

Adolescents' and Mothers' Perceptions of the Cognitive and Relational Functions of Collaboration and Adjustment in Dealing With Type 1 Diabetes

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We examined how adolescents' and mothers' perceptions of cognitive and interpersonal functions of collaboration surrounding Type 1 diabetes differed and how they related to adolescent age, psychosocial, and diabetes adjustment. Adolescents ($M = 14.16$ years) and mothers completed questionnaires assessing the functions of collaboration for the adolescent, quality of the mother-adolescent relationship, emotional adjustment, and adherence to the diabetes regimen. Confirmatory factor analysis (CFA) of perceptions of collaboration confirmed three dimensions: collaboration to compensate for cognitive function, interpersonal enjoyment, and frequency of collaboration. Although adolescents' and mothers' views of interpersonal enjoyment and frequency of collaboration converged, their perceptions of compensation were unrelated. Mothers' perceptions of adolescents' compensation were unrelated to perceptions of enjoyment and frequency. Both adolescents and mothers perceived less compensation and less enjoyment of collaboration with increasing adolescent age, but only adolescents reported collaborating less frequently with higher age. Better emotional adjustment and adherence occurred when mothers and adolescents perceived enjoying collaboration (controlling for mothers' acceptance) regardless of age. Enjoying collaboration at an interpersonal level may be an important avenue for successful diabetes management during adolescence.

Keywords: collaboration, Type 1 diabetes, adolescence, parent-child relationship, adjustment

Collaboration between parents and children is effective in promoting cognitive development (Rogoff, 1998), as parents provide scaffolding to close the gap between the child's capabilities and what is required of the task (Gauvain, 2001). Collaborative problem solving has been extensively studied in childhood (Gauvain, 2001; Rogoff, 1998), with its frequency thought to decline in late childhood as children internalize their cognitive interactions with others (Vygotsky, 1978). However, parent-child collaboration may continue to be beneficial during adolescence, especially when adolescents are faced with difficult everyday problems that are consequential for their successful health and well-being, as occurs with a chronic illness (Beveridge, Berg, Wiebe, & Palmer, 2006; Seiffge-Krenke,

2001). Collaboration involves parents and children actively engaging with one another as they pool resources and discuss joint problem solving and coping (Berg & Upchurch, 2007; Rogoff, 1998) and has been distinguished from support provision by its more direct, joint, and equal involvement (Berg & Upchurch, 2007). In collaborating on problems surrounding chronic illness, collaboration may not only serve a cognitive function (i.e., compensating for cognitive limitations) that facilitates adjustment, but also an interpersonal function (e.g., providing support and encouragement, Meegan & Berg, 2002). In the present study, we compared adolescents' and mothers' perceptions of the cognitive and interpersonal functions of collaboration and its perceived frequency, as adolescents and

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mothers dealt with everyday problems surrounding Type 1 diabetes, age differences in these functions, and whether collaboration supported psychosocial adjustment and adherence to the diabetes regimen.

Adolescents are faced with numerous problems and decisions that are new (e.g., dating and sexual activity, career choice) where collaborative parental involvement could be beneficial for successful problem solving. In addition to these normative challenges, some adolescents are faced with a chronic illness, such as Type 1 diabetes, which represents a high stress context for adolescents and mothers (Beveridge et al., 2006; Seiffge-Krenke, 2001). Adolescence is a particularly challenging time for diabetes care as it is marked by heightened family conflict, increased psychological distress, poorer adherence, and deteriorating metabolic control (Seiffge-Krenke, 2001). Our previous work suggests that adolescent-mother collaboration surrounding specific difficult management problems is beneficial for both diabetes management (Wiebe et al., 2005) as well as emotional adjustment (Berg et al., 2007). These benefits from collaboration could arise because collaboration with one's parent compensates for the adolescent's limited cognitive skill in dealing with such complexities.

In addition to the cognitive function, collaboration may be beneficial as it serves an interpersonal function especially in close relationships, such as the parent-adolescent relationship (Berg & Upchurch, 2007; Meegan & Berg, 2002). The extent to which collaboration serves to enhance interpersonal relationships has not been the focus of collaborative cognition research during child development. However, even in early childhood parent-child collaboration depends not only on aspects of the child's cognitive skill, but the child's emotional functioning (Perez & Gauvain, 2005), parenting style (Gauvain & Huard, 1999), and interpersonal behaviors such as providing support and being directive (Gauvain, Fagot, Leve, & Kavanagh, 2002). The interpersonal function of collaboration is consistent with theoretical perspectives that collaboration exists in the context of warm and accepting relationships (Beveridge & Berg, 2007) and may be especially important during adolescence, as parents and adolescents experience changes in their relationship (Collins, Laursen, Mortensen, Luebker, & Ferreira, 1997).

Mothers and adolescents may diverge in their views of the cognitive and relational functions of collaboration. Adolescents and mothers may especially differ in views of the cognitive compensation function of collaboration as adolescents view themselves as more competent at diabetes tasks than do their parents (Miller & Drotar, 2003). Furthermore, mothers may have a more differentiated view of collaboration than do adolescents as they perceive that although adolescents may continue to need collaboration for its cognitive benefits, adolescents may not enjoy this direct and active engagement.

Relatedly, age-related decreases in collaboration may be most salient for the cognitive function, especially from the adolescent's perspective, as the adolescent gains cognitive maturity (Steinberg & Morris, 2000). The adolescent's view of the decreased need for collaboration as a cognitive tool may affect views of the interpersonal enjoyment of collab-

oration, as collaboration may increasingly be viewed as intrusive (Holmbeck et al., 2002). Finally, both adolescents and mothers may view collaboration as occurring less frequently with increasing age because of the decreased cognitive need of older adolescents (Berg et al., 2007).

Despite age-related decreases in the cognitive and interpersonal functions of collaboration, maintaining mother-adolescent collaboration may be associated with better emotional adjustment and adherence to the complicated diabetes regimen (Berg et al., 2007; Wiebe et al., 2005). Both mothers and adolescents experience more negative adjustment in the context of diabetes than do healthy adolescents and their mothers (Dantzer, Swendsen, Maurice-Tison, & Salamon, 2003; Frank et al., 1998). Collaboration is beneficial for both diabetes management (Wiebe et al., 2005) and psychosocial adjustment in mothers and children (Berg et al., 2007). As collaboration involves mutual engagement by mothers and adolescents (Beveridge & Berg, 2007), adjustment may be enhanced if both view collaboration in similar ways, especially for younger adolescents who often converge with mothers' views of diabetes care (Beveridge et al., 2006). High levels of warmth and acceptance in mother-adolescent relationships are also associated with markers of healthy development (Beveridge & Berg, 2007) including better adherence (Davis et al., 2001) and lower depressive symptoms (Butler, Skinner, Gelfand, Berg, & Wiebe, 2007). Thus, it is important to assess whether collaboration predicts better psychosocial and diabetes management adjustment when controlling for maternal acceptance.

The primary purpose of the study was to identify different functions of collaboration, compare adolescents' and mothers' function, and examine their association with adjustment. Mothers and adolescents (age 11–17) completed measures of their perceptions of collaboration, psychosocial adjustment, adherence to the diabetes regimen, and maternal acceptance. First, we established that adolescents' and mothers' perceptions of collaboration could be captured by cognitive, interpersonal, and frequency dimensions, and compared their views. We expected views of collaboration as compensation to be most divergent across adolescents and mothers, given adolescents' tendency to view themselves as more competent than do mothers. Second, we examined age differences in these functions with expectations that with increasing age adolescents would be less likely to endorse statements concerning the compensation function as well as its frequency. Third, we hypothesized that mothers' and adolescents' perceptions of the cognitive and interpersonal functions of collaboration would relate to better psychosocial adjustment (after controlling for maternal acceptance). Finally, we expected that the benefits of collaboration would extend to the adolescent's ability to adhere to the diabetes regimen.

Method

Participants

The study was reviewed and approved by the University of Utah IRB. Parents gave written informed consent and

adolescents gave written assent. Participants included 84 adolescents and their mothers who were recontacted 1.5 years after completing an initial project (see Wiebe et al., 2005); the majority (66%) agreed. Adolescents and mothers who participated in the follow-up were not different from those who did not participate on measures of emotional adjustment (mother's depression, adolescent's depression, $p > .70$), demographic variables (age and Hollingshead index, $ps > .60$), adolescent or mother reports of adherence ($p > .13$), nor mother or adolescent reports of FACES II collected at Time 1 only (Olson, Russell, & Sprenkle, 1983), a general measure of family functioning ($ps > .20$). Adolescents were 11.5 to 17.5 years of age ($M = 14.16$, $SD = 1.7$; 53 % male, 47 % female) and had been diagnosed with Type 1 diabetes for at least 1 year before starting the initial project ($M = 4.00$ years, $SD = 2.8$). The adolescents were on an intensified diabetes regimen taking an average number of 3.51 injections and 4.64 blood glucose tests daily during the initial assessment.

Mothers ranged in age from 30.2 to 60.2 years ($M = 48.6$, $SD = 5.7$), were largely Caucasian (97%), married (86%), and had at least some college education. Over 60% of the mothers indicated an annual income of over \$50,000. The average Hollingshead Index was 4.18, indicating a medium business, minor professional class sample.

Procedure

Mothers and adolescents were invited by mail to take part in the follow up. Those who were willing to participate returned a signed informed consent form and were mailed a packet of questionnaires with a postage paid return envelope. Mothers and adolescents were instructed to complete their questionnaires separately and returned them in separate envelopes.

Measures

Perceptions of Collaboration Questionnaire (PCQ). This measure developed for use in this study assessed perceptions of collaboration between mothers and adolescents in diabetes-related problem solving. Adolescents and mothers completed parallel versions of the 12-item PCQ (see Appendix). In both versions items were rated with regard to the adolescent (i.e., mothers rated their perceptions of collaboration to compensate for the adolescent's cognitive function, adolescent's enjoyment, and frequency of collaboration) on 5-point scales (1 = strongly disagree to 5 = strongly agree). Items were formulated to represent three dimensions of collaboration: (1) Cognitive Compensation (C) (i.e., working together helps to make up for the adolescent's cognitive limitations), (2) Interpersonal Enjoyment (E) (i.e., collaboration is enjoyable because the relationship between adolescent and mother benefits from working together), and (3) Frequency (F) (i.e., adolescent and mother often work together). The items were derived by drawing on the collaborative literature (see Meegan & Berg, 2002 for a review), which notes the importance of the cognitive compensation function of collaboration as well as

the interpersonal function. Based on the results of confirmatory factor analyses (see Results section), we selected nine items to form the final PCQ scales. Three scales were computed for each member of the dyad by averaging across three items per scale. Internal consistencies of the PCQ scales were adequate for both adolescents (C: $\alpha = .64$; E: $\alpha = .73$; F: $\alpha = .77$) and mothers (C: $\alpha = .65$; E: $\alpha = .70$; F: $\alpha = .68$).

Parenting style. Adolescents completed the 30-item Child Report of Parent Behavior Inventory and mothers the parent version (CRPBI and PRPBI, respectively; Schaefer, 1965), which contains three subscales. We focused in the present study on the subscale acceptance (warm and loving behavior), as it best captures the component most likely to be involved in enjoying collaboration (one of the dimensions of the PCQ). Adolescents and mothers used a 1 (*does not describe at all*) to 6 (*describes very well*) scale to describe mothers' acceptance (e.g., "enjoys doing things with you," $\alpha = .93$ for adolescent and $\alpha = .90$ for parents in present sample).

Adolescent's negative adjustment. Adolescents' negative emotional adjustment was measured using three scales. The Children's Depression Inventory (CDI) is a 27-item self-report scale that measures adolescents' depressive symptoms and is associated with difficulties in managing diabetes (Kovacs, 1985). The CDI has high internal consistency ($\alpha = .90$ in our sample). The PANAS (Watson, Clark, & Tellegen, 1988) measures positive and negative affect, with 10 positive and 10 negative descriptors rated on a 1 (slightly) to 5 (extremely) scale indicating how the adolescent felt during the past month. The PANAS has high reliability ($\alpha = .91$ for negative and $\alpha = .88$ for positive emotions in our sample). The Diabetes Quality of Life (DQOL) scale for youth (Ingersoll & Marrero, 1991) measures the psychosocial impact of diabetes on three subscales: (1) diabetes life satisfaction (17 items), (2) negative disease impact (23 items), and (3) disease-related worries (11 items), with each item answered on a 5-point Likert scale. Internal consistency for each scale was high (alphas $> .85$).

Mother's negative adjustment. Maternal adjustment was measured using two scales: the PANAS ($\alpha = .92$ for negative, $\alpha = .86$ for positive affect) and the Center of Epidemiological Studies of Depression Scale (CES-D; Radloff, 1977), with excellent reliability in our sample ($\alpha = .91$).

To reduce the number of dependent measures reflecting negative emotional adjustment, z-scores for the negative emotional adjustment measures were calculated and averaged separately for adolescents and mothers to generate a measure of negative emotional adjustment used in the analyses below (see Olsen, Berg, & Wiebe, 2008, for analyses justifying this aggregation).

Diabetes management. To assess adherence in the past month, adolescents and mothers completed the 14-item Self-Care Inventory (La Greca, Follansbee, & Skyler, 1990). Participants rated the adolescent's adherence on a 5-point scale (1 = never did it to 5 = always did it without fail) to items such as "Administering insulin at the right time." If the item did not apply to participants' diabetes

regimen, a non-applicable option was available. All participants completed at least 80% of the scale items; adherence scores were computed by averaging applicable items ($\alpha = .73$ for adolescents, $\alpha = .78$ for mothers). This scale has good validity correlating with measures of glycosylated hemoglobin in our previous studies (Berg et al., 2008; Wiebe et al., 2005).

Analysis Plan

To account for the dependencies between adolescents and their mothers in perceptions of collaboration we utilized statistical techniques that allowed for analyzing the data at a dyadic level. First, to establish the three-factor structure of the PCQ in both adolescents and their mothers we used CFA and modeled three factors for each member of the dyad in one analysis. The PCQ factors and residual variances of corresponding PCQ items were allowed to correlate between adolescent and mother. CFA was used as it allowed us to test for the hypothesized factor structure of the instrument, to test for factorial invariance for adolescents and mothers, and for its flexibility in handling dyadic data. Second, we examined the relationship between scores based on this analysis and age to address age differences in dimensions of collaboration.

Third, to examine whether adolescents' and mothers' perceptions of collaboration and their convergence in these perceptions predicted negative adjustment, we conducted multivariate hierarchical linear modeling with application to matched pairs (HMLM2; Raudenbush, Bryk, Cheong, & Congdon, 2000). These analyses simultaneously estimated models for adolescents (A) and mothers (M), to account for the dependency between mothers and adolescents. These models took the following general form, which assessed whether perceptions of collaboration predicted negative adjustment over and above the effect of parental acceptance. The following illustrates the analyses for the compensation (C) dimension, with separate models conducted for each dimension of collaboration.

$$\text{Level 1, Negative Adjustment}_{\text{dyad } i} = \pi_{ai} (\text{Adolescent})_i + \pi_{mi} (\text{Mother})_i + e_i;$$

$$\begin{aligned} \text{Level 2, } \pi_{ai} = & \beta_{a0} + \beta_{a1} (\text{AAcceptance}) + \beta_{a2} (\text{AC}) \\ & + \beta_{a3} (\text{MC}) + \beta_{a4} (\text{AAge}) + \beta_{a5} (\text{AC} \times \text{MC}) \\ & + \beta_{a6} (\text{AAge} \times \text{AC}) + \beta_{a7} (\text{AAge} \times \text{MC}) \\ & + \beta_{a8} (\text{AC} \times \text{MC} \times \text{AAge}) + r_a; \end{aligned}$$

$$\begin{aligned} \pi_{mi} = & \beta_{m0} + \beta_{m1} (\text{MAcceptance}) + \beta_{m2} (\text{AC}) \\ & + \beta_{m3} (\text{MC}) + \beta_{m4} (\text{AAge}) + \beta_{m5} (\text{AC} \times \text{MC}) \\ & + \beta_{m6} (\text{AAge} \times \text{MC}) + \beta_{m7} (\text{AAge} \times \text{MC}) \\ & + \beta_{m8} (\text{AC} \times \text{MC} \times \text{AAge}) + r_m; \end{aligned}$$

Where Negative Adjustment_{dyad i}, (Adolescent)_i, and (Mother)_i are dummy variables indicating role within the dyad. The Level 1 equation without the Level 1 intercept accounts for the dependency arising because of the nesting

of persons within dyads (see Raudenbush et al., 1995). The independent variables were adolescents' and mothers' perceptions of maternal acceptance, collaboration (AC and MC, respectively, being the adolescent's and mother's perceptions of how much the adolescent needed collaboration to compensate for cognition) and the adolescent's age. Each of the facets of collaboration and adolescent age were centered around their mean to create interaction terms (Aiken & West, 1991). Fourth, a parallel analysis as described above for negative adjustment was conducted to assess whether perceptions of collaboration predicted the adolescent's and mother's report of adherence.

Results

Dimensions of Collaboration and Differences in Adolescents' and Mothers' Views of Collaboration

To address whether adolescents and their mothers diverged in their perceptions of collaboration on the PCQ, we modeled three factors for each member of the dyad and analyzed the data on a dyadic level. When running the initial CFA, some of the original PCQ items represented mixtures of two PCQ scales or did not clearly express the intended construct (items 7, 8, and 11; see Appendix). The three problematic items were dropped from the analysis and we ran the CFA with three items per PCQ factor (Figure 1).

As a first step, we compared the hypothesized six-factor model (three factors per dyad member; $\chi^2 = 177.09$, $df = 111$, $CFI = .88$, $TLI = .84$, $RMSEA = .08$, $SRMR = .08$) to an alternative two-factor model (one overall collaboration factor per dyad member; $\chi^2 = 274.88$, $df = 125$, $CFI = .74$, $TLI = .68$, $RMSEA = .12$, $SRMR = .11$) and found that the six-factor model fitted better, $\chi^2(14) = 97.79$, $p < .001$. Second, we tested for metric factorial invariance of adolescent and mother factors by constraining corresponding factor loadings to be equal across dyad members. Adding this constraint did not change the model fit, $\chi^2(6) = 8.18$, ns , which confirmed that the selected PCQ items have the same factor structure for adolescents and mothers and justified forming three PCQ scales for each dyad member. Considering the small sample and the complexity of the fitted model, the fit of the resulting final model (Figure 1) was adequate ($\chi^2 = 185.27$, $df = 117$, $CFI = .88$, $TLI = .84$, $RMSEA = .08$, $SRMR = .08$).

The findings presented in Figure 1 show some differences between adolescents' and mothers' perceptions of collaboration. Whereas the compensation, enjoyment, and frequency factors were highly intercorrelated in adolescents (C-E: $r = .81$; C-F: $r = .88$; E-F: $r = .71$; these correlations are the standardized estimates of the factor covariances reported in Figure 1), mothers perceived only frequency to be related to both compensation and enjoyment, but compensation and enjoyment were unrelated (C-E: $r = .26$, ns ; C-F: $r = .74$; E-F: $r = .60$; see also covariances in Figure 1). Mothers believed that their adolescent could experience compensation from collaboration irrespective of whether or not the adolescent enjoyed it, whereas for adolescents compensation and enjoyment were closely linked. Adolescents'

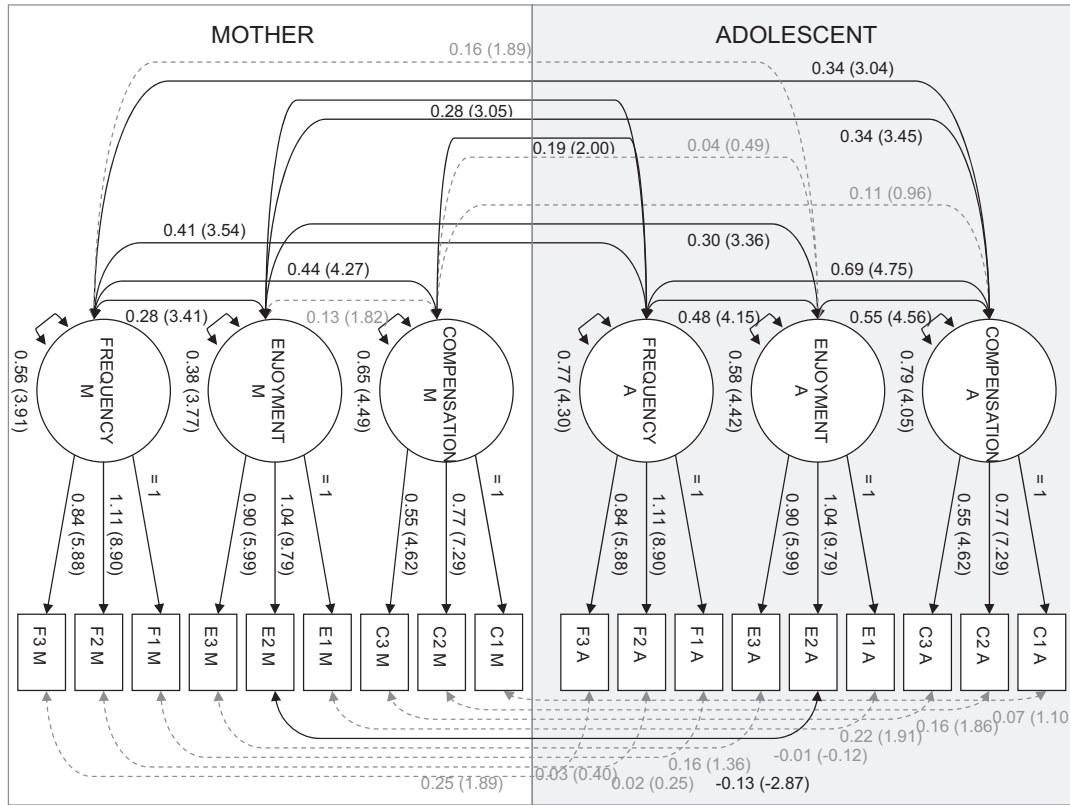


Figure 1. Dyadic factor structure of the PCQ. Corresponding factor loadings between adolescent and mother are constrained to be equal. Unstandardized parameter estimates are given with their respective z-scores in parentheses. Nonsignificant covariances are identified by gray dashed lines.

compensation and mothers' compensation were unrelated, $r = .15, ns$. Thus, adolescents and mothers held diverging perceptions of the cognitive function of collaboration, but held similar views of how much collaboration was perceived to be enjoyable, $r = .63$, and how frequently it was used, $r = .62$. Three summary scores were calculated separately for adolescents and mothers to reflect the mean values of the items that loaded on these three factors.

Associations Between Perceptions of Collaboration and Adolescent's Age

As can be seen in Table 1, with increasing age adolescents perceived collaboration to compensate less for cognitive function, reported enjoying it less, and reported collaborating less frequently. Mothers also perceived that with age adolescents collaborated less for compensation, and enjoyed

Table 1
Intercorrelations Among Study Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Adolescent compensation		.62**	.50**	.14	.43**	.19	-.44**	.43**	.21	-.12	.07	.19	.23*
2. Adolescent enjoyment			.35**	.04	.48**	.01	-.36**	.61**	.30**	-.47**	-.06	.33**	.32**
3. Adolescent frequency				.10	.19	.21	-.38**	.33**	.05	.12	.23	.10	.14
4. Mother compensation					.14	.33**	-.30**	-.01	.06	-.01	.20	-.01	-.16
5. Mother enjoyment						.25*	-.38**	.36**	.52**	-.24*	-.25*	.29*	.55**
6. Mother frequency							-.17	.06	.31**	.08	-.07	.05	.22*
7. Adolescent age								-.15	-.18	.26*	-.19	-.05	-.23*
8. Adolescent acceptance									.34**	-.44**	.03	.16	.30**
9. Mother acceptance										-.29**	-.35**	.23*	.32**
10. Adolescent negative adjustment											.20	-.28*	-.17
11. Mother negative adjustment												-.20	-.30**
12. Adolescent adherence													.48**
13. Mother report of adherence													

* $p < .05$. ** $p < .01$.

it less. However, mothers' reports of the frequency of collaboration were unrelated to adolescents' age.

Negative Psychosocial Adjustment and Perceptions of Collaboration

As predicted, we found that both adolescents' and mothers' reports of maternal acceptance were positively correlated with their respective reports of compensation (only for adolescents), enjoyment, and frequency, and negatively correlated with their negative adjustment (see Table 1). Therefore, maternal acceptance was used as a control variable in the analyses (adolescent report included in models for adolescent adjustment, mother report for models of mother adjustment).

First, a model was constructed predicting adolescent and mother negative emotional adjustment from perceptions of collaborating for compensation (see Table 2). After controlling for adolescents' views of mothers' acceptance both adolescents' and mothers' ratings of collaboration for compensation were positively related to negative adjustment. This might reflect that adolescents' and mothers' views of compensation were a response to the adolescents' greater negative adjustment. A significant three-way interaction was found between age, adolescents' and mothers' percep-

tions. As this interaction was produced largely because of the age differences in compensation that produced few young adolescents who had low levels of compensation and few older adolescents who had high levels of compensation by both mother and adolescent report, we do not interpret it further. For mothers' psychosocial adjustment, only her views of her acceptance were associated with her own lower negative adjustment.

A similar model was conducted using adolescents' and mothers' perceptions of enjoyment of collaboration to predict negative adjustment (Table 2). Even when controlling for adolescents' perceptions of mothers' acceptance, greater adolescent enjoyment of collaboration was associated with lower negative adjustment. For mothers, her perceptions of adolescents' enjoyment of collaboration did not predict her own negative adjustment after controlling for her perceptions of her levels of acceptance.

Finally, for the model using adolescents' and mothers' perceptions of frequency of collaboration to predict negative adjustment (Table 2), after controlling for acceptance there was a significant positive effect between frequency and negative adjustment. For mothers no significant effects of perceptions of frequency were found.

Table 2
Level 2: HMLM2 Analyses Predicting Negative Emotional Adjustment From Perceptions of Collaboration

	Adolescent		Mother	
	Coeff	(SE)	Coeff	(SE)
Compensation				
Intercept	-0.71	(.52)	-0.08	(.38)
Maternal acceptance	-0.22**	(.04)	-0.20**	(.05)
Adolescent compensation	2.28**	(.74)	0.15	(.52)
Mother compensation	2.15**	(.75)	0.36	(.54)
Adolescent age	0.07*	(.03)	-0.03	(.02)
Mother × adolescent compensation	-1.60	(.83)	0.13	(.59)
Age × adolescent compensation	-0.05	(.04)	-0.00	(.03)
Age × mother compensation	-0.07	(.03)	-0.00	(.02)
Age × adolescent × mother compensation	0.13**	(.04)	-0.02	(.03)
Enjoyment				
Intercept	0.78	(.54)	0.13	(.37)
Maternal acceptance	-0.14**	(.06)	-0.17**	(.05)
Adolescent enjoyment	-1.74*	(.84)	-0.05	(.52)
Mother enjoyment	-1.12	(.88)	-0.86	(.67)
Adolescent age	0.03	(.03)	-0.05**	(.02)
Mother × adolescent enjoyment	-0.85	(.84)	-0.57	(.57)
Age × adolescent enjoyment	-0.05	(.03)	0.00	(.02)
Age × mother enjoyment	0.08	(.04)	-0.00	(.03)
Age × adolescent × mother enjoyment	-0.04	(.05)	0.01	(.03)
Frequency				
Intercept	0.03	(.54)	-0.18	(.36)
Mother acceptance	-0.25**	(.05)	-0.21**	(.05)
Adolescent frequency	3.30**	(.98)	0.51	(.65)
Mother frequency	0.71	(1.01)	-0.49	(.73)
Adolescent age	0.08**	(.03)	-0.03	(.02)
Mother × adolescent frequency	0.29	(2.2)	1.83	(1.49)
Age × adolescent frequency	-0.04	(.06)	-0.01	(.04)
Age × mother frequency	0.05	(.05)	0.04	(.03)
Age × adolescent × mother frequency	0.01	(.13)	-0.08	(.09)

* $p < .05$. ** $p < .01$.

Adherence to Diabetes Regimen and Perceptions of Collaboration

A similar set of analyses as was conducted for negative adjustment was conducted for adolescents' and mothers' reports of adherence, via three HMLM2 analyses (see Table 3). Mothers' perceptions of compensation predicted her perceptions of adolescents' adherence, with better adherence associated with lower perceptions that the adolescent needed compensation. For the analyses of perceptions of enjoyment, greater perceptions that the adolescent enjoyed collaboration by both adolescent and mother predicted better adolescent reports of adherence. Greater mother's perceptions of enjoyment predicted her own perceptions of better adolescent adherence. No significant effects were found for mothers' and adolescents' views of frequency.

Discussion

Dimensions of Collaboration and Differences Between Adolescents' and Mothers' Perceptions

The results of the CFA indicated that both mothers and adolescents saw collaboration as serving a compensatory function even during adolescence, when children are more cognitively advanced. The challenges in solving everyday diabetes problems during adolescence (e.g., managing dia-

betes away from home, adjusting to metabolic dysregulations that occur because of puberty; Beveridge et al., 2006) may present difficult problems for which collaboration is especially beneficial. Mothers' and adolescents' perceptions of compensation were not significantly related, indicating potential disagreements in how much collaboration served a compensation function for adolescents.

The fact that both mothers and adolescents perceived an interpersonal function of collaboration supports the view that collaboration not only makes up for limited cognitive abilities, but also serves to regulate relationships (Beveridge & Berg, 2007; Meegan & Berg, 2002). The interpersonal enjoyment aspect of collaboration has been neglected in the work on collaborative problem solving in child development. The results indicate that for adolescents the interpersonal function was closely intertwined with the cognitive function and the frequency of collaboration. Thus, one pathway for increasing the use of collaboration may be through facilitating how enjoyable it is. Mothers' perceptions, however, were less tightly connected, such that they perceived that the adolescent could need collaboration for compensation without enjoying it.

Perceptions of Collaboration and Adolescent Age

Consistent with our hypothesis, age-related differences were found in perceptions of collaboration. Both mothers and ado-

Table 3
Level 2: HMLM2 Analyses Predicting Adherence From Perceptions of Collaboration

	Adolescent		Mother	
	Coeff	(SE)	Coeff	(SE)
Compensation				
Intercept	3.76	(.07)	3.51	(.05)
Maternal acceptance	0.00	(.01)	0.01	(.01)
Adolescent compensation	0.06	(.10)	0.04	(.07)
Mother compensation	-0.02	(.10)	-0.15*	(.07)
Adolescent age	0.00	(.00)	-0.01*	(.00)
Mother × adolescent compensation	0.02	(.11)	0.02	(.08)
Age × adolescent compensation	0.01	(.00)	0.01	(.00)
Age × mother compensation	0.00	(.00)	-0.01	(.00)
Age × adolescent × mother compensation	-0.01	(.00)	-0.00	(.00)
Enjoyment				
Intercept	3.67	(.06)	3.51	(.05)
Maternal acceptance	-0.01	(.00)	0.00	(.01)
Adolescent enjoyment	0.25**	(.10)	-0.04	(.07)
Mother enjoyment	0.29**	(.11)	0.27**	(.09)
Adolescent age	0.00	(.00)	0.00	(.00)
Mother × adolescent enjoyment	-0.01	(.10)	0.04	(.07)
Age × adolescent enjoyment	0.00	(.00)	0.00	(.02)
Age × mother enjoyment	-0.01	(.00)	0.00	(.03)
Age × adolescent × mother enjoyment	0.01	(.01)	-0.01	(.03)
Frequency				
Intercept	3.79	(.07)	3.56	(.05)
Mother acceptance	0.00	(.01)	0.01	(.01)
Adolescent frequency	0.08	(.12)	0.04	(.08)
Mother frequency	-0.02	(.13)	0.13	(.10)
Adolescent age	0.00	(.00)	0.0	(.00)
Mother × adolescent frequency	-0.08	(.24)	-0.33	(.18)
Age × adolescent frequency	0.01	(.01)	0.01	(.00)
Age × mother frequency	0.00	(.01)	0.00	(.00)
Age × adolescent × mother frequency	-0.02	(.01)	-0.01	(.01)

* $p < .05$. ** $p < .01$.

lescents perceived that with age adolescents collaborate less to compensate for cognitive function and enjoy it less. These age-related differences may be driven by mothers' and adolescents' increasing view of the adolescent as cognitively capable of completing daily diabetes management tasks. Further, working together during late adolescence has the potential to feel intrusive and overprotective (Wiebe et al., 2005). Although adolescents viewed collaboration as less frequent with age, the relation between age and mother's reports of the frequency of collaboration was not significant. Mothers and adolescents may have slightly different views of what constitutes collaboration, with mothers viewing that they "work with" their adolescent even when the adolescent perceives that they are independently managing everyday problems.

Perceptions of Collaboration and Negative Adjustment and Adherence

Despite the fact that adolescents reported less compensation, enjoyment, and less frequent use of collaboration with age, adolescents of all ages benefited in terms of lower negative adjustment and better adherence to the diabetes regimen when they reported enjoying it. There was no interaction with age, indicating that all adolescents benefited. These results for adolescents were not simply because of the fact that enjoyment of collaboration was associated with having mothers who were more accepting, and that maternal acceptance was associated with better psychosocial adjustment (Butler et al., 2007). Although adolescents' perceptions of maternal acceptance were associated with their perceptions of greater compensation, enjoyment, and more frequent use of collaboration, consistent with the benefits of an accepting parent-child relationship on outcomes (Beveridge & Berg, 2007), the benefits of enjoyment were not simply because of maternal acceptance. Similarly, mothers also benefited psychosocially when they reported that their adolescent enjoyed collaborating with them, although mothers' findings were accounted for by her ratings of acceptance. The importance of enjoyment of collaboration in providing support and encouragement is consistent with research with spouses coping with chronic illness (Berg & Upchurch, 2007). The cross-sectional nature of our study limits our interpretation of the direction of the effects. Viewing collaboration as enjoyable interpersonally could lead to lower negative adjustment and better adherence. Alternatively, when the adolescent is highly adherent and experiencing low negative adjustment, collaborating with mother may be more enjoyable. Current longitudinal research ongoing in our laboratory will be able to address these issues.

Our enjoyment findings for negative adjustment were constrained to within reporter effects such that reports of enjoyment were only associated with negative adjustment within adolescents and within mothers. Thus, we cannot rule out the possibility that one's own negative affect may lead to negative interpretations about interacting with one's mother or adolescent (Luoma et al., 2004). However, if these results were because of negative emotion biasing one's perceptions of collaboration, we would have expected more across the board relations between negative adjust-

ment and perceptions of collaboration as cognitive compensation and frequency as well.

When controlling for maternal acceptance, adolescents' and mothers' reports of compensation and adolescents' reports of frequency were associated with greater adolescent negative adjustment. These results could suggest that when controlling for the quality of the mother-child relationship, the frequent use of collaboration for compensation is in response to the adolescent's negative adjustment. These multivariate effects, however, should be interpreted with caution as they are in contrast to the zero order correlations indicating that adolescents' report of compensation and frequency were unrelated to their own negative adjustment.

There was little indication that cross-over effects (e.g., mothers' perceptions affecting adolescent outcomes or vice versa) or discrepancies between mothers and adolescents were associated with additional effects on either mothers' or adolescents' negative adjustment or adherence. The high correspondence in general in mothers' and adolescents' perceptions of interpersonal enjoyment and frequency may have contributed to these results. Two exceptions, however, did occur. First, mothers' views of compensation were associated with adolescents' greater negative emotional adjustment, possibly reflecting that mothers view collaboration as necessary when their child is struggling emotionally. Second, mothers' views of enjoyment independently predicted adolescents' perceptions of adherence over and above adolescent's perceptions of enjoyment.

Limitations, Future Directions, and Conclusions

The results need to be interpreted in the context of some limitations and suggestions for future research. First, the results are based on self-report and would be strengthened by including an everyday problem-solving situation in which ongoing mother-adolescent collaboration and perceptions are mapped onto cognitive ability and behavioral coding of enjoyment. Second, the lack of external markers of the success of diabetes management (e.g., HbA1c) limits our conclusions that collaboration may be beneficial for diabetes management. However, our previous work using interviews regarding mothers' involvement in daily diabetes problems also indicates the benefit of collaboration for glycemic control (Wiebe et al., 2005). Third, our results may have limited generalizability as the sample consisted of White mother-adolescent dyads. Collaboration may be even more important for adolescent and parent functioning in cultural groups (e.g., Latinos and Asians) that emphasize connectedness among individuals within the social context (Harrison et al., 1994). In addition, the role of fathers' involvement will be important to consider in future research, as their involvement may be especially important during adolescence (Berg et al., in press). Fourth, additional research is ongoing to determine how perceptions of collaboration are linked to other family-based concepts such as perceptions of emotional and instrumental support. Fifth, we examined perceptions of collaboration within the highly stressful context of dealing with a chronic illness. Although the larger problem solving literature on collaboration leads us to believe that its value extends beyond the context of dealing with chronic illness (Rogoff, 1998), further research is needed especially

during the adolescent years. Finally, research ongoing in our laboratory will address whether the factor structure of the PCQ replicates with a larger sample size, which is important given our use of CFA with a small sample.

In sum, our results suggest that the benefits of collaboration between mothers and their children extend into adolescence, especially when adolescents are dealing with challenging everyday problems surrounding stressful life circumstances in dealing with a chronic illness. Further, collaboration not only serves a cognitive function in problem solving, but also interpersonal support functions (Berg & Upchurch, 2007) that may emerge out of a warm and accepting parent-child relationship. The results are consistent with research indicating the value of teamwork interventions (Anderson et al., 1999) for children's adjustment as they manage stressors across adolescence. Clinically, it may be important for collaboration to be viewed as a useful tool for families struggling with a stressful life context to maintain the monitoring that is needed together with granting the child autonomy. The health-care provider may be an important resource in this regard by providing messages as to what type of parental involvement is needed for adequate diabetes management (Wiebe, Berg, Fortenberry, Sirstins, Lindsay, Donaldson, et al., 2008). The results suggest that collaboration may be a beneficial way that parents and adolescents can work together to solve difficult and stressful everyday problems.

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Appendix

Perceptions of Collaboration Questionnaire (PCQ): Adolescent and Mother Versions

Compensation

- C1 A: I make better decisions when my mom and I work together. (2)
 M: My child makes better decisions when he/she and I work together. (2)
- C2 A: I view working together with my mom as necessary, as it is harder for me to solve problems and make decisions by myself. (1)
 M: It is necessary for my child and I to work together, as it is harder for my child to solve problems and make decisions by him/herself. (1)
- C3 A: Working together with my mom is useful as she makes up for things that I don't do well. (9)
 M: Working together with my child is useful as I make up for things that he/she doesn't do well. (9)

Enjoyment

- E1 A: I enjoy the support and encouragement I receive when I work together with my mom. (6)
 M: My child enjoys the support and encouragement he/she receives when I work together with him/her. (6)
- E2 A: Solving everyday problems and making decisions together with my mom brings us closer together. (10)
 M: Solving everyday problems and making decisions together with my child brings us closer together. (10)
- E3 A: I dislike getting my mom's assistance as it makes me feel incompetent (R). (12)
 M: My child dislikes my assistance as it makes him/her feel incompetent (R). (12)

Frequency

- F1 A: My mom and I always work together to deal with diabetes decisions. (3)
 M: My child and I always work together to deal with diabetes decisions. (3)
- F2 A: Nearly every day my mom and I work together to make diabetes decisions. (4)
 M: Nearly every day my child and I work together to make diabetes decisions. (4)
- F3 A: It is rare for my mom and I to share diabetes tasks and make decisions together (R). (5)
 M: It is rare for my child and I to share diabetes tasks and make decisions together (R). (5)

Excluded

- X1 A: Decision making with my mom is slower as it takes longer to come to a decision than doing it by myself (R). (7)
 M: Decision making with my child is slower as it takes longer to come to a decision than doing it by myself. (7)
- X2 A: My mom and I avoid working together as it causes conflict (R). (8)
 M: My child and I avoid working together as it causes conflict (R). (8)
- X3 A: Solving diabetes problems with my mom is best as two heads are better than one. (11)
 M: Solving diabetes problems with my child is best as two heads are better than one. (11)

Note. A = Adolescent Version; M = Mother Version; R = reverse coded. The original item order in the questionnaire is indicated in parentheses.

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