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# Hierarchical Linear Modeling Analysis of Change in Maternal Knowledge Over the Transition to Adolescence

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**Amber M. Grundy<sup>1</sup>, Dawn M. Gondoli<sup>1</sup>,  
and Elizabeth H. Blodgett Salafia<sup>1</sup>**

## **Abstract**

Change in maternal knowledge over the transition to adolescence was assessed using hierarchical linear modeling (HLM). In addition, maternal warmth, behavior control, and adolescent delinquency were considered as predictors of knowledge as well as time-varying covariates. Five years of self-report data were collected from 159 mothers and their early adolescents, beginning when the adolescents were in fourth grade. The results indicated that there was a significant mean decrease in maternal knowledge over time for both mother and adolescent reports. In addition, the data followed a quadratic trend, which was necessary to account for the slight increase in knowledge from T1 to T2. Maternal warmth, but not maternal behavior control, was a consistent predictor of the knowledge trajectory. Adolescent delinquency also predicted change in knowledge over time. Adolescent gender, mother's T1 marital status, and change in mother's marital status were not significant predictors. The study makes several important contributions, including examining knowledge across the transition to adolescence and considering a number of predictors of the knowledge trajectory.

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<sup>1</sup>University of Notre Dame

## **Corresponding Author:**

Amber M. Grundy, 118 Haggard Hall, Department of Psychology, University of Notre Dame, IN 46556

Email: [amber.grundy@gmail.com](mailto:amber.grundy@gmail.com).

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Past research has indicated that there are strong and consistent associations between low parental knowledge and negative child and adolescent outcomes (see Crouter & Head, 2002, for review). As a result of these studies, we believe that maintaining high parental knowledge is an important aspect of parenting during late middle childhood and early adolescence, yet some authors have hypothesized that knowledge is likely to decrease over time (e.g., Patterson & Stouthamer-Loeber, 1984). However, few authors have actually examined change in knowledge over time. Therefore, little is known about how parental knowledge may change, who is most likely to experience changes in knowledge, or why knowledge may change (i.e., what variables may influence the rate of change). In this study, we used hierarchical linear modeling (HLM) to examine change in maternal knowledge. We also considered whether maternal warmth, maternal behavior control, and adolescent delinquency affected patterns of change.

Conceptual papers have suggested that knowledge is likely to normatively decrease as children move from late middle childhood to early adolescence (see Crouter & Head, 2002, for review; see also Dishion & McMahon, 1998; Patterson & Stouthamer-Loeber, 1984). When children are very young, parental knowledge is not difficult to obtain because parents generally directly supervise and monitor their young children (Collins, Harris, & Susman, 1995; Mounts, 2001). However, as children move toward adolescence, obtaining complete and accurate knowledge becomes more difficult. During this period, there are increases in adolescent behavioral autonomy and greater mutuality in authority relationships (Collins et al., 1995; Holmbeck, Paikoff, & Brooks-Gunn, 1995). Adolescents begin to spend more time away from their parents, become more involved in extracurricular activities, and parents are less directly involved in their children's friendships (e.g., Mounts, 2001).

Although there has been a lack of attention in empirical studies to change in parental knowledge during early adolescence, two papers from one research program have examined change in knowledge during later adolescence (Laird, Pettit, Bates, & Dodge, 2003; Laird, Pettit, Dodge, & Bates, 2003). First, Laird, Pettit, Bates, et al. (2003) used latent growth curve modeling (LGCM) to examine linear change in knowledge for a sample of 9th to 12th graders. Their results showed that parental knowledge decreased

slightly over time for parents of boys, but it did not change for parents of girls (Laird, Pettit, Bates, et al., 2003). Second, Laird, Pettit, Dodge, et al. (2003) examined change in knowledge for the same sample using HLM. Their results showed that boys reported some decreases in knowledge while girls reported no change. Based on these results, there has not been much compelling evidence for samplewide change in knowledge over time. However, the sample that Laird, Pettit, Bates, et al. (2003) and Laird, Pettit, Dodge, et al. (2003) assessed composed of high school-aged adolescents. The literature suggests that the important family reorganizations (which lead to increased behavioral autonomy and decreased direct parental supervision and may result in declines in knowledge) take place earlier in the adolescent period (e.g., Collins et al., 1995). In fact, more recently, Pettit, Keiley, Laird, Bates, and Dodge (2007) reported that mother-reported knowledge decreased over time for a sample of 5th to 11th graders.

## Correlates of Maternal Knowledge

In addition to considering the different ways in which maternal knowledge changed over time, the present study also considered potential predictors of change in maternal knowledge. Both affect- and control-related dimensions of parenting have been identified as important correlates of maternal knowledge (e.g., Fletcher, Steinberg, & Williams-Wheeler, 2004; Soenens, Vansteenkiste, Luyckx, & Goossens, 2006). Past research has also identified adolescent behavior as an important predictor of knowledge (e.g., Grundy, Gondoli, & Blodgett Salafia, 2007; Laird, Pettit, Bates, et al., 2003; Laird, Pettit, Dodge, et al., 2003). Thus, we investigated the roles of maternal warmth, maternal behavioral control, and adolescent adjustment.

*Maternal warmth.* Some authors have developed theories as to why maternal warmth would be expected to have a positive association with parental knowledge. Soenens et al. (2006) proposed that warm parents create an environment in which adolescents feel comfortable sharing information with their parents, allowing parents to maintain high levels of knowledge. Gray and Steinberg (1999) indicated that adolescents who perceive their parents to be warm and supportive may be more likely to cooperate with their parents' attempts to be knowledgeable, thus leading to greater parental knowledge (see also Steinberg, Fletcher, & Darling, 1994).

A number of authors have reported that warmth is positively associated with parental knowledge (e.g., Bumpus, Crouter, & McHale, 2006; Gondoli, Grundy, Blodgett Salafia, & Bonds, 2008). In a recent cross-sectional study, Bumpus et al. (2006) found that parental warmth was associated with greater

knowledge in a sample of fourth- and fifth-grade students. Similarly, cross-sectional studies have revealed that warmth was positively associated with knowledge among high school students (Fletcher et al., 2004; Soenens et al., 2006). In a longitudinal example, Gondoli et al. (2008) found that higher prior maternal warmth was associated with less decrease in knowledge for early adolescents in fourth through sixth grades. With a younger longitudinal sample, Patrick, Snyder, Schrepferman, and Snyder (2005) found that higher warmth in kindergarten predicted higher levels of knowledge in third and fourth grades. High levels of warmth may promote the adolescent's day-to-day cooperation with parents and increase self-disclosure, ultimately leading to greater parental knowledge (Blodgett Salafia, Gondoli, & Grundy, in press; Crouter & Head, 2002; Kerr & Stattin, 2000; Stattin & Kerr, 2000).

*Maternal behavior control.* In contrast to warmth, behavior control has been defined in the literature as parenting behaviors that are designed to manage and control the adolescent's behaviors as well as to communicate clear expectations for behavior (Barber & Thomas, 1996; Soenens et al., 2006). Many authors have proposed that parents who are firm and consistent in enforcing rules will have greater knowledge, and that this knowledge leads to lower levels of a variety of delinquent behaviors (e.g., Barber, Olsen, & Shagle, 1994; Fletcher, Darling, & Steinberg, 1995; Patterson, Capaldi, & Bank, 1989; Patterson & Stouthamer-Loeber, 1984).

Despite strong beliefs in the field about the utility of behavior control, empirical research on the effects of control on knowledge has been less clear than the research involving warmth. For example, Soenens et al. (2006) found that behavior control had both a direct and indirect (through adolescent self-disclosure) influence on knowledge, but that these associations were smaller than those for warmth and knowledge. They concluded that the direct path was likely the result of attempts to provide structure for the adolescent's behaviors (Soenens et al., 2006). Fletcher et al. (2004) also reported concurrent associations between behavior control and knowledge. These authors hypothesized that when parents make an effort to know what their children are doing by providing structure and clear expectations, their children will be less inclined to participate in forbidden activities. However, their results also indicated that these relationships were of much smaller magnitude than those found for warmth and knowledge (Fletcher et al., 2004). Still, other authors have reported that behavior control was not a predictor of parental knowledge at all (Kerr & Stattin, 2000; Stattin & Kerr, 2000). In sum, the research linking maternal behavior control with knowledge has been somewhat contradictory, suggesting that further research is necessary.

*Adolescent delinquency.* Researchers have long acknowledged that children's characteristics and behaviors may have an effect on parenting behaviors (Bell, 1968; Cox & Paley, 1997; Kerr & Stattin, 2003; Kidwell, Fischer, Dunham, & Baranowski, 1983). Notably, several studies have indicated that adolescent deviance is associated with lower knowledge (e.g., Brody, 2003; Kerr & Stattin, 2000; Laird, Pettit, Bates, et al., 2003; Laird, Pettit, Dodge, et al., 2003; Stattin & Kerr, 2000). For instance, Stattin and Kerr (2000) found that low knowledge was related to high delinquency, smoking, and drug use for a sample of Swedish teens. For the same sample, Kerr and Stattin (2000) reported links between higher levels of knowledge and lower internalizing and externalizing behaviors and fewer deviant friends. However, much of the previous research linking knowledge and adolescent behavior has relied on cross-sectional data; thus, the direction of effects could not be accurately evaluated.

There have only been a few longitudinal studies demonstrating relationships between adolescent adjustment and knowledge. In one example, Laird, Pettit, Bates, et al. (2003) reported that adolescent behavior problems at Grade 9 were negatively associated with concomitant levels of parental knowledge. These authors also reported that higher levels of antisocial behavior problems were associated with lower levels of concurrent knowledge at all four time points. However, neither antisocial behavior nor delinquency predicted change in knowledge over time (Laird, Pettit, Bates, et al., 2003). Laird, Pettit, Dodge, et al. (2003) also reported a concurrent association between higher levels of delinquent behavior and lower levels of parental knowledge but found that decreases over time in delinquent behavior were not associated with increases in parental knowledge. However, using a cross-lagged panel design for the same data, these authors found that higher levels of delinquent behavior predicted lower levels of parental knowledge 1 year later (Laird, Pettit, Bates, et al., 2003). In addition, Grundy, Gondoli, and Blodgett Salafia (2009) found that high prior adolescent behavioral competence predicted subsequent high maternal knowledge over a 4-year period, from fourth through seventh grades (see also Grundy et al., 2007).

*Demographic predictors.* We also considered mothers' Time 1 (T1) marital status (married or divorced) and any change in marital status during the duration of the study (change or no change) as predictors of the knowledge trajectory. Easterbrooks and Emde (1988) reported that the effects of marital transitions on parenting and child adjustment may be particularly strong at challenging times in the child's life. Because the transition to adolescence is likely to be a challenging period for parents and adolescents, mothers who

concurrently experience a change in marital status may have more difficulty maintaining high levels of knowledge during this time. However, Laird, Pettit, Bates, et al. (2003) found that although living in a single-parent home was associated with lower initial parental knowledge in ninth grade, it was not associated with increases or decreases in knowledge over time.

Prior research on change in knowledge over time has also revealed potential gender differences. For instance, Laird, Pettit, Bates, et al. (2003) and Laird, Pettit, Dodge, et al. (2003) found that parents of boys showed moderate decreases in knowledge over time, while parents of girls did not. Kerr and Stattin (2000) reported differences in mean levels of knowledge for boys and girls (parents of girls were consistently higher on knowledge); however, these authors indicated that the pattern of relationship among variables did not differ for boys and girls. Still, other authors have reported no gender differences on parental knowledge (Stattin & Kerr, 2000). Thus, further investigation of the role of gender in predicting knowledge over time is necessary.

## **Method**

### *Participants and Procedure*

During the 1st year of the study, initial contact letters were distributed by primary schools in a medium-sized, Midwestern, U.S. city. The letters briefly described the study and instructed mothers of fourth graders to contact the research office if interested in participating. To ensure that families had the same degree of experience with the adolescent transition, mother-child dyads were eligible if the fourth grader was the oldest child in the family (i.e., all families were making this transition for the first time in their ontogeny). In addition, dyads were eligible if the mother was currently married to the fourth grader's father and had never been divorced, or if the mother was currently divorced. Dyads were not eligible if the mother was currently separated or remarried. We chose to limit eligibility to currently married or currently divorced (but not remarried) mothers because of the added complexity of having family structures, which included step- and half siblings of different ages and patterns of coresidence. Eligibility was determined by screening questions administered over the phone by doctoral-level research assistants.

Five hundred thirty-seven mother-adolescent dyads contacted the research office. Of the 537 who contacted the study, 198 met the inclusion criteria. One hundred eighty-one (91%) of the eligible dyads completed the study at Year 1; 13 dyads (7%) refused to participate after hearing more about the

study, and 4 dyads (2%) dropped out after repeatedly canceling their laboratory appointment. Due to attrition over the course of the 5-year study (e.g., relocation or refusal to continue participation), a final total of 159 dyads' data were available for analysis in the present study.

Once annually, the mothers and their adolescents visited a university research laboratory and separately and independently completed self-report questionnaires. In addition, a packet consisting of self-report parenting measures was mailed to the mother to be completed 1 week before the laboratory visit. This was done to reduce the amount of material the mother had to complete during the visit. In accordance with the university's Institutional Review Board, participants completed consent and assent forms prior to completing their questionnaires. As compensation for their participation, dyads were paid US\$30.00 in the 1st year of the study, US\$40.00 in the 2nd year, US\$50.00 in the 3rd year, US\$60.00 in the 4th year, and US\$70.00 in the 5th year.

The analyses for the current study were based on the 159 dyads with complete data for all 5 years of the study. This sample consisted of 71 boys and 88 girls who were between the ages of 9 and 11 years at the fourth grade assessment ( $\bar{X} = 9.69$ ,  $SD = 0.53$ ). The age range of the mothers was 27 to 51 years, with an average age of 37.55 years ( $SD = 4.38$ ). Most of the sample identified themselves as European American (95.6%), and fewer identified themselves as African American (1.9%), Latina/o (1.3%), Asian American (0.6%), or "Other," including combinations of races (0.6%). At the time of the fourth grade assessment, 146 mothers were married (91.8%) and 13 mothers were divorced (8.2%). The married mothers had been married an average of 13.2 years ( $SD = 3.85$ ), and the divorced mothers had been divorced an average of 5.76 years ( $SD = 3.24$ ). There was an average of 2.41 children in the families. The families tended to be well educated and middle class; the mothers had completed, on average, 3.31 years of education after receiving their high school diplomas, 70.4% of the mothers worked full- or part-time jobs outside the home, and the families' annual household incomes ranged from US\$5,400 to US\$400,000, with a mean annual income of US\$76,126 ( $SD = US\$52,847$ , median = US\$65,000). According to *t* test, analysis of variance, and chi-square procedures, the 159 mother-child dyads included in the present analyses did not differ significantly on any of the T1 demographic variables from the 22 dyads who were not included.

## Measures

**Maternal knowledge.** Maternal knowledge at all time points was measured using a nine-item scale that assessed the degree to which the mother was

knowledgeable about the adolescent's whereabouts, acquaintances, and behaviors (Blodgett Salafia et al., 2007; Grundy et al., 2007, 2009). Adolescent and mother perceptions of maternal knowledge were measured with parallel items. This knowledge scale has been widely used to assess parental knowledge of adolescents (e.g., Patterson & Stouthamer-Loeber, 1984; Steinberg et al., 1994). Sample items included the following: "How often does your mom know where you go when you are not at home?" and "How often do you know who your child's friends are?" Mothers and adolescents responded to each item using a 5-point Likert-type scale ranging from 0 (*never*) to 5 (*always*). Items were scored such that higher scores indicated greater knowledge. Across the 5 years of data collection, coefficient alpha values ranged from .75 to .84 for adolescent reports and .68 to .83 for mother reports.

**Maternal warmth.** Maternal warmth was measured with preadolescent and mother versions of a 13-item scale developed for our longitudinal project (Bonds, Gondoli, Sturge-Apple, & Salem, 2002; Gondoli et al., 2008). The scale was closely based on the 10-item Acceptance versus Rejection subscale of the revised Child Report of Parental Behavior Inventory (CRPBI-R; Barber, 1996). Our warmth scale measured warm affect, affection, and nurturance. Sample items included, "My mom makes me feel like I am really important to her" and "I smile at my child." The adolescents were instructed to indicate how often their mothers acted in accord to each statement on a 5-point Likert-type response scale that ranged from 0 (*never*) to 4 (*always*). The mothers were instructed to indicate how often they acted in accord to each statement on the same 5-point scale. Higher scores indicated higher levels of warmth. Across the 5 years of data collection, coefficient alpha values ranged from .87 to .93 for adolescent reports and .89 to .92 for mother reports.

**Maternal behavior control.** Maternal behavior control was measured using a seven-item scale developed by Barber et al. (1994). Sample items included, "My mom gives me as much freedom as I want," and "I let my child go out any night he or she wants." Mothers and adolescents responded using a 5-point Likert-type scale, ranging from 0 (*never*) to 4 (*always*). Items were scored such that higher scores indicated a greater degree of maternal behavior control. Across the 5 years of data collection, coefficient alpha values ranged from .58 to .77 for adolescent reports and .63 to .75 for mother reports.

**Adolescent delinquency.** Adolescent delinquency was measured using the 12-item delinquency subscale of the Youth Self Report (YSR; Achenbach, 1991). Sample items included, "I hang around with kids who get into trouble" and "My child runs away from home." Mothers and adolescents



responded using a 3-point Likert-type scale, where 0 = *not true*, 1 = *somewhat or sometimes true*, and 2 = *very true or often true*. Across the 5 years of data collection, coefficient alpha values ranged from .36 to .72 for adolescent reports and .46 to .67 for mother reports. These reliability values are consistent with values reported by other studies of adolescent delinquency (e.g., Wiesner & Windle, 2004). Other authors have indicated that reliabilities for adolescent delinquency scales like the one used in the present study are likely to be low because of the very low base rates of items on the scales (see Wiesner & Windle, 2004, for further discussion).

**Demographic predictors.** Adolescent gender was coded as 0 = *male* and 1 = *female*. Mothers reported their current marital status at each wave of the study. T1 marital status was coded such that 0 = *married*, 1 = *divorced*. Mothers who reported no change in marital status at any wave were coded as 0, and mothers who reported a change in marital status at any wave of the study were coded as 1.

## Results

### *Descriptive Statistics*

Descriptive statistics for the study variables are presented in Table 1. Examination of the means for both adolescent- and mother-reported maternal knowledge revealed declines in knowledge over time, with the exception of T1 to T2 (see Table 1). Pairwise *t* tests showed that the mean differences were statistically significant ( $p < .05$ ) for both mother and adolescent reports, with one exception: The increase in maternal knowledge from T1 to T2 for mother reports was not statistically significant (see Table 1). The results of the *t* tests also showed that the declines in knowledge were more robust for adolescent reports than for mother reports.

### *HLM Results*

We next examined change in adolescent and mother reports of knowledge using HLM. This technique allowed us to examine whether there was significant individual variation around the mean trajectory of knowledge. HLM also made it possible to consider the effects of predictors of knowledge on both the starting point (intercept) of knowledge and the rate at which knowledge changed (slope). HLM allowed us to consider the possibility of nonlinear (quadratic) change in knowledge.

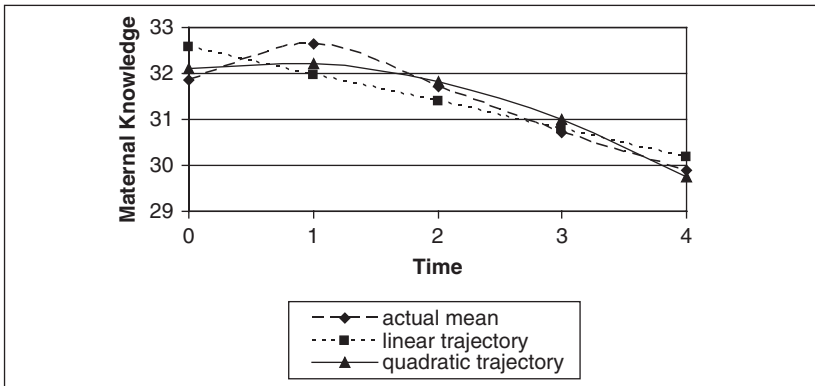
**Table 1.** Descriptive Statistics for Study Variables ( $N = 159$ )

Variable	Adolescent Report			Mother Report		
	$\bar{X}$	SD	Mean Change	$\bar{X}$	SD	Mean Change
Maternal knowledge T1	31.87	4.29	—	33.60	2.24	—
Maternal knowledge T2	32.63	3.59	+0.76*	33.74	2.09	+ .14
Maternal knowledge T3	31.70	4.00	-0.93*	33.16	2.59	-.58*
Maternal knowledge T4	30.70	4.37	-1.0*	32.35	2.92	-.81*
Maternal knowledge T5	29.89	4.66	-0.81*	31.76	3.41	-.59*
Maternal warmth T1	45.28	6.16		41.81	5.46	
Maternal warmth T2	45.16	5.86		41.48	5.52	
Maternal warmth T3	44.21	6.72		41.33	5.49	
Maternal warmth T4	42.25	8.13		41.06	6.03	
Maternal warmth T5	42.12	7.72		40.73	5.61	
Maternal control T1	20.35	3.41		21.79	2.77	
Maternal control T2	20.09	3.25		22.06	2.75	
Maternal control T3	20.01	3.24		21.97	2.69	
Maternal control T4	19.60	3.38		21.31	3.18	
Maternal control T5	19.41	3.85		21.08	3.35	
Adolescent delinquency T1	1.46	1.48		1.16	1.39	
Adolescent delinquency T2	1.36	1.60		1.06	1.40	
Adolescent delinquency T3	1.81	1.69		1.06	1.34	
Adolescent delinquency T4	2.23	2.27		1.05	1.36	
Adolescent delinquency T5	2.74	2.57		1.17	1.86	

\* $p < .05$  for pairwise  $t$  test.

### HLM Results for Adolescent Reports

We first examined unconditional models to establish the best estimate of how knowledge changed over time for the sample as a whole. Time was recoded as T0 to T4, so that the intercept corresponded to the average report of knowledge at the time of the first assessment (Grade 4). The first model was an unconditional linear model, where the trajectory of knowledge was predicted only by time. The results of this unconditional linear model indicated an intercept of 32.573 ( $p < .05$ ), which meant that at T1 the average report of knowledge was 32.573 (on a scale ranging from 0 to 36). The linear slope was equal to  $-.597$  ( $p < .05$ ; see Figure 1). The statistically significant negative slope indicated that individual reports of knowledge decreased at mean rate of  $-.597$  points per year. In addition, the results revealed significant



**Figure 1.** Adolescent-Reported Maternal Knowledge and HLM Estimates of Linear and Quadratic Trajectories

Note: HLM = hierarchical linear modeling.

random effects of both intercept ( $SD = 3.030$ ;  $p < .05$ ) and slope ( $SD = 1.131$ ;  $p < .05$ ). This meant that there was significant individual variation around the mean of both the intercept and slope, which could potentially be explained by the addition of predictors of change in knowledge.

The second model was an unconditional quadratic model, where knowledge was predicted by both a linear and quadratic coefficient of time. The formula used to calculate the outcome was  $y = I + S(\text{time}) + Q(\text{time})^2$ , where  $I$  is the intercept,  $S$  is the linear slope, and  $Q$  is the quadratic slope. The values for the rate of change in the linear slope were 0, 1, 2, 3, and 4. The values for the rate of change in the quadratic slope were 0, 1, 4, 9, and 16. In other words, the linear slope represented “time,” whereas the quadratic slope represented “time-squared.” If the data had only a linear trajectory, it would have a significant value of  $S$  and a value of  $Q$  equal to 0. If the data had only a quadratic trajectory, it would have a significant value of  $Q$  and a value of  $S$  equal to 0. However, it is also possible that the data may have nonzero values for both the linear and quadratic coefficients, indicating a combination of linear and quadratic trends.

The results of this unconditional quadratic model indicated an intercept of 32.117 ( $p < .05$ ), a nonsignificant linear slope of .316 ( $p > .05$ ) and a significant quadratic slope of  $-.228$  ( $p < .05$ ; see Figure 1). In addition, the results revealed significant random effects of intercept ( $SD = 3.158$ ;  $p < .05$ ), linear slope ( $SD = 2.012$ ;  $p < .05$ ), and quadratic slope ( $SD = 0.347$ ;  $p < .05$ ). One limitation of HLM is that it does not provide fit statistics to indicate which

model was a better fit to the data. However, when a model shows a significant quadratic effect, it is generally preferred over the model that shows only a linear effect. Furthermore, after plotting the raw data with the estimated linear and quadratic curves, the quadratic model was determined to be a better approximation of the data. It appeared that the quadratic coefficient was necessary to explain the slight increase in knowledge from T1 to T2, whereas knowledge from T2 to T5 demonstrated a fairly linear decrease over time (see Figure 1).

Next we entered the T1 predictors into the quadratic model one at a time, in order to assess their individual effects on the intercept and slopes of knowledge. These variables were Level-2 predictors or variables that varied across the sample but did not vary within individuals (e.g., adolescent gender). T1 maternal warmth, maternal behavior control, and adolescent delinquency were also Level-2 predictors in this context because they were single-time measurements, and therefore they did not vary within individuals. These predictors were all centered prior to estimating the models, so that the intercept of knowledge represented the initial level of knowledge for individuals who were at the mean for the predictor, rather than individuals who reported a value of 0 for the predictor. Maternal warmth, maternal behavior control, and adolescent delinquency were also subsequently considered as time-varying covariates. In those analyses, the predictors were Level-1 predictors because they were assessed over time, allowing them to vary both within and across individuals.

*Predictors of adolescent-reported trajectories of knowledge.* First, adolescent gender was entered as a predictor of the knowledge trajectory. Gender was not a significant predictor of the knowledge intercept, linear slope, or quadratic slope (see Table 2). T1 marital status was a marginally significant predictor of the knowledge intercept. Adolescents whose mothers were married at T1 reported slightly higher initial knowledge than adolescents whose mothers were divorced at T1. Marital status at T1 was not a significant predictor of the linear or quadratic slope of knowledge. Change in marital status was not a significant predictor of the knowledge intercept, linear slope, or quadratic slope.

T1 maternal warmth had a significant, positive association with the intercept of knowledge and nonsignificant associations with the linear and quadratic slopes. The positive association between T1 maternal warmth and the intercept of knowledge indicated that adolescents who perceived their mothers to be above average on warmth at T1 also perceived their mothers to have higher-than-average initial knowledge. T1 maternal behavior control was not a significant predictor of the knowledge intercept or slopes.

**Table 2.** HLM Results for Adolescent and Mother Reports: Influence of Covariates on the Knowledge Trajectory ( $N = 159$ )

Variable	Intercept	Linear Slope	Quadratic Slope	Time-Varying Covariate
<b>Adolescent reports</b>				
Adolescent gender	0.151	-.387	.114	—
T1 marital status	-2.078*	.886	-.295	—
Change in marital status	-0.525	.857	-.272	—
Maternal warmth	0.287**	-.061	.001	.264**
Maternal behavior control	-.090	-.016	.012	.057
Adolescent delinquency	-0.726**	-.150	.053	-.478**
<b>Mother reports</b>				
Adolescent gender	-0.479	-.173	.128	—
T1 marital status	-0.456	.008	-.021	—
Change in marital status	-0.062	.177	-.123	—
Maternal warmth	0.128**	-.047	.016**	.108**
Maternal behavior control	0.106*	-.053	.022	.134**
Adolescent delinquency	-0.350**	.024	-.041	-.206**

Note: HLM = hierarchical linear modeling.

\* $p < .1$ . \*\* $p < .05$ .

T1 adolescent delinquency had a significant, negative association with the intercept of knowledge and nonsignificant associations with the linear and quadratic slopes. The negative association between T1 delinquency and the intercept of knowledge indicated that adolescents who reported above-average delinquency scores at T1 perceived their mothers to have lower-than-average initial knowledge.

*Time-varying covariates.* We next examined maternal warmth, maternal behavior control, and adolescent delinquency (individually) as time-varying covariates. These analyses allowed us to assess whether change in the outcome variable was related to change in the predictor variable and the direction of that relationship. Because maternal knowledge had an average trajectory that showed decline over time, covariates that were positively associated with knowledge predicted less decrease in knowledge over time, and covariates that were negatively associated with knowledge predicted greater decrease over time.

Maternal warmth was positively associated with the trajectory of knowledge (see Table 2). In order to better interpret the nature of this relationship, we examined separate unconditional models predicting adolescent reports of

maternal warmth. These models indicated that maternal warmth had a linear trajectory with an intercept of 45.712 ( $p < .05$ ) and a slope of  $-.941$  ( $p < .05$ ). The positive relationship between knowledge and warmth over time, therefore, indicated that individuals who reported above-average trajectories for maternal warmth (e.g., less decrease) were more likely to report above-average trajectories for maternal knowledge (e.g., less decrease). Maternal behavior control was not significantly associated with the trajectory of knowledge.

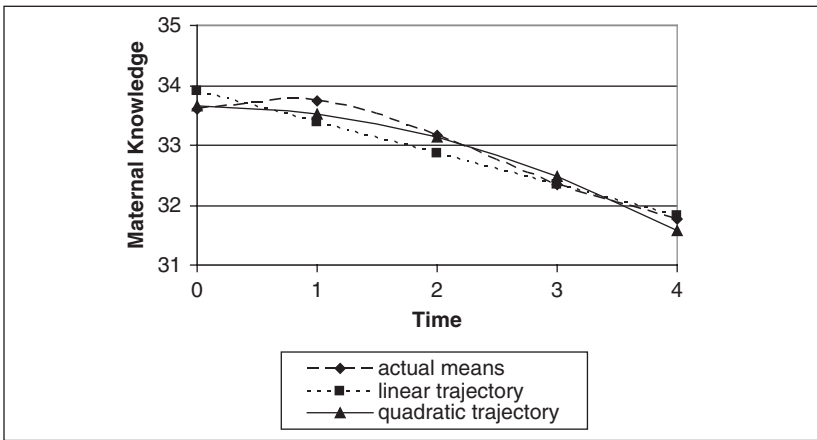
Adolescent delinquency was negatively associated with the trajectory of knowledge (see Table 2). Separate unconditional models predicting adolescent reports of delinquency indicated that delinquency had a quadratic trajectory with an intercept of 1.393 ( $p < .05$ ), a linear slope of  $.031$  ( $p > .05$ ), and a quadratic slope of  $.076$  ( $p < .05$ ). The negative relationship between knowledge and delinquency indicated that individuals who reported higher-than-average trajectories on delinquency (e.g., more increase) were more likely to report lower-than-average trajectories on maternal knowledge (e.g., more decrease).

### *HLM Results for Mother Reports*

The same series of analyses conducted for adolescent reports were also conducted for mother reports. The results of the unconditional linear model indicated an intercept of 33.915 ( $p < .05$ ) and a slope of  $-.520$  ( $p < .05$ ; see Figure 2). In addition, there were significant random effects of both intercept ( $SD = 1.532$ ;  $p < .05$ ) and slope ( $SD = 0.449$ ;  $p < .05$ ), indicating that there was significant individual variation around both the intercept and slope of knowledge that may be explained by the addition of predictors of the knowledge trajectory.

The results of the unconditional quadratic model indicated an intercept of 33.657 ( $p < .05$ ), a linear slope of  $-.004$  ( $p > .05$ ), and a quadratic slope of  $-.129$  ( $p < .05$ ; see Figure 2). In addition, the results revealed significant random effects of intercept ( $SD = 1.595$ ;  $p < .05$ ), linear slope ( $SD = 1.103$ ;  $p < .05$ ), and quadratic slope ( $SD = .342$ ;  $p < .05$ ). After plotting the raw data with the estimated linear and quadratic curves, the quadratic model was determined to be a better approximation of the data.

*Predictors of mother-reported trajectories of knowledge.* Adolescent gender was not a significant predictor of the knowledge intercept or slopes. T1 marital status was also not a significant predictor of the intercept or slopes. Finally, change in marital status was not a significant predictor of the intercept or slopes.



**Figure 2.** Mother-Reported Maternal Knowledge and HLM Estimates of Linear and Quadratic Trajectories  
 Note: HLM = hierarchical linear modeling.

T1 maternal warmth had significant, positive associations with the intercept and quadratic slope of knowledge (see Table 2). The positive association between T1 maternal warmth and the intercept of knowledge indicated that mothers who perceived themselves to be above average on warmth at T1 also perceived themselves to have higher-than-average initial knowledge. In addition, the positive association between T1 maternal warmth and the quadratic slope of knowledge indicated that mothers who perceived themselves to be above average on warmth at T1 reported less steep decreases for knowledge over time.

T1 maternal behavior control was a marginally significant predictor of the intercept, and it was not significantly related to the linear or quadratic slopes (see Table 2). The positive association between T1 maternal behavior control and the intercept of knowledge indicated that mothers who reported higher-than-average maternal behavior control also reported slightly higher initial knowledge. T1 delinquency had a significant, negative association with the intercept of knowledge and nonsignificant associations with the linear and quadratic slopes (see Table 2). The negative association between T1 delinquency and the intercept of knowledge indicated that mothers who reported above-average adolescent delinquency at T1 also reported lower-than-average initial knowledge.

*Time-varying covariates.* Maternal warmth was positively associated with the trajectory of knowledge (see Table 2). Separate unconditional models

predicting mother reports of maternal warmth indicated that maternal warmth had a linear trajectory with an intercept of 41.766 ( $p < .05$ ) and a slope of  $-.277$  ( $p < .05$ ). The positive relationship between knowledge and warmth therefore indicated that mothers who reported higher-than-average trajectories for maternal warmth (e.g., less decrease) were also more likely to report above-average trajectories for maternal knowledge (e.g., less decrease).

Maternal behavior control was also positively associated with the trajectory of knowledge (see Table 2). Separate unconditional models predicting mother reports of maternal behavior control indicated that maternal behavior control had a quadratic trajectory with an intercept of 21.793 ( $p < .05$ ), a linear slope of  $.231$  ( $p > .05$ ), and a quadratic slope of  $-.108$  ( $p < .05$ ). The positive relationship between knowledge and behavior control over time indicated that mothers who reported higher-than-average trajectories for maternal behavior control (e.g., less decrease) were more likely to report above average trajectories for maternal knowledge (e.g., less decrease).

Mother report of adolescent delinquency was negatively associated with knowledge. Separate unconditional models predicting mother reports of adolescent delinquency indicated that delinquency had a linear trajectory with an intercept of 1.092 ( $p < .05$ ) and a nonsignificant slope of  $.001$  ( $p > .05$ ). The negative relationship between knowledge and delinquency indicated that mothers who reported higher-than-average trajectories on delinquency (e.g., an increase) were more likely to report lower-than-average trajectories on maternal knowledge (e.g., some decrease).

## Discussion

Our results revealed a general pattern of moderate declines in maternal knowledge over the transition to adolescence for both mother and adolescent reports. These findings differ from the results of two prior studies that have examined mean change in knowledge (Laird, Pettit, Bates, et al. 2003; Laird, Pettit, Dodge, et al., 2003). These authors found that adolescent-reported knowledge generally did not change over time, although boys reported slight declines.

We believe that the age of the samples may account for the differences in results. The Laird, Pettit, Bates, et al. (2003) and Laird, Pettit, Dodge, et al. (2003) studies focused on a sample of high school students. Our sample was younger, beginning when the students were in the fourth grade and continuing through ninth grade. Authors have hypothesized that knowledge may decrease over time because of normative changes in parent-adolescent relationship that occur during the transition to adolescence (Crouter & Head, 2002; Dishion & McMahan, 1998; Patterson & Stouthamer-Loeber, 1984). We believe that the



age of our sample allowed us to better capture these declines in knowledge as they occurred, whereas the Laird, Pettit, Bates, et al. (2003) and Laird, Pettit, Dodge, et al. (2003) studies may have begun measuring knowledge after the more substantial familial changes had occurred. In support of these ideas, our findings are similar to the findings of Pettit et al. (2007), who also reported linear decreases in mother-reported knowledge in a sample they followed from pre- to early adolescence.

### *Adolescent Gender*

For both adolescent and mother reports, gender had no significant effects on the intercept or slopes in HLM. Although visual inspection of the data suggested that maternal knowledge may decrease more when the target adolescent is male, such apparent differences were not significant. The lack of significant gender differences in change in knowledge over time contrasts with the findings reported by Laird, Pettit, Dodge, et al. (2003), who found decreases in knowledge for boys but not for girls. Perhaps, Laird, Pettit, Bates, et al. (2003) and Laird, Pettit, Dodge, et al. (2003) were able to detect significant gender differences because of the older age of their sample. It is possible that high school students show greater gender differences on maternal knowledge than do younger adolescents.

### *Marital Status*

For adolescent reports, T1 marital status had a marginally significant effect on the intercept of knowledge, indicating that adolescents whose mothers were married at T1 started slightly higher on knowledge than did adolescents whose mothers were divorced. This result is in line with other authors who have indicated that marital transitions are likely to affect parenting-related variables, especially during challenging periods in the child's life, such as the transition to adolescence (Easterbrooks & Emde, 1988). Change in marital status, however, had no significant effects on the intercepts or slopes of knowledge for either mother or adolescent reports. We may have found significant differences for these variables with a larger sample size that exhibited greater marital diversity.

### *Parenting Behaviors*

For both adolescent and mother reports of knowledge, T1 maternal warmth predicted higher levels of initial warmth, and warmth was also positively

associated with change in knowledge over time (as a time-varying covariate). Thus, mothers who started high on warmth and mothers who increased in warmth over time were more likely to start higher on knowledge and experience less dramatic decreases in knowledge over time.

Past research has shown a consistent and robust association between maternal warmth and maternal knowledge (Bumpus et al., 2006; Fletcher et al., 2004; Gondoli et al., 2008; Grusec, 1997; Kerns, Aspelmeier, Gentzler, & Grabill, 2001; Patrick et al., 2005; Soenens et al., 2006). Thus, our findings were consistent with prior studies of the relationships between knowledge and warmth. These associations may have been due to higher levels of adolescent self-disclosure of information to parents who are high in warmth (Blodgett Salafia et al., in press; Crouter & Head, 2002; Kerr & Stattin, 2000; Kerr, Stattin, & Trost, 1999; Stattin & Kerr, 2000). Soenens et al. (2006) hypothesized that warm parents create an environment in which adolescents feel comfortable talking and sharing information with their parents. In addition, adolescents who perceive their parents to be high in warmth may also be more cooperative with their parents' attempts to be knowledgeable (Gray & Steinberg, 1999; Steinberg et al., 1994).

In contrast, when behavior control was considered as a potential predictor of the knowledge trajectory, the results were less clear than those for warmth. When mothers reported engaging in high levels of behavior control, they also reported slightly higher initial knowledge and continued to report high levels of knowledge over time. In contrast, among adolescents, behavior control was not associated with either the intercept or the slopes of knowledge, nor was it related to knowledge over time.

Somewhat inconsistent findings have been revealed in prior studies examining associations between behavior control and knowledge. For instance, Fletcher et al. (2004) and Soenens et al. (2006) reported positive associations between knowledge and control. Conversely, Kerr and Stattin (2000) and Stattin and Kerr (2000) concluded that there were no significant associations between knowledge and control. It is important to note that the measurement of the behavior control variable across studies has varied widely. In the Soenens et al. (2006) study, the measure of behavior control included "parental monitoring," which included parental actions designed to promote parental knowledge. For instance, this measure included the following item: "My mother/father makes efforts to know who my friends are, where I spend my time, etc." (Soenens et al., 2006, p. 309)

In another example, Fletcher et al. (2004) conceptualized behavior control as the extent to which adolescents reported shared decision making with parents. They asked adolescents to indicate who made the decisions for 13

different common situations, such as “How late at night I can stay out” (Fletcher et al., 2004). The response scale for these items ranged from “I decide this without discussing it with my parents,” to “My parents decide this without discussing it with me” (Fletcher et al., 2004, p. 786). Thus, this scale appears to measure the degree of adolescent decision-making autonomy rather than the degree to which parents regulated or imposed restrictions on their adolescents’ behavior. This scale may have also tapped the degree of positive affect in the parent-adolescent relationship, which is consistently associated with knowledge (e.g., Bumpus et al., 2006; Gondoli et al., 2008). Because these recent studies have used control measures that either tap directly into knowledge (e.g., Soenens et al., 2006) or that overlap somewhat with affect in parent-adolescent relationship (e.g., Fletcher et al., 2004), their reported associations between control and knowledge may have been somewhat inflated.

The measure of behavior control in the present study asked mothers and adolescents to report how often they allowed certain behaviors, or set limits on their adolescents’ activities. For instance, we asked mothers and adolescents to report whether the adolescent is allowed to go out any night that they want to, or whether the mother is “firm when it comes to rules.” These items were intended to measure parental management of behavior and limit setting. Kerr and Stattin (2000) and Stattin and Kerr (2000) used a measure of behavior control that was similar to the one used in the present study. Control measures like the one in the present study and the one in the Stattin and Kerr (2000; Kerr & Stattin, 2000) studies appeared to be more clearly “firm vs. lax control” and are relatively unrelated to warmth or knowledge (especially when adolescent reports are used). It is possible that mothers may believe that firmness and limit setting should lead to greater knowledge. Thus, mothers who reported greater firmness in our sample also tended to perceive themselves as higher on knowledge. Future research might focus explicitly on potentially divergent beliefs and perceptions regarding behavior control among mothers and adolescents.

### *Adolescent Behavior*

Both mother and adolescent reports indicated that T1 delinquency was related to the initial level of knowledge. Knowledge and delinquency were also positively associated over time for both mother and adolescent reports. These findings are consistent with the cross-sectional studies that have reported concurrent associations between delinquency or deviant behavior and knowledge (e.g., Barnes & Farrell, 1992; Beck, Shattuck, Haynie, & Simons-Morton, 1999; Brody, 2003; Jacobson & Crockett, 2000; Stattin & Kerr, 2000). In

addition, our results are consistent with Laird, Pettit, Bates, et al. (2003) who examined a cross-lagged, longitudinal model and found that higher levels of delinquent behavior predicted lower levels of parental knowledge 1 year later. As adolescents become more delinquent, parents may disengage and decrease their attempts to be knowledgeable (Laird, Pettit, Bates, et al., 2003). Parents may stop asking their adolescents for information in order to avoid negative interactions, or they may stop seeking information from other sources, such as teachers and the parents of their adolescents' friends because of embarrassment or frustration about their adolescents' behavior (Laird, Pettit, Bates, et al., 2003). Parents may also find it more difficult to maintain high levels of knowledge because their adolescents make greater efforts to hide delinquent behaviors from them.

Our findings for the T1 predictors of knowledge indicated that where one started on both maternal warmth and adolescent delinquency (in Grade 4) were important predictors of concurrent levels of knowledge. However, initial levels of these predictors (in Grade 4) did not predict how rapidly knowledge declined over time; rather, how one changed over time in warmth or delinquency affected the rate of change in knowledge. In terms of practical advice for parents, we would emphasize that the course of knowledge can be changed during adolescence, even if it is lower-than-average early on. Pettit et al. (2007) reported that the rate of decline in knowledge over time was lower among mothers who indicated that they had mounted a behavior-change "campaign" and considered that campaign successful. In Pettit et al.'s study, the parents were asked if they had decided to make an extended effort to change their child's behavior, and if so, whether they believed their child's behavior had changed (Pettit et al., 2007). These authors did not ask parents to report what they were doing to change their adolescents' behaviors, just whether or not they had made an extended effort to do so. As a result, they were not able to determine whether these campaigns involved increases in firmness and control or increases in warm parenting behavior.

For maternal behavior control, adolescent-reported control showed no associations with knowledge. However, mother-reported T1 behavior control was marginally positively associated with the Grade 4 levels of knowledge, and change in behavior control was positively associated with change in knowledge over time. Thus, from the mothers' perspective, having higher-than-average T1 control and maintaining that higher-than-average control over time was beneficial for acquiring higher levels of knowledge and also for tempering the decreases in knowledge over time.

Therefore, our results would seem to indicate that increasing parental warmth helps to slow the decrease in knowledge, and from the mothers'

perspective, increasing firmness should also help. Thus, we would conclude that parents who feel that their knowledge is too low or declining too rapidly should make a deliberate effort to increase their knowledge by attempting to increase their warmth toward their adolescents. It is still important to foster high levels of warmth and low levels of delinquency at T1, but by increasing maternal warmth, parents can help to slow the decline in knowledge over the transition to adolescence, even if the dyad started out low on warmth at T1.

### *Limitations*

There were a few limitations of the present study that should be noted. First, our sample was predominantly middle class and European American. Therefore, our analyses were based on a group of mothers and adolescents with relatively high resources who were not ethnically diverse. A larger, more diverse sample may allow broader generalizations of the findings. Second, the majority of our sample was married at T1 and remained stably married throughout the 5 years of the study. A more balanced distribution of married and divorced mothers as well as greater numbers reporting change in marital status would also have made the results more interpretable and generalizable to a broader population. Additional reporters, such as fathers or teachers, would also have been a valuable addition to the present study.

### *Contributions*

Limitations notwithstanding, the present study makes several important contributions to the literature. First, the use of HLM allowed us to consider change in mean levels of knowledge, rather than just rank-order change. Only a few prior studies have assessed mean change in knowledge, and those studies generally found no change (Laird, Pettit, Bates, et al., 2003; Laird, Pettit, Dodge, et al., 2003).

We also examined whether maternal warmth and behavioral control are predictors of knowledge during the transition to adolescence. We found that, for our sample, warmth was a better predictor of knowledge than control. In fact, control did not consistently predict knowledge for either mother- or adolescent-reported knowledge. In contrast to Fletcher et al.'s (2004) conclusion when discussing the role of control that "sometimes, warmth is not enough" (p. 795), our results seem to indicate that high maternal warmth may indeed be sufficient for obtaining and maintaining high levels of parental knowledge. This is a fairly contentious area in the literature, with some authors arguing strongly for the importance of control in generating parental

knowledge (e.g., Barber et al., 1994; Fletcher et al., 2004; Patterson et al., 1989; Steinberg, Lamborn, Dornbusch, & Darling, 1992) and others arguing that control is not important and that parents should focus more on bolstering the affective qualities of the parent-child relationship (Kerr & Stattin, 2000; Stattin & Kerr, 2000). We examined these associations using a rigorous, longitudinal design, and believe that we have contributed valuable information to the debate over the relative importance of these aspects of parenting.

## Conclusion

The present study makes an important contribution to the literature by using a sample of adolescents and their mothers during the transition to adolescence. This has been a relatively understudied population, and we believe that our findings have important implications for future parenting intervention research. We have also contributed to an ongoing debate in the literature over the relative contributions of warmth and control to the prediction of knowledge. Finally, we have found longitudinal associations between knowledge and adolescent behavior using both mother and adolescent reports.

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## Declaration of Conflicting Interests

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**Bios**

**Amber M. Grundy**, PhD, is an adjunct assistant professor at the University of Notre Dame. She is also the project coordinator for Reading for Life. She received her PhD in developmental psychology from Notre Dame in 2007. Her primary research focus is on maternal knowledge and adolescent adjustment during early adolescence.

**Dawn M. Gondoli** received her PhD in family studies and human development from University of Arizona in 1994. She is an associate professor of psychology in University of Notre Dame. Her interests include parenting and maternal and child well-being during adolescence.

**Elizabeth H. Blodgett Salafia**, PhD, received her doctoral degree from the University of Notre Dame in 2008. She is now at the Department of Child Development and Family Science at North Dakota State University. Her research has focused extensively on familial relations and parenting as antecedents of adolescent adjustment.