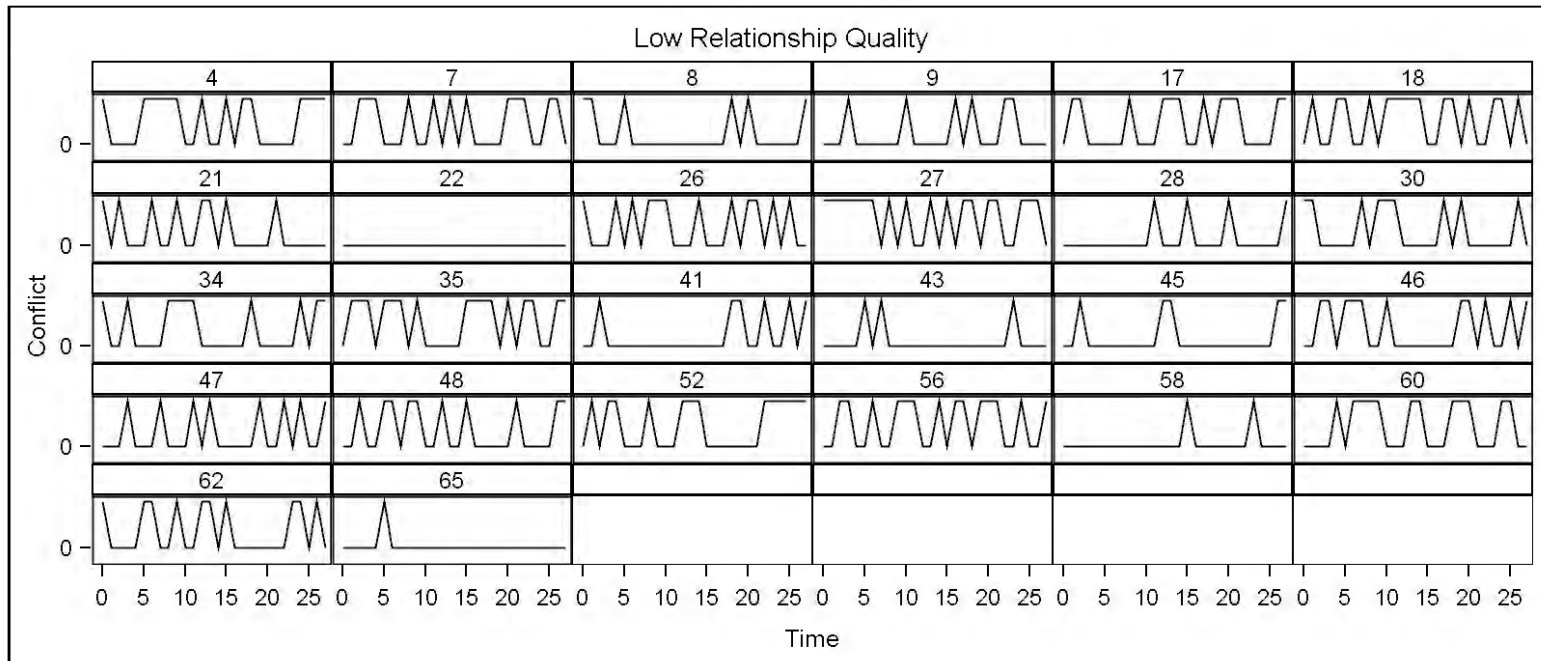
Time course of IV:
Daily relationship conflicts
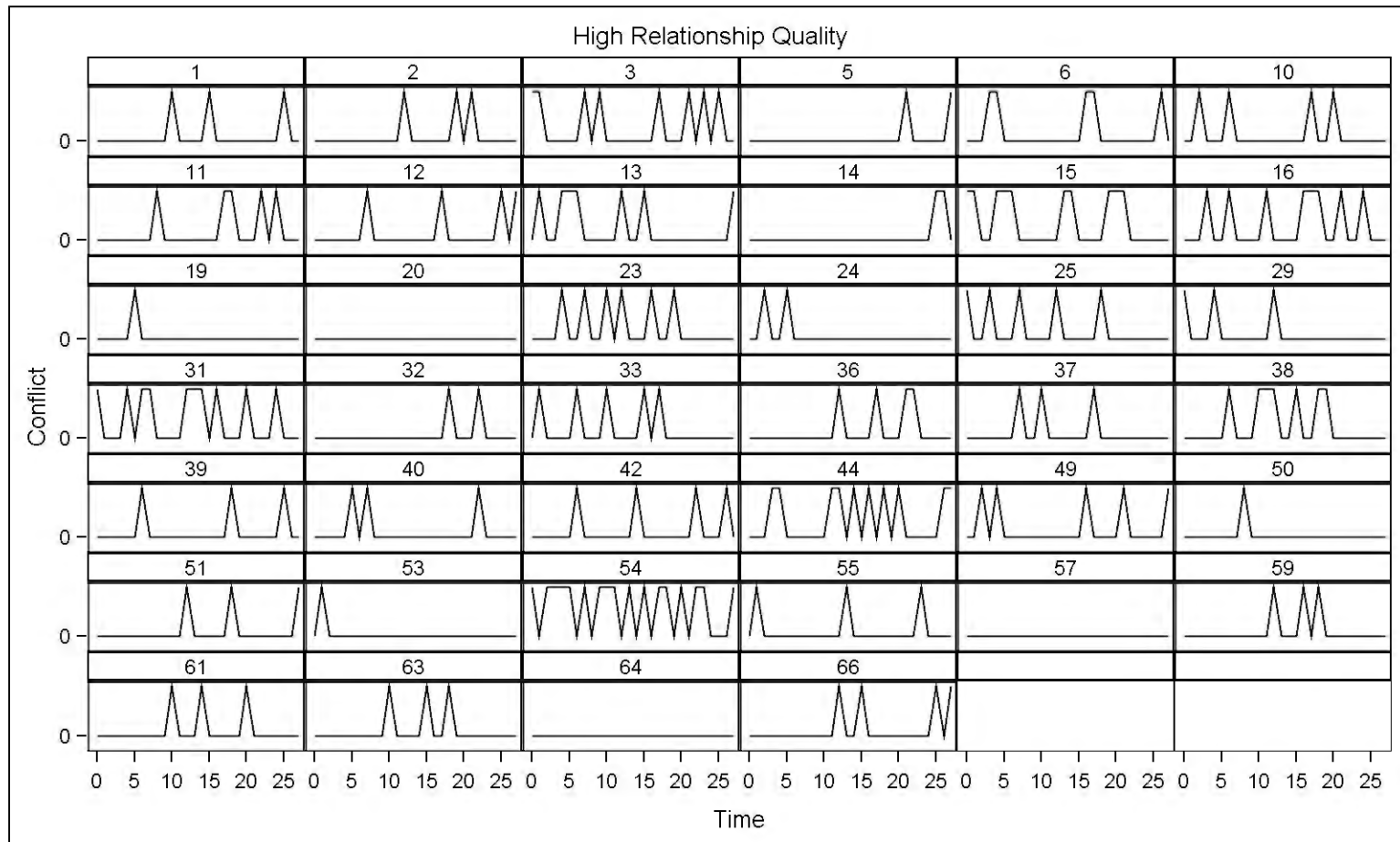
Nonindependencies in Diary Data: I. Person-Level Nonindependence

- In your overall dataset there are lots of mini-datasets, each from a different person

- So person is a source of nonindependence

- Need to allow for:
  - Different intercepts for each person
  - Different slopes for each person

II. Temporal Nonindependence

- Each person is moving forward in time
- We need to start by examining the temporal process and model it correctly
  - Include elapsed time as a predictor
  - Weekday vs. weekend
  - Allow for residual nonindependence, e.g., allow adjacent residuals to correlate.

Data Matrix

Obs.	ID	Day	Conf	Intimacy	RQ	MConf	day7c	MConfc
1	1	0	0	4.78	1	0.30356	-1.92857	0.08669
2	1	1	0	2.07	1	0.30356	-1.78571	0.08669
3	1	2	1	3.80	1	0.30356	-1.64286	0.08669
4	1	3	0	3.69	1	0.30356	-1.50000	0.08669
5	1	4	0	4.65	1	0.30356	-1.35714	0.08669
6	1	5	1	3.61	1	0.30356	-1.21429	0.08669
7	1	6	1	3.78	1	0.30356	-1.07143	0.08669
8	1	7	0	3.68	1	0.30356	-0.92857	0.08669
9	1	8	0	6.47	1	0.30356	-0.78571	0.08669
10	1	9	0	6.19	1	0.30356	-0.64286	0.08669
Etc.	.	.	.	.	.	.	.	.
Etc.	.	.	.	.	.	.	.	.

SAS Commands

```
proc mixed covtest data=int.conflictF3 method=reml cl;
class id time;
model y=conflict rq conflict*rq meanconfc weekc/solution cl outp=yp
outpm=ypm ddf=59, 63, 59, 63, 63;
random int conflict/subject=id type=un s g gcorr;
repeated time/subject=id type=ar(1);
```

Results: Intimacy as a function of daily conflict
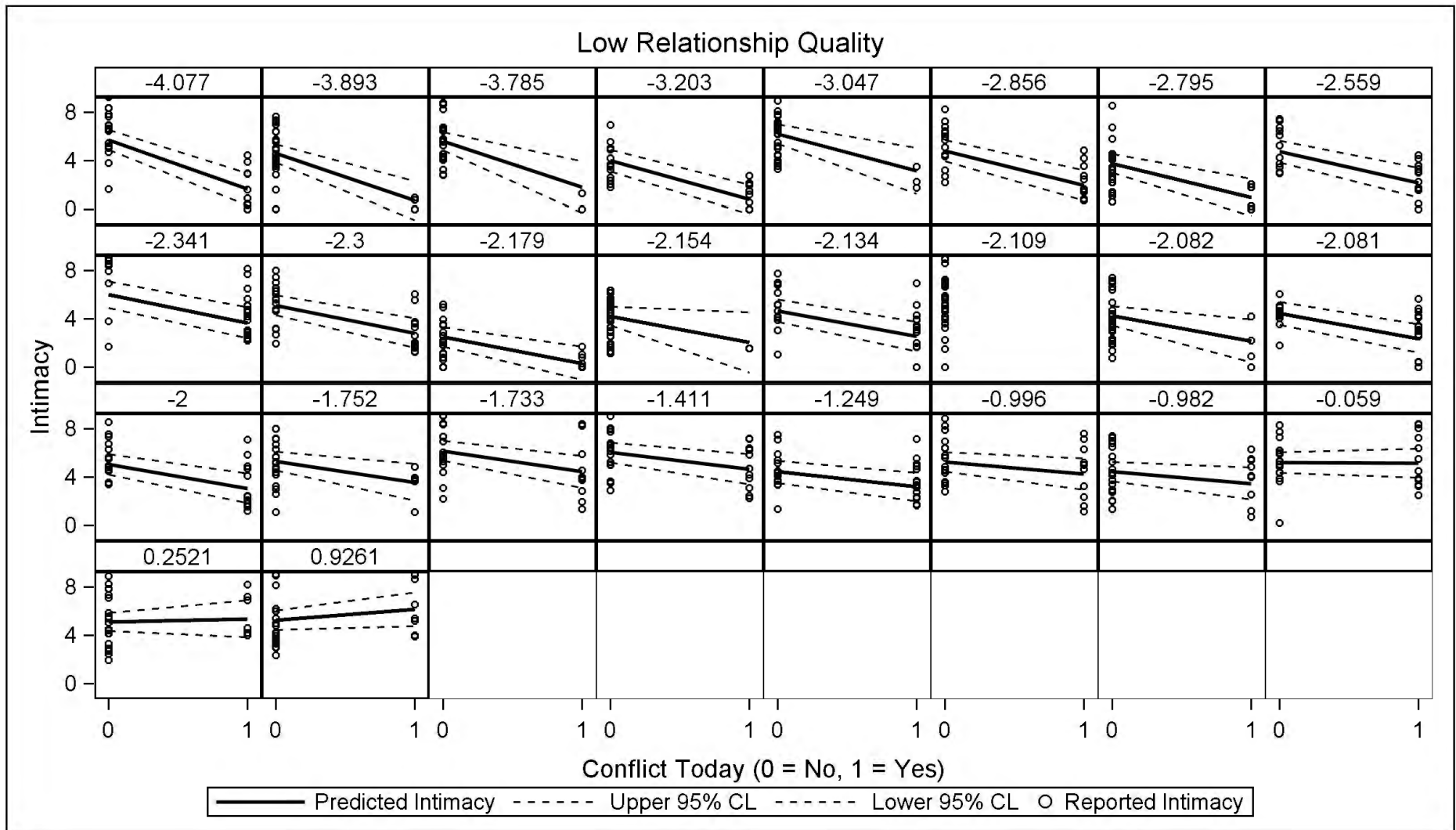
Results: Intimacy and daily conflict

Spaghetti Plots

| 0:LoRQ | 1:HiRQ |

Separating Levels of Analysis

Obs.	ID	Day	Conf	Intimacy	RQ	MConf	day7c	MConfc
1	1	0	0	4.78	1	0.30356	-1.92857	0.08669
2	1	1	0	2.07	1	0.30356	-1.78571	0.08669
3	1	2	1	3.80	1	0.30356	-1.64286	0.08669
4	1	3	0	3.69	1	0.30356	-1.50000	0.08669
5	1	4	0	4.65	1	0.30356	-1.35714	0.08669
6	1	5	1	3.61	1	0.30356	-1.21429	0.08669
7	1	6	1	3.78	1	0.30356	-1.07143	0.08669
8	1	7	0	3.68	1	0.30356	-0.92857	0.08669
9	1	8	0	6.47	1	0.30356	-0.78571	0.08669
10	1	9	0	6.19	1	0.30356	-0.64286	0.08669
Etc.	.	.	.	.	.		.	.
Etc.	.	.	.	.	.		.	.

SAS Commands: Separating Levels
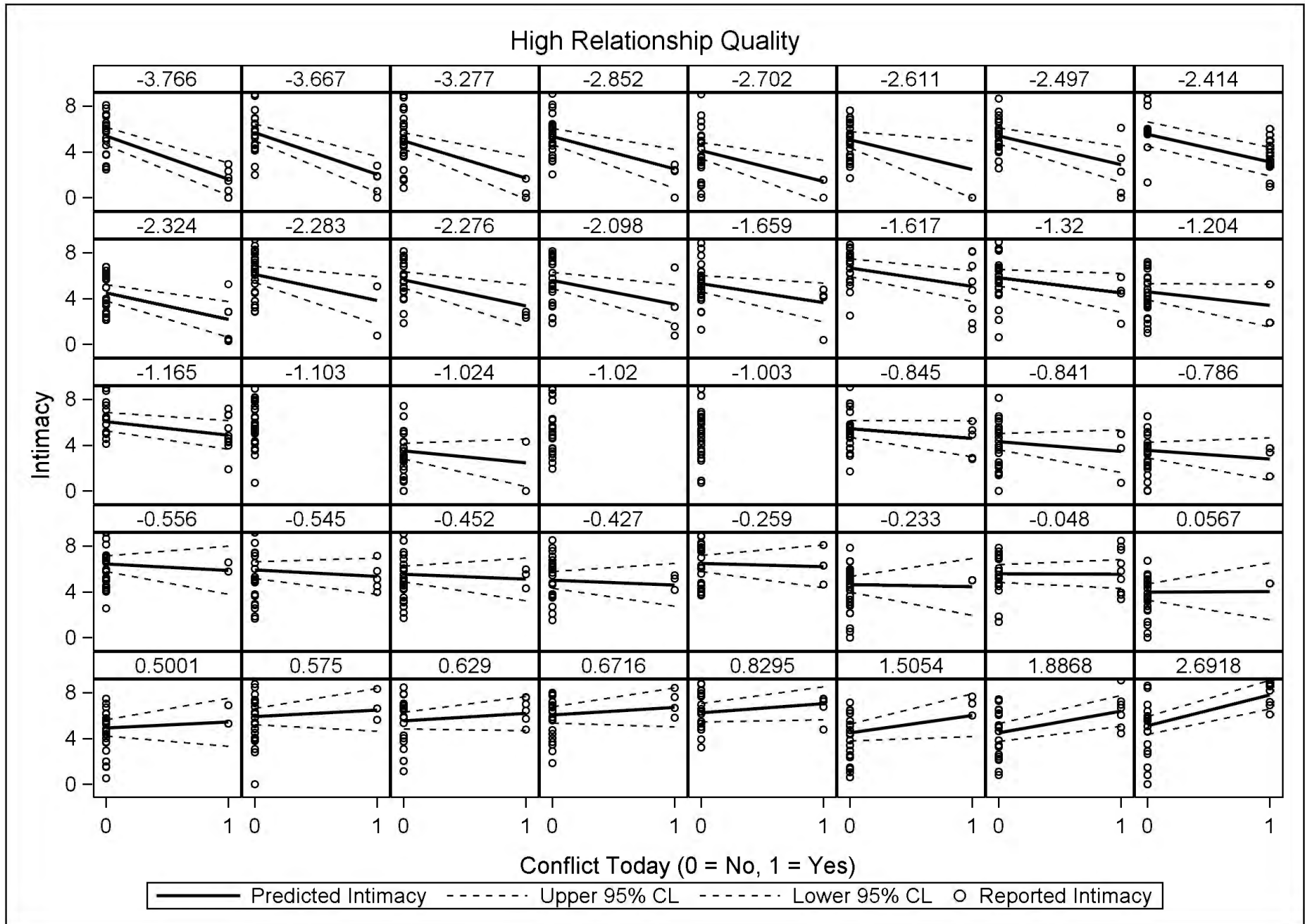
```
proc mixed covtest data=int.conflictF3 method=reml cl;
class id time;
model y=conflict rq conflict*rq meanconfc weekc/solution cl outp=yp
outpm=ypm ddf=59, 63, 59, 63, 63;
random int conflict/subject=id type=un s g gcorr;
repeated time/subject=id type=ar(1);
```
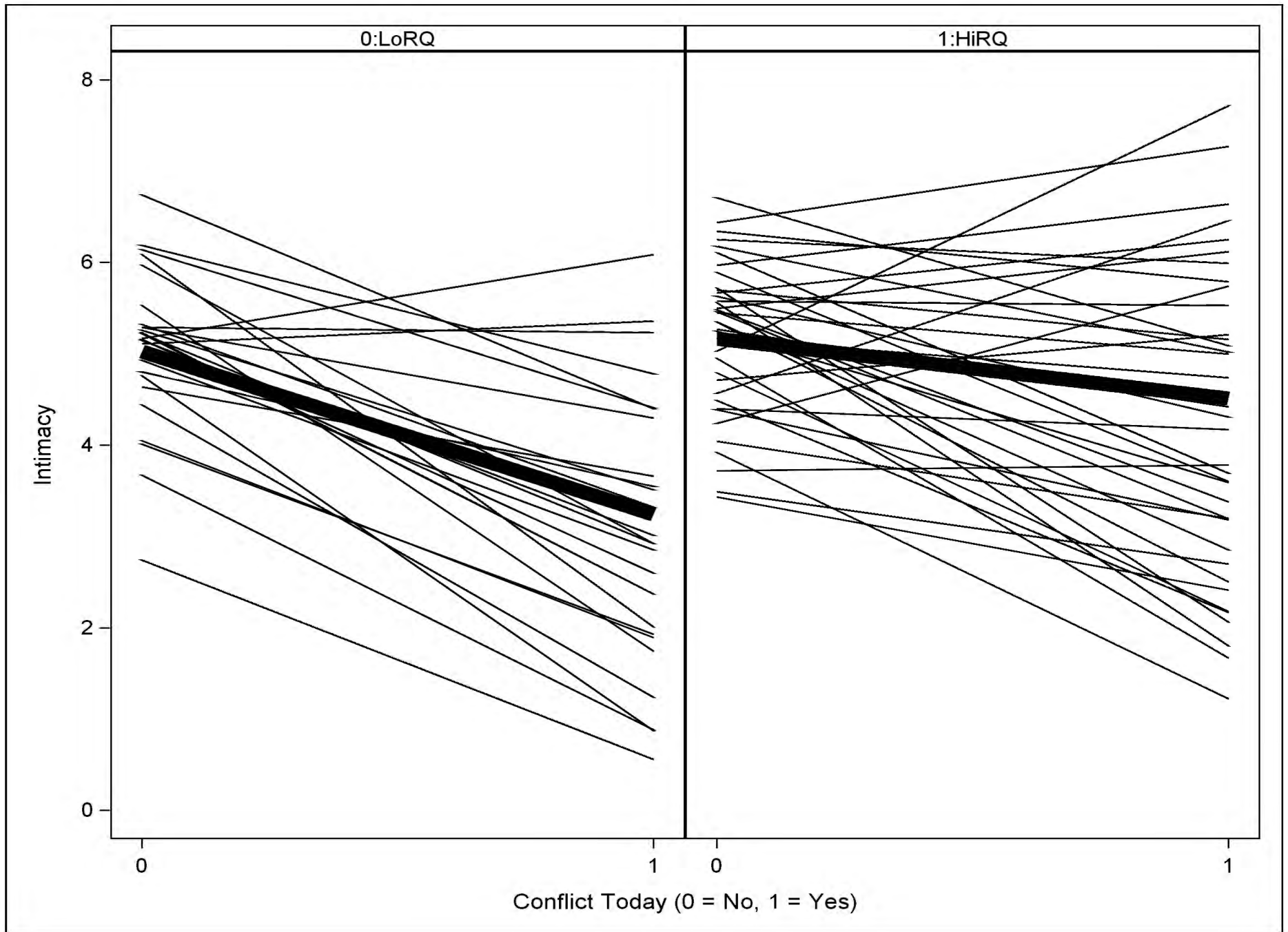
SAS Commands: Managing Time

```
proc mixed covtest data=int.conflictF3 method=reml cl;
class id time;
model y=conflict rq conflict*rq meanconfc weekc/solution cl outp=yp
outpm=ypm ddf=59, 63, 59, 63, 63;
random int conflict/subject=id type=un s g gcorr;
repeated time/subject=id type=ar(1);
```

Example of APA-Style Write-Up of Conflict Data

Sample Write-up for Conflict Dataset

In sum, the key hypothesis to be tested is whether relationship quality is a moderator of the impact of daily conflicts on intimacy.

Method

Sample

The sample consisted of sixty-six women in a cohabiting intimate relationship. Fifty eight of these were in an opposite-sex relationship and eight were in a same-sex relationship. The women had a mean age of 26.2 years ($SD = 3.1$). The racial breakdown in order of size was White ($n = 38$, 64%), Asian ($n = 12$, 16%), Hispanic ($n = 8$, 12%), and Black ($n = 8$, 8%).

Measures

Daily conflict. Conflict was measured each day by the following diary question: "Did you experience any tension or disagreement with your partner today." A "No" answer was coded 0 and a "Yes" answer was coded 1.

Daily intimacy. The 6-item Reis and Shaver Intimacy Scale was used (Reis & Shaver, 2000). Raw scores were rescaled to a 0-10 interval, such that 0 was the lowest possible score and 10 was the highest possible score. Summary statistics for intimacy over participants and time were: $M = 4.8$, $SD = 2.3$, range $= 0 - 10$.

Relationship quality. Participants completed the single item measure of how globally satisfied they felt about their relationship. The question was "Overall, how satisfied are you with your relationship with [intimate partner]". The response options were (with ns in parentheses): 5= best I could ever imagine a relationship being ($n = 10$), 4 = extremely satisfied ($n = 18$), 3 moderately satisfied ($n = 12$), 2 = a bit dissatisfied ($n = 19$), 1 = very dissatisfied ($n = 7$). A dichotomous (0, 1) version used in the analyses was created by combining code 3, 4 and 5 into a high relationship quality group ($n = 40$, 61%) and codes 2 and 1 into a low-relationship quality group ($n = 26$, 39%).

Example of APA-Style Write-Up of Conflict Data

Participants were recruited using flyers on a university campus. They responded to the flyers by email or by phone. They completed an on-line background questionnaire and online nightly diaries for 28 consecutive days.

Results

Preliminary analyses

The analysis dataset consisted of 66 (couples) x 28 (days) = 1,848 observations. Inspection of scatterplots person by person indicated that four of the couples did not report any relationship conflicts on any of the 28 diary days. These persons, therefore could not contribute to the estimation of within-person reactivity to conflicts nor to relationship quality differences in this within-person relation. The scatterplots did not reveal any outliers in the dataset. Other than weekday-weekend differences (more intimacy on weekends), there were no apparent time trends in the data. Further, because including temporal effects did not alter the substantive results, we omit these from the statistical model reported next. Reports of conflict varied both between-persons and within-persons; because we wished to estimate within-person relationships we controlled for between-person mean conflict in the analyses to be reported (Raudenbush & Bryk, 2002). Finally, although there were too few same-sex couples to examine them separately, when the analyses reported below were rerun with women in opposite-sex only, the results were substantively unchanged.

Main analyses

We analyzed our data using a multilevel model that specified a within-subject process of reactivity to daily conflicts that we predicted would be stronger for those in low-quality as opposed to high-quality relationships. The results are presented in Figures 10.3 and 10.4 and Table 10.2. Figure 10.3 shows fitted regression lines for each individual in the low- and high-RQ groups together with thick fitted lines for the average person in each group. Visual inspection of the thick lines suggests that our prediction was borne out: The slope for the low relationship quality group is steeper than it is for the high quality group.

For a statistical test of the hypothesis we turn to the upper panel of Table 10.2, labeled fixed effects. First, note that time in weeks and mean conflict are included in the analyses as control variables; this means that any central results cannot be artifacts of temporal changes or

Example of APA-Style Write-Up of Conflict Data

between subject differences in average number of conflicts over the diary recording period. Regarding the central analyses, because both conflict and relationship quality were dummy-coded (0, 1), (a) the intercept estimated the level of daily intimacy for no-conflict days for women in low-quality relationships, (b) the coefficient for conflict estimated the difference in intimacy between no-conflict and conflict days for women in low-quality relationships, (c) the coefficient for relationship quality estimated the intimacy difference between women in low and high-quality relationships on no-conflict days, and (d) the coefficient for the conflict by relationship quality interaction estimated the difference in the conflict coefficient between women in low- and high-quality relationships.

On no-conflict days, there were no group differences in intimacy. On average, women in low- and high-quality relationships reported intimacy levels of approximately 5 units, that is, at the middle of the 0-10 scale. On conflict days, women in low-quality relationships were, on average, 2.0 units lower in intimacy than they were on no-conflict days (95% CI: -2.8, -1.3; all subsequent CIs are 95%). Women in high-quality relationships showed a conflict difference of half that amount: $-2.03 + 1.04 = -1.0$ units (CI: -1.6, -0.3).

As Figure 10.3 shows, there was substantial between-person variability in slopes and intercepts in the both the low and high RQ groups. The lower panel of Table 10.2 presents numerical estimates and statistical tests of this variability. These are reported as variances and covariances. Both the intercept and the conflict coefficients show substantial and statistically significant variability. Expressed as a standard deviation, the variation for the conflict slopes is $\sqrt{2.78} = 1.7$ units, which, assuming a normal distribution in the population, implies that 95% of the population are with $\pm$ 3.3 units of the typical value for their group.

To better comprehend the size of this heterogeneity for the conflict reactivity slopes, it is useful to calculate how much overlap it implies between distributions of the low- and high-RQ groups (Cohen, 1988). With mean conflict reactivities of -2.0 and -1.0 units, respectively, and a common standard deviation of $\sqrt{2.78} = 1.7$ units, there is a 62% overlap between the distributions of the two groups. At the same time, there is appreciable between group separation: The patterns of means and standard deviations imply that 73% of participants in the females in the high-

Example of APA-Style Write-Up of Conflict Data

Table 10.2

Estimates for multilevel model of intimacy as a function of daily conflict and relationship quality (N=66 persons, 28 days).

Fixed effects (intercept, slopes)	Estimate	(SE)	t	p[b]	95% CI	
					Lower	Upper
Intercept	4.94	(0.21)	25.95	<.001	4.52	5.35
Week (7 days)	-0.03	(0.04)	-0.72	0.48	-0.10	0.05
Conflict	-2.03	(0.37)	-5.41	<.001	-2.77	-1.28
Relationship Quality[c]	0.37	(0.28)	1.32	0.192	-0.19	0.92
Conflict by RQ	1.04	(0.50)	2.09	0.041	0.04	2.03
Conflict Mean	1.64	(0.93)	1.77	0.082	-0.22	3.49

Random Effects ((co-)variances)	Estimate	(SE)	z	p[b]	95% CI[d]	
					Lower	Upper
Level 2: between-person						
Intercept	0.77	(0.16)	4.66	<.001	0.53	1.23
Conflict	2.78	(0.68)	4.08	<.001	1.81	4.80
Intercept & Conflict	-0.12	(0.25)	-0.49	0.626	-0.60	0.36
Level 1: within-person						
Residual	3.58	(0.12)	29.34	<.001	3.35	3.83
Autocorrelation	-0.047	(0.025)	-1.87	0.062	-0.096	0.002

Note: [a]The degrees of freedom were set at 66-3=63 for tests on the intercept and relationship quality. Because there were four participants who had no variation in daily conflict, the degrees of freedom were set at 66-3-4=59 for conflict and conflict by rq. [b]All *p* values are two-tailed except in the case of variances, where one-tailed *p*-values are used (because variances are constrained to be non-negative). [c]Relationship Quality is coded 0 for those in low-quality relationships and 1 for those in high-quality relationships. [d]Confidence intervals for variances were computed using the Satterthwaite method (see Milliken et al, 2006).

Example of APA-Style Write-Up of Conflict Data

Figure 10.3. Spaghetti plots of average (bold) and individual fitted lines representing the effect of conflict on daily intimacy for females partners high (right panel) and low (left panel) in global relationship quality.
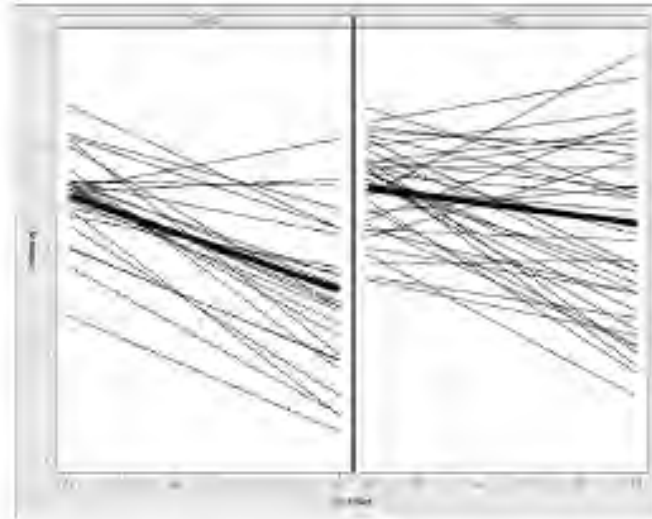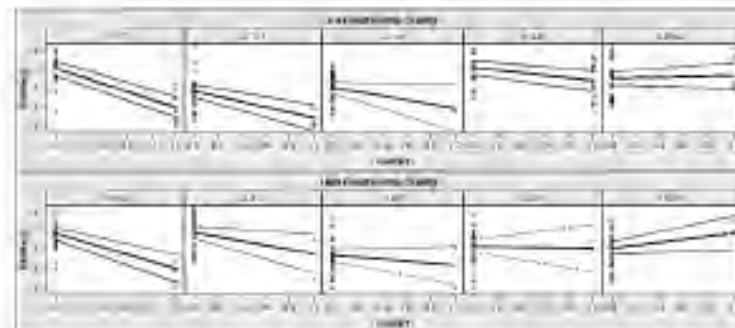

Figure 10.4 Plots of raw data and fitted lines representing effect of conflict on daily intimacy for five selected low (upper panel) and high (lower panel) global relationship women. The 95% confidence intervals for each slope are also shown.

Summary:
Diary data on individuals allow you to

- Distinguish within-person processes from between-person differences

- To allow for, and examine predictors of, heterogeneity in within-person processes
  - You don't need to know ahead of time what the sources of the heterogeneity is.

- Allowing for these differences solves the nonindependence problem

- Temporal nonindependence is also important and must be accounted for in the analyses

Tomorrow: Everything Gets Harder (But Also More Interesting)

- We have three sources of nonindependence:
  - Dyad
  - Person within dyad
  - Time within person within dyad
- We have between dyad and within-dyad heterogeneity
- We have correlated heterogeneity: e.g., if a female partner is reactive to daily stressors, does that mean that her male partner will tend to be similar to her?

That's all for now