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A Micro-Developmental View of Parental Well-being in Families Coping with Chronic Illness

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Abstract

Families are co-regulating systems in which the daily experiences of one member affect the well-being of another member of the family. We examined daily, micro-developmental processes by modeling the associations between adolescents' daily problems and emotional experiences in managing type 1 diabetes and changes in parental negative and positive affect surrounding the illness. Using a daily diary method, 161 mothers (*M* age=40 years), fathers (*M* age=42 years), and early adolescents (*M* age=12.4 years) rated their negative and positive emotions surrounding diabetes for 14 days. Adolescents reported, via a checklist, the number of problems they experienced in managing diabetes each day. Using dynamical systems modeling, we found that adolescents' problems and emotions were related to changes in their parents' reports of negative affect, though differently for mothers and fathers. On days when adolescents reported more problems, fathers' affect changed more slowly back to homeostasis. Adolescents' problems were not associated with change in mothers' negative affect, but when adolescents reported greater negative daily affect, mothers were drawn to greater negative affect, displaying a higher set point. Models accounting for parental coupling effects suggested that when adolescents reported more negative affect, mothers' affect changed more slowly back to homeostasis. Neither adolescents' problems nor their emotions were associated with changes in mothers' or fathers' reports of daily positive affect. These results indicate different temporal patterns in mothers' and fathers' negative affect that illustrate how mothers, fathers, and adolescents react differently to chronic illness within the family system.

Keywords

parenting; early adolescence; type 1 diabetes; daily affect; dynamical systems

Families are co-regulating systems in which the stresses and strains of one family member affect the well-being of another member of the family (Repetti, Wang, & Saxbe, 2009). These family processes unfold throughout development, potentially changing as both children and parents age. The primary interest in the developmental literature has been on how daily emotions and problems experienced by parents, most especially those occurring at work or within their marriage, spill over to affect interactions with children and spouses (Almeida, Weathington, & Chandler, 1999; McDonald & Almeida, 2004; Repetti & Wood, 1997). Transactional perspectives of family processes (Sameroff, 2009), however, predict that not only do stressors that parents experience affect the well-being of children, but that children's stressors and emotions also affect the well-being of their parents. From a transactional perspective, these family interactions can be examined at a macro level, whereby the goal is to understand how these processes change across large time scales, or at a granular level, by focusing on daily family experiences. A focus on these daily snapshots of family interactions holds the potential to reveal the micro-developmental processes that inform how the family is developing together.

A growing literature indicates associations between parents' well-being and their adolescent and adult children's problems (e.g., Fingerman, Cheng, Birditt, & Zarit, 2012), including emotional problems, substance abuse, financial and legal problems, and health (Greenfield & Marks, 2006). A child's daily problems could potentially destabilize parental well-being, with the magnitude of this destabilization depending on the extent of parental involvement with the child. The effects of adolescents on parents' daily emotional experiences may be most apparent within contexts that are highly stressful or emotional such as events surrounding a chronic illness (Butner et al., 2009; Streisand et al., 2005).

The present study examined the relationship of early adolescents' daily problems managing type 1 diabetes with parental positive (PA) and negative affect (NA) surrounding their child's illness. Type 1 diabetes is one of the most common chronic illnesses in childhood and adolescence (Centers for Disease Control, 2014). Management of this illness requires a complex and intensive daily regimen including meal planning, repeated glucose testing, and insulin injections. Adolescents report experiencing problems dealing with blood glucose levels that are too high or too low and conflict with parents (Berg et al., 2013; Beveridge, Berg, Wiebe, & Palmer, 2006; Fortenberry, Berg, & Wiebe, 2012). Problems with diabetes management may increase across the adolescent years as evidenced by poorer adherence and metabolic control (Helgeson, Reynolds, Siminerio, Escobar, & Becker, 2008), and may have implications for parental well-being across adolescence. Caregivers of children with chronic illness report experiencing more parental stress than parents of healthy children (Cousino & Hazen, 2013), and the care demands of diabetes have been shown to have long term consequences for parental well-being (Kovacs et al., 1990).

The goal of this study was to understand how adolescents' daily diabetes problems and emotional experiences surrounding diabetes were related to both mothers' and fathers' daily affective experiences in response to their child's illness. Adolescence is an especially important developmental period in managing diabetes, as parents begin encouraging their children to manage their illness independently. To hone in on the transactional aspects of

managing diabetes in this developmental period, we focused on the daily interplay of how parents' affect changes in relation to their adolescents' problems in managing diabetes.

Given that diabetes management requires daily adherence (e.g., checking blood glucose, injecting insulin) and parental monitoring of those adherence behaviors, adolescents' problems with diabetes management and their emotional responses surrounding diabetes may be associated with parental affect on a daily basis. Problems with diabetes, such as highs and lows in blood glucose, occur daily and are associated with adolescents' daily negative affect (Fortenberry et al., 2009). These negative emotional experiences may in turn be associated with daily parental affect. Very little is known, however, about how adolescents' daily diabetes-related problems and emotions relate to parents' emotional experiences. Caring for a child with diabetes has been associated with high parental stress as the daily care demands of diabetes (e.g., responding to hyper and hypoglycemic episodes, disruptions to sleep and work) are quite challenging (Streisand et al., 2010). Additionally, we know very little about how parents' experiences of those diabetes problems may be associated with their spouse's affective experiences surrounding diabetes.

In families comprised of two parents, complex relationships among adolescents' diabetes problems, adolescents' emotional experiences, and a spouse's emotions may relate to parents' daily affective experiences. Family systems theory views the family as an interdependent unit whereby the behavior of each family member is considered within the context of the family as a whole (Fingerman & Bermann, 2000; Gavazzi, 2014). From this perspective, it is reasonable to predict that adolescents' emotions and problems relate to parental affect; however, the relationship between adolescents' problems and parental well-being may differ for mothers versus fathers. Mothers generally spend more time than fathers in childrearing activities (Yeung, Sandberg, Davis-Kean, & Hofferth, 2001) and are typically more involved than fathers in diabetes management (Berg et al., 2008), putting them 'in the trenches' of daily diabetes care. Given their greater involvement, mothers' emotions may be less disrupted by diabetes problems, as they have experience handling these events on a daily basis. As fathers have less daily involvement (Berg et al., 2013), their emotions may be more associated with substantial disruptions in diabetes management (e.g., when problems with diabetes occur). Parental affect may also change in response to a spouse's affect. Because parents may collaborate in caring for their adolescents' health, it is important to understand how parents' affective experiences are associated with changes in adolescents' management problems and daily emotions, and their partners' affective experiences. Such complex relationships highlight the need to go beyond simple coupling relationships to capture how problems and affect are shared in adolescent-mother-father triads (Granic, 2000).

A Dynamical Systems Approach to Families Coping with Diabetes

Transactional perspectives of families are challenging quantitatively (Sameroff & Mackenzie, 2003). They imply recursive causal loops wherein problems, for example, induce changes in well-being that induce changes in problems and so forth within each family member and across family members and continue across development between parents and children. This complex web of connections is difficult to tease apart and may

generate misleading results by merely examining the associations of one variable on another through time (Butner, Berg, Baucom, & Wiebe, 2014).

We approached these interrelationships from a dynamical systems perspective, focusing on the resultant temporal patterns and the stability of those patterns (Guastello & Gregson, 2012). The basic premise of the systems approach is that the recursive causal loops within and between family members create stable patterns. When examining the associations between daily problems and well-being, for example, problems function as perturbations on the temporal pattern, helping to stabilize or destabilize well-being through time. Using this methodological approach, one can begin to disentangle the relationship between well-being and problems. However, it is important to note that dynamical systems argue for bi- and multi-directional relationships, making causality difficult or even impossible to determine (Butner, Gagnon, Geuss, Lessard, & Story, 2015).

Although previous work has not used dynamical systems to understand parent-adolescent emotional experiences, dynamical systems have been applied to examinations of couples' affective processes across time (Butler & Randall, 2013; Butner, Diamond, & Hicks, 2007). Butner, Diamond, and Hicks (2007) represented affect co-regulation between romantic partners by examining how an individual's affect predicted changes in affect of the partner. In the current study, we examined whether adolescents' problems managing diabetes and their associated emotions were related to changes in parental affect. Given that affect can be shared between partners (Berg, et al., 2008; Saxbe & Repetti, 2010), we accounted for the extent to which one parent's affective experiences predicted changes in the other parent's affect. That is, parental affective experiences are characterized by the confluence among the problems that an adolescent has with diabetes, the adolescent's daily emotions related to diabetes, and the emotions of a spouse surrounding diabetes.

A simple dynamical systems model takes day-to-day changes into account by regressing change in affect from current affect (Butner, Gagnon, Geuss, Lessard, & Story, 2014). Figures 1a and 1b were created using data of one mother's NA across 14 days. Figure 1a depicts a hypothetical relationship between change in mother's NA and mother's current NA where we have overlaid the best fitting straight line, akin to linear regression. In this case, the slope is negative. This relationship depicts how current NA indicates where we would expect the parent to move next. If current negative emotions were very high, change is negative (the predicted value for change would be a negative value) depicting a decrease in negative emotions the next day. If current negative emotions were low, change is positive, depicting an increase in negative emotions over time. The pattern displayed in Figure 1a is known as a *fixed point attractor*, representing a pattern of change of a mothers' affect through time. The *set point* is where in this pattern a parent moves that reflects a point of no-change (in Figure 1a, where the linear slope crosses the zero point on the Y-axis, noted in the figure by the dotted vertical line). Compare this pattern to that in Figure 1b which depicts a mother's NA across 14 days as a time series. The set point in Figure 1b (indicated by a dotted horizontal line) is the value upon which the time series hovers around over the fourteen days – now on the Y axis. In this case, it is close to the mean value of mother's change in NA. The deviations from the set point in Figure 1b appear merely as fluctuations.

However, in terms of change, as illustrated in Figure 1a, these fluctuations are redefined as part of the pattern relating to the set point as opposed to measurement error.

Our illustration in Figure 1a argues that well-being has homeostatic properties. Parents' affect is constantly moving off the set point in response to daily events in parenting, work, etc. and the set point functions like a sink and keeps pulling them back. Imagine a diabetes problem, such as a low blood glucose reading, that relates to a sudden increase in NA. The regression line implies that over time, NA should move back towards the set point capturing how parents would be regulating their own NA back to homeostasis. A steeper slope represents returning faster to this set point and also represents a greater resistance to disturbances in the system, or perturbations, more generally. In this example, a potential perturbation could be an adolescent's diabetes problems. A shallower slope indicates a longer return time and also a system that is more susceptible to perturbations, such as adolescents' daily problems. The stability of the system represents how resistant the system is to perturbations (e.g., how resistant changes in parental NA are to adolescents' problems).

In this system, we can incorporate two ways in which daily adolescent problems and emotions may relate to daily parental affective experiences. In the first case, adolescent problems can move the set point of parental affect. For example, on days when adolescents report more problems, parental PA might be attracted to a lower value and NA attracted to a higher value. If we then imagine a changing degree of problems over days (i.e., increases or decreases), parental affect would move with those changes - what is commonly characterized as coupling. The second kind of relationship is where adolescent problems alter the stability of the attractor. In this case, on days where adolescents report more problems, parents may be more or less sensitive to these problems. For instance, parents could lose stability in response to problems displaying much greater volatility in their affect, becoming more vulnerable to problems (i.e., displaying great changes in NA). Alternatively, it could be that when adolescents report many problems, parents are able to garner resources, perhaps through self-control or support from others, which could mitigate the influence of problems over time (i.e., displaying less change in NA).

In the present study, we examined these change processes in mothers' and fathers' daily NA and PA. Mothers and fathers reported their daily NA and PA for 14 days, while adolescents reported on their daily problems in managing diabetes and their own daily NA and PA with respect to diabetes. We first examined whether adolescents' reports of daily diabetes problems and affect were related to changes in mothers' and fathers' daily affect. Following the frameworks set out by family systems theory and transactional perspectives, we predicted that adolescents' problems and affect would relate to changes in parents' affect. We expected, however, that adolescents' problems and emotions would be differentially associated with mothers' and fathers' emotions given the extent to which each parent is involved in daily diabetes management. Given that fathers tend to be less involved in daily diabetes management, we anticipated larger disruptions in diabetes management that may arise as more problems occur would be related to changes in their daily affective experiences. Second, we examined whether relationships between adolescents' daily problems and parental PA and NA were maintained once we accounted for coupling in emotion between mothers and fathers. We did not make predictions as to whether these

associations would be maintained when parental emotion was added into the model, given the paucity of research on family daily affect and problems.

Method

Study Design

The data from this study came from a larger project on type 1 diabetes management during adolescence (Berg, et al., 2009). Participants included adolescents, their mothers, and, when possible, their fathers. This longitudinal study spanned three years with data collections occurring every six months and a 14-day daily diary component in the second data collection point during the first year. Our data drew from mothers', fathers', and adolescents' end-of-day diaries; thus responses reflected experiences that occurred in the last 24 hours.

Participants in the larger study were recruited during routine medical visits to a university-based diabetes clinic with a dedicated pediatric endocrinology unit (85%) or a local independent medical practice (15%). Eligibility criteria included being between 10 and 14 years old, being diagnosed with type 1 diabetes for at least one year, being able to read and write in either English or Spanish, and living with mother. Of those who were eligible, 66% agreed to participate resulting in 252 adolescents diagnosed with type 1 diabetes mellitus, their mothers, and 188 fathers (reasons for non-participation included commute distance, 23%; too busy, 21%; not interested, 30%; uncomfortable with being studied, 16%; time commitment, 6%, other illness in family, 5%; and no reason, 3%).

Participants in present study

Our family-level analyses required daily diary data from adolescent-mother-father triads, resulting in a sample size of 161 triads[1]. Of the original 252 adolescent-mother pairs recruited, 203 mothers and 207 adolescents completed the daily diary. Of the 188 fathers recruited for the study, 161 completed the daily diary. These triads were mostly intact families with 89% of adolescents living with both parents 100% of the time. Mothers, fathers, and adolescents completed on average 12 days of the daily diary.

On average, adolescents in our subsample were 12.97 years of age (SD = 1.51) and 50% were female. The average length of diagnosis was 4.44 years (SD = 2.86). Over half of the adolescents were on an insulin pump (60%) and their average HbA1c value recorded in medical records using point of care assays was 8.2% (SD = 1.35); this average level of glycemic control is poorer than the 7.5% currently recommended for adolescents with type 1 diabetes.

Parents of the adolescents were middle-aged (M mothers' age = 41 years; M fathers' age = 43 years). Families were predominantly Caucasian (93%) and middle class, with more than 70% reporting annual household incomes of $50,000 or more. Over half (56%) of mothers and fathers (59%) reported having achieved 2 years of college or more.

[1]Adolescents whose mother and father both participated in the diary did not significantly differ from adolescents who had only one parent participate in number of reported problems or positive or negative affect (ps < .10).

Procedures

This study was approved by the university institutional review board. Mothers and fathers gave written informed consent and adolescents gave written assent. Adolescents and their mothers came into the laboratory for a 2-hour session in which they completed a questionnaire packet and were given a tutorial for completing the 14-day daily diary. Fathers received training by phone. The diaries were web-based and were submitted via a secure website at the end of each day. A trained research assistant checked each diary for completion and made reminder phone calls if diaries were not complete by 9 pm. Each participant was compensated $4 for each completed diary and $50 for attending the 2-hour questionnaire and training session.

Materials

Daily adolescent diabetes problems—Each day adolescents reported whether they experienced any of 9 diabetes-related problems. The problems were drawn from prior work in which parents and children were interviewed about the most stressful event they experienced weekly in diabetes management (Beveridge et al., 2006). Problems included (1) forgetting or skipping a blood-sugar test, (2) taking the wrong amount of insulin, (3) problems with exercising or playing sports, (4) problems eating what child wanted to, (5) feeling bad (upset, angry, sad) because of diabetes, (6) managing diabetes away from home, (7) problems with high blood sugar, (8) figuring out how much insulin to take based on exercise, eating, and blood sugar, and (9) problems with low blood sugar. Each problem was assigned a yes/no response and a sum was taken to obtain the total number of diabetes problems experienced each day. Adolescents reported an average of 1.28 (SD = 0.93) problems managing their diabetes per day and the most frequently reported problems were problems with high blood sugar (39%), forgetting/skipping blood-glucose tests (30%), and problems with low blood sugar (22%). Adolescents' reports of daily problems ranged from 0 – 9.

Daily affect—Using a modified Positive and Negative Affect Schedule (PANAS; Watson & Clark, 1999), parents and adolescents reported the extent to which they felt positive (happy, excited) and negative (anxiety, sad, annoyed, mad, depressed, nervous, irritated, angry) emotions in relation to their child's diabetes each day for 14 days. Items were rated on a 5-point response scale (1 [not at all] – 5 [extremely]). Averages of positive and negative emotions were computed to obtain average daily PA ($\alpha_{mothers}$ = 0.67, $\alpha_{fathers}$ =0.75, $\alpha_{adolescents}$ = 0.80) and NA (α > 0.92 for all participants). Reports of daily NA ranged from 1 – 5 for mothers and adolescents and 1 – 4.75 for fathers. Reports of daily PA ranged from 1 – 5 for each member of the triad. Across days, mothers and fathers both reported similar levels of positive t and negative emotional experiences.

Covariates—In each model, we controlled for adolescent age (grand mean centered) and gender (male = 0, female = 1).Under non-systems approaches, these covariates would be plausible alternatives for explaining our results. However, we did not expect these to have impact in the systems models herein. Dynamical systems assumes that the relationships are under constant perturbations as a function of only examining part of the system. These perturbations should include the possible impact of many covariates including these. That

said, as adolescent age and gender are often important covariates in family literature, we tested their relationships.

Analytic Strategy

Our approach to understanding the daily associations between adolescents' problems with diabetes management and affect and parental NA and PA utilized models that depicted inherent stability or instability in parental affect over time. We did this by creating models where the dependent variables were *changes* in parental NA and PA. We conducted stacked analyses using multilevel modeling to account for there being multiple members of the family system (i.e., adolescent, mother, father) as opposed to a single member of the family as presented in Figures 1a and 1b.

Creating dynamical systems models—Consider change in mothers' NA as an outcome represented by a difference score, NA_{t+1} - NA_t, where $_t$ is a given measurement occurrence on a given day. To generate a simple dynamical systems representation, we included mothers' NA_t as a predictor. When the slope on mothers' NA is negative, mothers' values over time are moving towards a homeostatic value, called a set point. The set point is determined by the value of NA when predicted change is zero. The steepness of the slope represents the rate at which NA moves towards the set point through time. We can then examine what variables moderate the NA coefficient as an indicator of strengthening of stability or weakening of stability (i.e., instability). That is, variables such as adolescents' problems or NA can increase or decrease the rate at which the system stabilizes. A main effect of another variable has the ability to move the set point. Predictors in our model of change in mothers' NA included mothers' daily NA, adolescents' daily reports of problems, a two-way mothers' NA * adolescents' problems interaction, adolescents' NA, and a two-way mothers' NA * adolescents' NA interaction. The main effects of adolescents' daily reports of problems and adolescents' NA in this model allow for a moving set point. Moderation of the parents' NA terms in this model represents strengthening or weakening of attraction towards a single location.

Incorporating actor-partner effects—The associations of adolescent diabetes problems and affect with the set point and stability of parental affective experiences could be the same across mother and father or different. In order to differentiate between parents in the family system, we built this model as a simultaneous equation for change in mothers' and fathers' affective experience. Thus, each model includes an intercept for mothers and fathers (predicted change when own PA or NA is zero) and main effects of mothers' and fathers' affect predicting change in their own affect. This arrangement allows for testing the equivalency of the coefficients on each parent (i.e., are the parents equal in their sensitivity to adolescent coupling?). This method is a form of multivariate or Actor-Partner Interaction (Kenny, Kashy, & Cook, 2006) approach to multilevel modeling, where we included a code for mothers and fathers, and repress intercepts (Raudenbusch, Brennan, & Barnett, 1995). Thus, 2-way interactions are represented as 3-way interactions (the 2-way interaction * the dummy code for mothers and fathers). We also included a covariance in the Level 1 residuals between husbands and wives that is assumed to be constant over couples and time. This accounts for remaining couple interdependencies. The nested equation (equation 1) for

change in parental NA is as follows, where Z = Fathers' NA_{t+1} - Fathers' NA_t when father (dummy coded) = 1 and Z = Mothers' NA_{t+1} – Mothers' NA_t when Mother (dummy coded) = 1. Fixed effects are represented by β and ω represent random effects:

$$\begin{aligned} Z=&\beta_1(\text{father})+\beta_2(\text{father}*\text{father's}NA_t)+\beta_3(\text{father}*\text{child problems}_t)+\beta_4(\text{father}*\\ &\text{child problems}_t*\text{father's}NA_t)+\beta_5(\text{father}*\text{child's}NA_t)+\beta_6(\text{father}*\text{child's}NA_t*\\ &\text{father's}NA_t)+\beta_7(\text{mother})+\beta_8(\text{mother}*\text{mother's}NA_t)+\beta_9(\text{mother}*\text{child problems}_t)+\\ &\beta_{10}(\text{mother}*\text{child problems}_t*\text{mother's}NA_t)+\beta_{11}(\text{mother}*\text{child's}NA)+\beta_{12}\\ &(\text{mother}*\text{child's}NA_t*\text{mother's}NA_t)+\omega_{1i}(\text{father})+\omega_{2i}(\text{father}*\text{father's}NA_t)+\omega_{7i}\\ &(\text{mother})+\omega_{8i}(\text{mother's}NA_t)+e \end{aligned}$$

To test for equivalency between parents, we conducted a test of deviances between the model depicted in equation 1 with a model depicted in equation 2 that excludes the dummy codes between parents. The intercept was returned back to the equation, all the redundant parameters were removed, and the error covariance between spouses was retained.

$$\begin{aligned} Z=&\beta_0+\beta_1(\text{own } NA_t)+\beta_2(\text{child's problems}_t)+\beta_3(\text{child's problems}_t*\text{own } NA_t)+\beta_4\\ &(\text{child's}NA_t)+\beta_5(\text{own }*\text{child's}NA_t)+\omega_{0i}+\omega_{1i}(\text{own } NA_t)+e \end{aligned}$$

This model stipulates that the parameter estimates are identical between mothers and fathers (since there is no distinction). Thus, a difference in deviances between the model from the first equation and the model from the second equation is a test of whether the mother and father models were equivalent (non- significance would indicate equivalence). Again, we included the error covariance between parents.

To determine if the relationships of the parent to the adolescent were distinct from parent-parent coupling, we expanded the first equation to include two more terms: fathers' NA to predict changes in mothers' NA and mothers' NA to predict changes in fathers' NA. We then examined the extent to which the adolescent effects were altered after controlling for this spousal coupling relationship. If the effects of adolescent NA were accounted for by spouse's daily NA, then the adolescent effects should approach zero due to partialing.

In modeling changes in both NA and PA, we first tested models where daily adolescent emotion and problems were simultaneous predictors of change in parental affect (depicted in equation 1). Our following models allowed for a mother-father coupling term to address whether the effects of parent-adolescent coupling remained after accounting for the effects between mothers and fathers (equation 2). In each model, we used grand mean centering, as this technique maintains the differences both between and across people. All models were run using full maximum likelihood in both SPSS Mixed (v21) and SAS PROC MIXED (v9.3) to verify consistent results across applications. Missing data were treated within the multi-level models under an assumption of missing at randomness. Significance was reported using α=.05, two-tailed.

Results

Change in Parental NA

We first considered how adolescents' daily number of problems managing their diabetes and their NA predicted changes in parental NA (Table 1). There were significant main effects for both mothers' (mother * mother's NA) and fathers' NA (father * father's NA). These effects simply reflect that daily NA predicts change in NA for both parents negatively. The relationships of greatest interest in this model were the main effects of daily adolescent problems and NA and the interaction terms between daily parental affect and adolescents' problems or NA. In the model depicted in Table 1, there were no significant main effects of adolescent daily problems on fathers' or mothers' change in NA. That is, on average, the set point was not changing as a function of changes in number of problems. However, there was a significant main effect of daily adolescent NA on mothers' change in NA. The main effect was positive, suggesting that on days when adolescents reported more NA, mothers were also drawn towards higher NA, displaying a higher NA set point.

There was a significant interaction between adolescents' problems and fathers' NA. Considering problems as the moderator, on days when adolescents reported more problems, the slope of how fathers NA predicted its own changes became shallower, indicating that fathers moved at a slower rate towards their set point in NA on days when adolescents experienced more problems. This interaction was not significant for mothers. Adolescent daily NA did not moderate mothers' or fathers' NA in this model.

Figures 2a and 2b depict the relationships of adolescents' problems and NA with change in parental NA. In Figure 2a, the mean slope of how fathers' NA predicted its own change increased as the number of adolescents' diabetes-related problems increased, suggesting instability. Mothers' slope, however, was not associated with adolescents' problems. This pattern of findings supports our ideas that as more involved caregivers, mothers may be less disturbed by daily diabetes problems as they have experience in handling such issues. Figure 2b depicts the main effect of adolescent NA on mothers' mean set point. This graph shows that the set point of mothers' NA was associated with adolescents' daily NA. Fathers' set point was not associated with adolescents' NA.

We tested to see if the effects of changes in mothers' and fathers' NA were the same by comparing the model from equation 1 to the model from equation 2. The deviance test was significant ($\Delta \chi^2 = 159.80$, $p < .001$), suggesting unique effects for mothers and fathers. We conducted a follow up model which allowed for all the parameters to be different between mothers and fathers except for the effects of adolescent NA, problems, and their interactions. These effects were also significant ($\Delta \chi^2 = 57.30$, $p < .001$), again suggesting unique parental effects. For fathers, more problems were related to a slower rate of return to the set point while, for mothers, affect moved with adolescents' reports of NA.

Last, given that mothers and fathers are part of a parental system that handles daily problems, it is possible that aspects of the shared emotional experience between spouses could account for the associations of problems and adolescent emotion with parental affect. That is, adolescents' problems could predict mothers' NA and thereby carry over to fathers,

and vice versa. We expanded equation 1 to include coupling terms to allow each parents' NA to predict partners' changes and examined the extent to which our reported findings of adolescent NA and reported number of problems changed. The addition of mother-father coupling effects is depicted in Table 2. The interaction between fathers' NA and adolescent problems remains the same suggesting that instability in father NA as problems increase is unique from the coupled spousal relationship. The main effect of adolescent NA on change in mothers' NA, however, was no longer significant suggesting that some of the mother-adolescent coupling of NA carried through the entire family (including the father). Additionally, an interaction between mothers' NA and adolescent NA emerged. This interaction suggests that after accounting for mother-father coupling effects, mothers' NA became less stable on days when adolescents experienced more NA. One likely explanation for this is that the pull on mother NA from the father and adolescent may sometimes be at odds, generating instability rather than consistent mother NA change. Notably, neither coupling term between parents was significant after controlling for adolescent NA and reported problems.

Change in Parental Positive Affect

We conducted identical models for positive affect (PA), where change in parental PA was the outcome and parental PA, adolescent PA, and adolescent problems were the predictors. Unlike the models for NA, the only significant results for PA were main effects for both mothers' and fathers' PA (Table 1). These patterns suggested that daily PA predicted change in PA for both parents negatively, reflecting movement toward homeostasis in positive affect. Changes in problems and adolescent PA were not related to changes in parents' PA.

Similar to our analyses on NA, we conducted comparison tests to see if the effects of changes in mothers' and fathers' PA were the same by comparing equation 1 to equation 2. Again this deviance test was significant ($\Delta \chi^2 = 186.2$, $p < .001$) which implies unique effects for mothers and fathers. The model allowing all parameters to be different between parents except for the effects of adolescent PA, problems, and their interactions was also significant ($\Delta \chi^2 = 298.2$, $p < .001$), suggesting that the main effects for mothers' and fathers' PA were unique to each parent after accounting for mother-father coupling effects.

Discussion

Managing type 1 diabetes is a demanding daily process that has implications for both the patient and the caregivers. The findings from this study highlight that adolescents' daily diabetes problems and related affect and mothers' and fathers' affect surrounding diabetes are part of an evolving system that moves across time. Our findings demonstrate that mothers' and fathers' daily experiences of NA are differentially related to adolescent problems with diabetes and related negative affective experiences. On days when adolescents reported more problems managing their diabetes, fathers moved more slowly back to their set point of NA. In contrast, on days when adolescents reported more intense NA, mothers also reported more intense NA. Whereas fathers' experiences of NA became less stable with increases in adolescents' management problems, mothers' NA simply moved together, or covaried, with the adolescents' experiences of such emotions. Neither

mothers' nor fathers' daily PA was affected by their adolescents' diabetes problems or associated PA.

Why mothers and fathers show different patterns of association may reflect the differential involvement each may have in managing their adolescent's illness. We observed that changes in mothers' NA moved together with adolescents' and fathers' experiences of NA. These results are in line with research noting that women are more attuned to the emotional life of the family than men (Kiecolt-Glaser & Newton, 2001) and research that has documented the transmission of negative affect between child and parent (Almeida, Wethington, & Chandler, 1999; Kim, Conger, Elder, & Lorenz, 2001). Although both parents are involved in diabetes management, mothers are more involved in the daily behavioral tasks of diabetes management (King et al., 2014; Seiffge-Krenke, 2002) and therefore have more exposure to their adolescent's emotional experiences. Their adolescent's experience of negative emotions related to diabetes may then be easily shared with the mother. Changes in fathers' NA were related more to changes in adolescents' problems. Mothers' greater involvement puts them on the front lines of experiencing the daily problems associated with diabetes. Given their regular involvement in diabetes management, mothers may become less reactive to daily diabetes problems or feel more efficacious in addressing those problems than fathers. Fathers may have less hands-on involvement in daily management problems, and thus display more reactivity when those problems increase.

The relation between adolescents' problems with diabetes and related emotions on parental affect were specific to NA. We did not find that fewer problems or more positive adolescent affect was related to parental PA. These null results for PA could be due to the composite PA score being based on only two positive emotions (happy and excited) and the reliability of these items for both mother and father was low. These findings may also be a function of asking respondents to report on their emotions as they related to diabetes that day. Negative emotions related to diabetes management may be indicative of a more serious problem or conflict, thus being more easily shared between adolescent and parent. Previous work assessing the co-regulation of affect between married couples finds support for shared NA but not PA (Saxbe & Repetti, 2010). Similarly, studies on the daily transmission of emotions from parents to children report significant transmission of NA but not PA (Larson & Gillman, 1999), suggesting perhaps that NA is more likely to be shared between family members.

Our findings contribute to the literature by illustrating a daily account of family life as adolescents, mothers, and fathers deal with the daily stresses that come with chronic illness. This study notes children's chronic illnesses are associated with parental well-being, whereas previous research on managing type 1 diabetes has focused on child or adolescent well-being. Parents play an important role in adolescents' successful management of type 1 diabetes, with parental involvement predicting adherence (King et al., 2014) and metabolic control (Berg et al., 2008), and understanding ways to support parental well-being may also support diabetes management. Maintaining parental well-being is an important factor to successful diabetes management during adolescence. Higher parental depressive symptoms (Wiebe et al., 2011) have been linked with poorer adolescent glycemic control and increases

in adolescent depressive symptoms. Understanding the relationship between adolescents' problems with diabetes management and parental well-being may not only have implications for parents' emotional experiences but also for adolescents' health. Our micro-developmental view of these family processes allow for a daily account of how parents and adolescents are handling type 1 diabetes during this developmental period.

In addition, the results of this study suggest that adolescents' diabetes affects both mothers' and fathers' daily well-being. Much research on adolescent diabetes focuses on mothers; however, fathers play an important role in type 1 diabetes management in early adolescence (Berg et al., 2008). The present results suggest that fathers' NA is associated with the daily stressors associated with parenting for an adolescent with a chronic illness. These findings are consistent with theories present in the larger developmental literature, including family systems theory (Gavazzi, 2014).

Further, consistent with the idea that families are interdependent units, we were careful to consider the possibility that husbands' and wives' emotional experiences could be influenced by their spouses' experiences. Previous work has established that emotional experiences are shared between spouses (e.g., Saxbe & Repetti, 2010), so controlling for these relationships when examining the mother-father-child triad is important. Interestingly, we found no significant coupling effects between husbands and wives when accounting for adolescent affect and problems. However, the main effect of adolescent NA on change in mothers' NA became not statistically significant after including mother-father coupling in the model, suggesting that some part of the association between adolescent and mother NA was associated with the negative emotions diabetes generates for her husband. The lack of coupling between mothers' and fathers' affect was surprising, given the consistent findings of affect covariation between spouses (Butner et al., 2010). The results could be attributable to the measurement of NA, in that we specifically asked about NA regarding the adolescent's diabetes. Affective coupling surrounding affect around the adolescent's diabetes may depend on how much mother and father collaborate on a daily basis about the child's diabetes management.

Some limitations of the study and ideas for future research should be noted. First, our sample was limited in diversity and consisted of largely married mothers and fathers. We can only generalize our observations to intact adolescent-mother-father triads. Second, the present study did not assess the severity of adolescents' problems in managing their diabetes and it is likely that some problems, such as having a low blood glucose episode, are more disruptive than others, such as not exercising. Third, our diary occurred only over 14 days and increasing the duration of the assessment period may reveal different patterns of parental affect, perhaps displaying different set points in NA. Finally, future work would benefit by an examination of the full transactional perspective (i.e., parent-adolescent and adolescent-parent affect transmission), given that previous work has established that parents' affect transmits to their children (e.g., Repetti, Wang, & Saxbe, 2009), ideally within a dataset with multiple time points per day. Future work may consider an expanded survey period in order to capture more complex, transactional relationships. The long-term effects of these daily associations between well-being and problems in diabetes management is important as parents who experience more negative emotions in response to diabetes management may be

at greater risk for depression. Future work may also consider how positive emotional experiences mitigate the long-term consequences of stress on parental health and well-being (Ekas & Whitman, 2011). Balancing negative affective responses to diabetes-related problems with more positive emotional experiences may help improve parents' well-being in the long run.

Findings from this study suggest that interventions for families with a child with type 1 diabetes should consider the family system as a whole. Existing behavioral family systems interventions in type 1 diabetes focus on problem solving and family communication (Ellis et al., 2005; Wysocki et al., 2007) and involve all caregivers in the home. Our results support the idea of including both mothers and fathers in intervention approaches, but suggest that mothers and fathers may benefit from different components of an intervention to the family system. A randomized, controlled trial examining the effectiveness of behavioral family systems therapy for diabetes found that the therapy was beneficial in improving communication between mothers and adolescents, but not fathers (Wysocki et al., 2007). Interventions may consider how each parent is involved in diabetes management and focus on improving involvement so that families work together effectively in daily management. Interventions for mothers may focus on responding to their child's negative diabetes-related emotions, whereas fathers may benefit from interventions on handling their child's diabetes problems. The ways in which parents respond to their children's illness has consequences not only for their own well-being but also their child's illness management.

The systems approach holds great promise for examining how parents respond to other aspects of their child's daily life, including daily school performance (Pomerantz & Eaton, 2001) and adolescent conduct problems (Granic & Patterson, 2006). It is important to note that by definition, systems are open and can be thought of as nested (e.g., children within families, families within communities). This study focuses on one small part of a system, the immediate family, but there is potential to observe many other relationships within this system.

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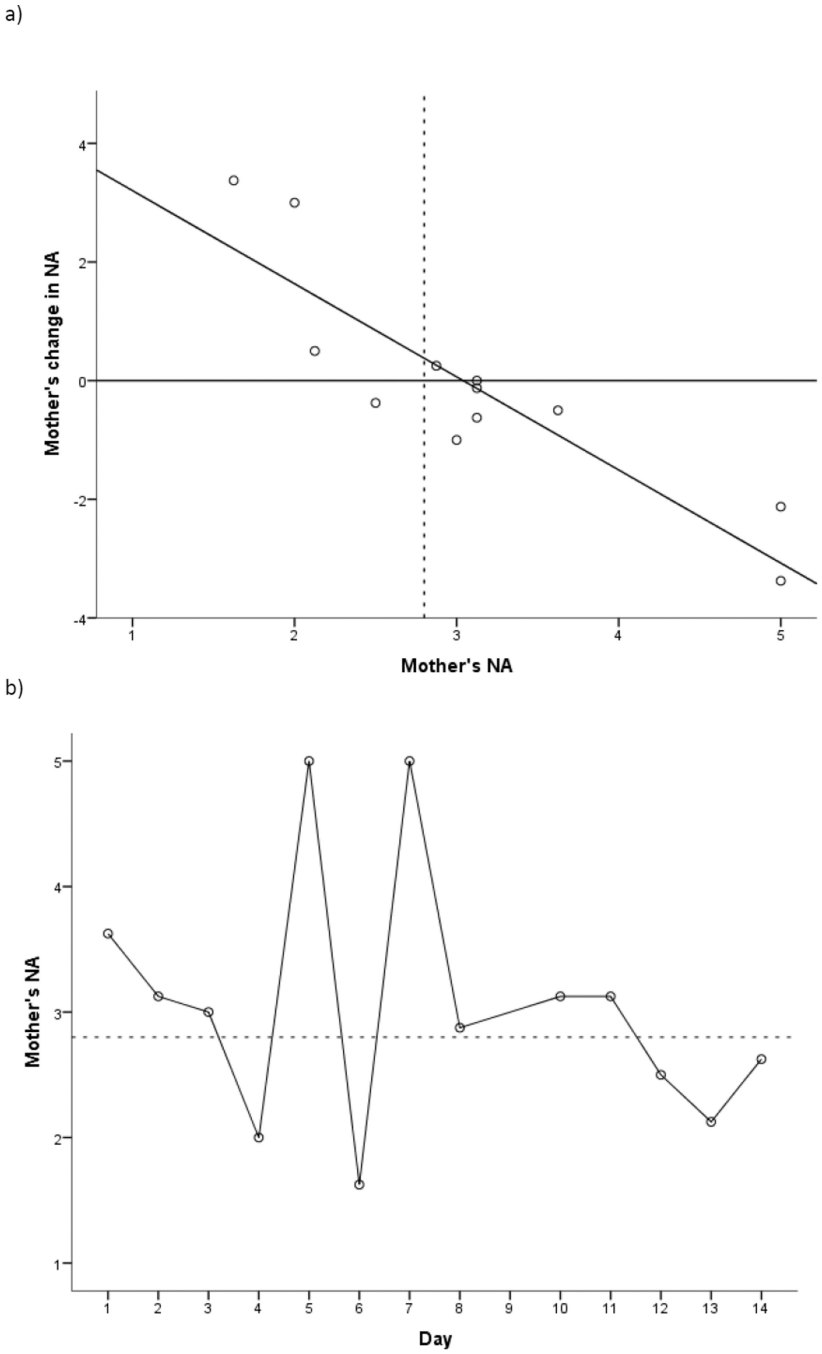

Figure 1.

An example of a simple dynamical systems model of change in affect from current affect (a) and a time series plot of depicting reports of negative affect across 14 days. In both graphs, the dotted line indicates the set point.

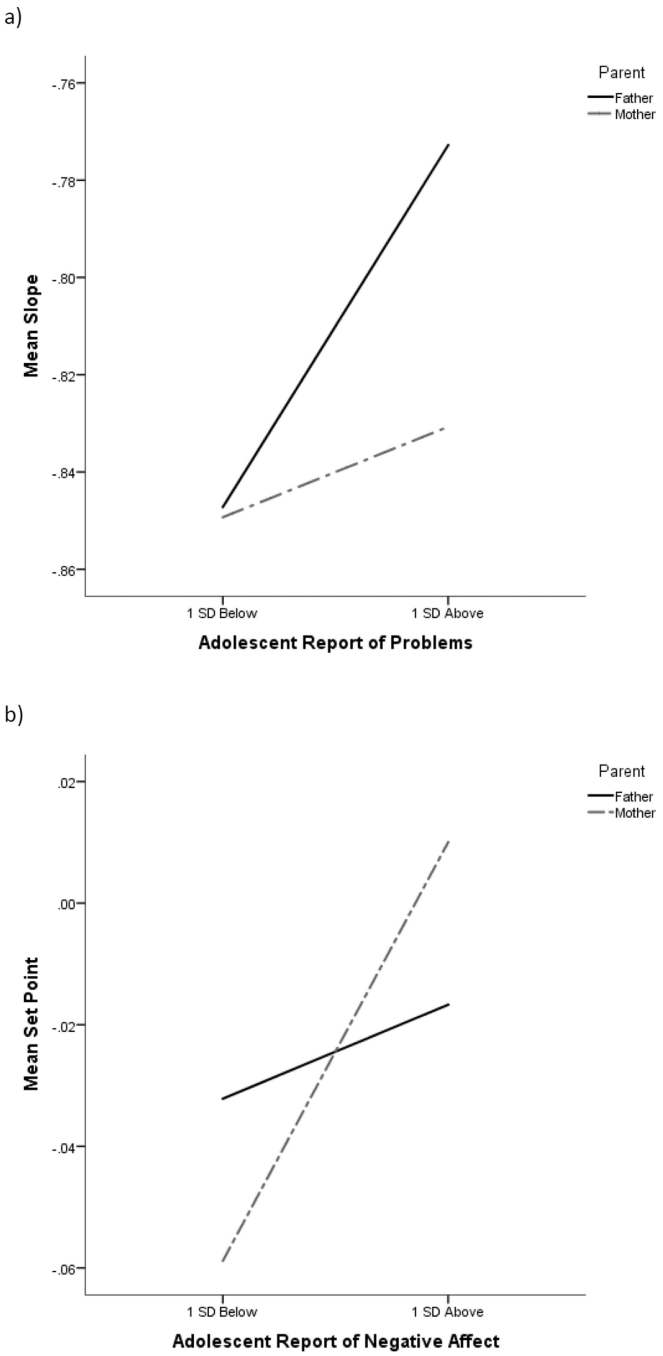

Figure 2.

Relationships between mean slope for mothers' and fathers' NA and number of adolescents' problems (a) and mothers' and fathers' mean set point and adolescents' experiences of NA (b).

Table 1

Adolescent problems and negative affect as simultaneous predictors of change in parental affect

	Negative affect				Positive affect			
	Estimate	***SE***	***t***	***p***	**Estimate**	***SE***	***t***	***p***
Fixed effects								
Adolescent age	−0.002	0.01	−0.17	0.86	−0.02	0.02	−0.09	0.37
Adolescent gender	−0.03	0.04	−0.71	0.48	−0.001	0.06	−0.02	0.99
Father	−0.02	0.03	−0.59	0.55	−0.02	0.06	−0.30	0.77
Father * father's affect	−0.81	0.03	−24.12	< .001	−0.79	0.03	−26.11	< .001
Father * adolescent’s problems	0.01	0.01	1.05	0.29	0.004	0.01	0.32	0.75
Father* father’s affect * adolescent’s problems	0.04	0.01	2.81	0.01	−0.01	0.01	−0.91	0.36
Father * adolescent’saffect	0.01	0.02	0.76	0.44	0.01	0.02	0.86	0.39
Father* father’s affect * adolescent’s affect	−0.04	0.03	−1.38	0.17	−0.01	0.02	−0.89	0.37
Mother	−0.02	0.03	−0.46	0.65	−0.03	0.05	−0.65	0.51
Mother * mother's affect	−0.84	0.03	−26.24	< .001	−0.77	0.03	−26.02	< .001
Mother * adolescent’s problems	0.01	0.01	0.77	0.45	0.004	0.01	0.34	0.74
Mother* mother’s affect * adolescent’s problems	0.01	0.01	0.53	0.59	−0.004	0.01	−0.35	0.73
Mother * adolescent's affect	0.05	0.02	2.31	0.02	0.02	0.02	1.14	0.25
Mother* mother’s affect * adolescent’s affect	−0.03	0.03	−1.22	0.22	−0.01	0.02	−0.86	0.39
Random effects								
Father	0.07	0.01		< .001	0.38	0.06		< .001
Father * father's affect	0.05	0.01		< .001	0.04	0.01		< .01
Mother	0.13	0.02		< .001	0.22	0.04		< .001
Mother * mother's affect	0.07	0.01		< .011	0.07	0.01		< .001

Table 2

Accounting for parent coupling and adolescent coupling in predicting change in parental negative affect

	Estimate	*SE*	*t*	*p*
Fixed effects				
Adolescent age	−0.01	0.01	−0.45	0.65
Adolescent gender	−0.04	0.04	−1.07	0.28
Father	−0.01	0.03	−0.33	0.74
Father * father's NA	−0.79	0.03	−22.55	< .001
Father * mother	0.003	0.02	0.17	0.87
Father * adolescent's problems	0.01	0.01	1.12	0.26
Father * father's NA * adolescent's problems	0.04	0.01	2.60	0.01
Father * adolescent's NA	0.01	0.02	0.66	0.51
Father * father's NA * adolescent's NA	−0.05	0.03	−11.58	0.11
Mother	−0.02	0.04	−0.53	0.60
Mother * mother's NA	−0.89	0.04	−24.74	< .001
Mother * father	0.04	0.03	1.41	0.16
Mother * adolescent's problems	0.01	0.01	0.96	0.33
Mother * mother's NA * adolescent's problems	0.02	0.02	1.34	0.18
Mother * adolescent's NA	0.04	0.03	1.57	0.12
Mother * mother's NA * adolescent's NA	−0.07	0.03	−2.05	0.04
Random effects				
Father	0.07	0.01		< .001
Father * father's NA	0.05	0.01		< .001
Mother	0.14	0.02		< .001
Mother * mother's NA	0.06	0.02		< .001