MULTIVARIATE ASSESSMENT OF ADHERENCE AND GLYCEMIC CONTROL IN YOUTH WITH TYPE 1 DIABETES

By

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A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
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To my family, whose support made my education possible.

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The considerable research examining family variables and their relationship to adherence and glycemic control in pediatric populations with type 1 diabetes (T1D) has generally identified only weak or inconsistent relationships between adherence and glycemic control. Even though youth with T1D are often nonadherent to their prescribed treatment regimens, the multiple determinants and ecological complexity of these behaviors make assessing nonadherence a challenging proposition. Adding to the difficulty, many adolescents experience hormonal changes during puberty that may cause insulin resistance, obfuscating the relationship between adherence and glycemic control (HbA_{1c}). Although difficult to identify, common sense, clinical evidence, and large studies of intensive T1D management support the presence of a strong relationship between improved adherence and metabolic control.

To improve ecological validity, our study included measures of diabetes-specific family functioning, medically-related parent stress, youth cognitive functioning, youth behaviors (internalizing and externalizing), and measures of adherence. One hundred-fifty-one youth and their caregivers completed parent and child measures, and separate structured adherence interviews, while only youth completed blood draws for HbA_{1c} assay. Path analysis was used to

model the interrelationships among these variables and their combined ability to predict HbA_{1c} in a sample of youth with T1D. For the final model, chi-square was not significant (X^2 = 9.2 (17, N=151), p = .93), indicating excellent model fit. Analysis of the model yielded an R-squared for glycemic control (HbA_{1c}) of .59, while the R-squared for adherence was .48. Child behavior significantly predicted adherence (Beta = -.37, $p < .001$), while adherence significantly predicted HbA_{1c} (Beta = -.78, $p < .001$). The latent construct representing adherence, mediated the relationship between critical parenting and HbA_{1c}, and adherence mediated the relationship between duration of diabetes and $HbA_{1c.}$ Child behavior also mediated the relationship between metacognition and parent stress. These findings suggest that an increased and comprehensive focus on assessing and monitoring family behaviors related to adherence is critical for optimizing health outcomes. Additional implications are discussed and directions for future research are presented.

CHAPTER 1
INTRODUCTION

Overview

Type 1 diabetes mellitus (T1D) is a chronic condition, typically diagnosed in childhood or adolescence. Research indicates that more intensive diabetes regimens for youth result in improved glycemic control (HbA_{1c}) and decreased long-term health risk (Diabetes Control and Complications Trial Research Group [DCCT], 1993, 1994, 2005). These findings established a widely accepted scientific basis for treatment with the goal of achieving glycemic control as close to normal as possible. Accordingly, physicians have increasingly prescribed more intense and complex treatment regimens. However, even with advances in diabetes management, achieving ideal control has proved a challenging goal, particularly for children and adolescents (Gruppuso, 2003). These regimens typically require the administration of multiple daily injections, glucose and dietary monitoring, carbohydrate estimation, dietary restrictions, and regular physical activity. Families and youth diagnosed with T1D face the unrelenting challenge of implementing a complex and time-consuming treatment regimen to effectively manage their condition. The increased use of these complex regimens has led to significant overall improvements in glycemic control (Svoren et al., 2007). Nevertheless, youth non-adherence remains a prevalent problem (Ellis, Naar-King, Frey, Rowland & Greger, 2003; Kovacs, Goldston, Obrosky, & Iyengar, 1992; Weissberg-Benchell et al., 1995) that can have serious long-term health consequences that include kidney disease, retinopathy, eye problems, and neuropathy (DCCT, 1993, 1994, 2005; Clark & Lee, 1995). Additionally, it has been estimated that two-thirds of individuals with diabetes will eventually die from heart disease (ADA, 2006). Extreme nonadherence can also lead to diabetic ketoacidosis (DKA), a relatively immediate and life-threatening condition (Golden, Herold, & Orr, 1985; Trachtenbarg, 2005).

Goals included examining the nature and treatment of T1D with a focus on family variables related to its management. The purpose of this investigation is to integrate and extend existing empirical knowledge through the use of multivariate modeling techniques that more accurately represent real-world complexity. The present study will utilize a structural equation modeling (SEM) approach to evaluate family variables expected to influence adherence to T1D treatment regimens and health outcome in a clinical sample of youth with T1D. Specifically, this model will examine latent constructs represented by measures of the parent-child relationship regarding diabetes management, and adherence. This model will also examine the unique and combined contributions of measures representing parent stress, youth executive functioning, problem youth behaviors, and family functioning specific to diabetes management, to predicting adherence and glycemic control in youth with T1D (Figure 1-1).

Background and Significance

Type 1 diabetes (T1D) is one of the most common chronic diseases of school-aged youth, affecting approximately 1 in every 400 to 600 youth under 20 years of age (National Institute of Diabetes and Digestive and Kidney Diseases, 2005). Historically, research has examined various characteristics of the disease (e.g., severity, time since diagnosis), of the patient (e.g., self-efficacy, disease knowledge), and of the family (e.g., family conflict, parental support) that have been hypothesized to predict management of T1D in pediatric patients. Despite an extensive history of research in this area, the identification of strong predictors of adherence and subsequent glycemic control has been limited. This may be because adherence to T1D treatment regimens is complex, often with contributions from multiple interrelated factors. Past difficulty accounting for variance in adherence and glycemic control may be partially due to the use of limited models used to assess complex relationships. In attempts at a parsimonious explanation, researchers have often used simple correlational models. More recently, the state of T1D

adherence research has evolved to using more complex regression techniques to evaluate moderation and mediation effects. Given the complexity and interrelatedness of family factors found to predict adherence, more comprehensive and ecologically valid models are overdue.

Type 1 Diabetes (T1D)

Although T1D has a peak age of onset in middle childhood, diagnosis can be made as late as middle adulthood. Type 1 diabetes results from the autoimmune destruction of the insulin producing pancreatic islet cells (beta cells). This cell destruction eventually stops the pancreatic production of insulin. Insulin is a hormone that regulates glucose metabolism and plays a vital role in growth, activity, wound healing, and brain function. Without insulin, energy from food cannot be converted into a usable form. Although the exact pathogenesis is unknown, the manifestation of T1D is thought to result from a combination of genetic predisposition and environmental factors that serve as catalysts (American Diabetes Association [ADA], 2005; Wysocki, Greco, & Buckloh, 2003). Given the absence of insulin produced by the body, glycemic control becomes a critical aspect of disease management.

It is generally accepted that monitoring blood glucose levels is an essential aspect of managing diabetes. Self-monitoring provides information about current blood glucose levels and a means of determining individual responses to insulin, and the influence of diet and exercise, on blood glucose levels. Monitoring provides information that allows the patient to achieve tighter blood glucose control, with a goal range of between 80 and 120. However blood glucose values are variable and the values present between testing are unknown. A more accurate long-term estimation of glycemic control is the HbA_{1c} test. The HbA_{1c} test estimates how much glucose is attached to hemoglobin cells. Since red blood cells have a 120 day life span, the HbA_{1c} test results are assumed to indicate the blood glucose concentration over the previous 120 day period (Davidson, 1998).

The American Diabetes Association's position statement on the standards of medical care for patients with diabetes mellitus mandated that treatment include lowering blood glucose levels to or to near normal in all patients (ADA, 1997). The American Diabetes Association (ADA, 2005) further recommended that adequate glycemic control for those with diabetes is maintaining an HbA_{1c} of less than 7%. However, the most recent National Health and Nutrition Examination Survey suggested that 60% of persons with diabetes fail to meet this goal.

A number of factors have the potential to affect glycemic control. In the period after diagnosis, children often go through a honeymoon period, during which their beta cells are still producing insulin to varying degrees (Madsbad, McNair, & Faber, 1980). The duration of this period is typically 18-24 months, during which glycemic control may be relatively easy to attain. However, after residual pancreatic activity subsides, maintaining effective glycemic control becomes significantly more challenging (Delamater, 2000). Puberty is another critical period wherein biological factors influence glycemic control. Studies suggest that the worsening of glycemic control often seen during puberty is in part due to decreased insulin sensitivity (Amiel, Sherwin, Simonson, Lauritano, & Tamborlane, 1986; Bloch, Clemens, & Sperling, 1987). Additionally, racial disparities have also been demonstrated, with African-American youth generally having worse glycemic control than Caucasian youth (Auslander, Anderson, Bubb, Jung, & Santiago, 1990; Auslander, Thompson, Dreitzer, White, & Santiago, 1997; Delamater, Albrecht, Postellon, & Gutai, 1991). Adherence to an individually prescribed treatment regimen is critical to the management of T1D.

Adherence

Nonadherence to a wide range of therapeutic regimens is common (Chui et al., 2003; Farber et al., 2003), with nonadherence to pediatric medical regimens estimated to be about 50% (Rapoff, 2002; Rapoff, 1999). Despite the known health complications, nonadherence among

children and adolescents with diabetes is particularly prevalent (Ellis, et al., 2003; Weissberg-Benchell et al., 1995). Many pediatric patients with T1D are nonadherent in regard to various aspects of T1D management. For example, most patients reported taking their insulin injections; however, 10% reported administering the wrong dose, 20% reported giving the injection at the incorrect time, and 19% reported having difficulty adhering to their physician's recommendations regarding adjusting their insulin dose (Delamater, Applegate, Eidson, & Nemery, 1998). Higher rates of nonadherence are typically reported for other diabetes treatment components. An evaluation of blood glucose testing found that 31% of pediatric patients do not adhere to the recommended timing or frequency of this aspect of their treatment regimen. Parents have reported that 48% of adolescents with T1D do not adhere to their recommended eating practices (Delamater et al., 1998). A nine-year follow-up study of newly diagnosed T1D patients determined that 45% of adolescents were nonadherent to their treatment regimen (Kovacs, Goldston, Obrosky, & Iyengar, 1992). The consequences to the individual due to poor adherence include not only health outcomes, but missed school days and compromised quality of life (Bender, Milgrom, Rand, & Ackerson, 1998). Overall, adequate adherence to a T1D diabetes treatment regimen is a problematic proposal for many pediatric patients.

Although the importance of adherence to the clinical management of T1D is critical, the impact of nonadherence also affects the quality of data obtained from scientific studies, in particular, clinical trials of medical treatment efficacy (Tebbi, 1993). Less than optimal adherence during clinical trials may obscure the efficacy of medical treatment or cause erroneous conclusions to be made regarding the effectiveness of a treatment or its dosage (Lasagna & Hunt, 1991). Although there has been little research on the financial implications of nonadherence in pediatric populations, nonadherence in adult populations has been linked to increased medical

costs due to hospital admissions, length of stay, and other health care expenditures (Sclar, Skaer, Chin, Okamoto, & Gill, 1991; Swanson, Hull, Bartus, & Schweizer, 1992). In 2002, the average cost of healthcare expenses for each person in the United States was $5,440. In that year, there were 800 million medical encounters. Research suggests that a significant portion of the healthcare advice and prescriptions dispensed in these encounters was wasted. Fifteen percent of total medical costs in this country and 25% of the total Medicare budget are spent on patients with diabetes, mostly for treating the complications of the disease (Davidson, 1998; Pfeifer, 1998). The annual cost to the healthcare system caused by non-adherence is estimated to be as high as 300 billion dollars (DeMatteo, 2004).

Given the high costs and the increased risk of life-threatening consequences due to nonadherence, understanding the multiple determinants of ineffective illness management is essential. In addition to the individual biological and psychological factors that influence adherence to a T1D treatment regimen, patient behaviors typically occur within the context of the family system (Wolpert & Anderson, 2001). Surprisingly, research regarding the family system and its influence on adherence to T1D treatment regimens is relatively limited.

Past Research

Some progress has been made in T1D research in the last two decades. Increased attention has been afforded adolescence and the developmental factors affecting adaptation to T1D diagnoses. For example, research has examined the impact of biological growth hormone factors, adolescent cognitive factors, and family influences on metabolic control and psychosocial outcomes in adolescents (Anderson, 1995). Investigations have become increasingly more theory-driven and are beginning to test competing psychosocial theories regarding adaptation to a T1D diagnosis (Glasgow & Anderson, 1995). Some findings have become well established, such as the multidimensional nature of regimen adherence (Johnson,

1992: Kurtz, 1990). Glasgow and Anderson (1994) suggested that much of the research regarding diabetes management has been "stuck" in a static design and analysis paradigm of cross-sectional correlational studies of relatively small convenience samples. These studies often use simple bivariate analyses that were appropriate at some point in the evolution of the diabetes adherence literature, but are now rarely informative given the current state of knowledge. In particular, pediatric psychology could benefit from theories of adherence that focus on how family interactions impact on the youth's adaptation to and coping with the demands of adherence (Glasgow & Anderson, 1995). It is widely recognized that parent behaviors are a critical influence on the adherence behavior of their youth with diabetes (Anderson & Auslander, 1980). However, few theoretical models have been offered that describe how family interactions support or interfere with the child's adaptation to diabetes treatment demands. Glasgow and Anderson (1995) have called for the use of structural equation modeling (SEM) or alternate approaches that are capable of identifying the independent and combined predictive utility of demographic, medical, developmental, and behavioral factors related to diabetes management. The literature has identified multiple psychosocial and family related variables that influence adherence to T1D treatment regimens. The combination of these variables into a comprehensive model, could further inform our understanding of the relationship between complex environment, adherence and glycemic control.

Theory

Ecological Systems Theory

Social ecological theory has been proposed as a useful framework for pediatric psychology research in general (Brown, 2002) as well as for predicting illness-management behaviors across the life span (Gonder-Frederick, Cox, & Ritterband, 2002). Social ecological theory (Bronfenbrenner, 1979) posits that complex problem behaviors, such as poor illness

management, are determined by multiple difficulties within the systems in which the child and family are embedded. Within the overarching context of social ecological theory, other theoretical perspectives may be of some utility in explaining specific interaction patterns within a family.

Coercion Model

Other influences on adherence are the effects of diabetes-related family factors, such as critical parenting, around diabetes care tasks (Anderson, 2004; Ellis et al., 2007; Hansen & Onikull-Ross, 1990; Laffel et al., 2003; Lewin et al., 2006). Critical parenting may affect adherence and glycemic control through processes explained by Patterson's (1982) coercion model. This model posits a process of behavioral contingencies that explain how parent and youth behaviors mutually influence each other in ways that increase the likelihood that the youth's aggressive behavior will increase while parental control over such behaviors will decrease (Patterson, 1995; Patterson, Reid, & Dishion, 1992; Reid, Patterson, & Snyder, 2002). These interchanges are characterized by parental demands for compliance, the child's refusal to comply, his or her escalating complaints, and finally the parent's capitulation. This theoretical perspective suggests that parenting and youth behaviors are reciprocal (Fite, Colder, Lochman, & Wells, 2006), yet may be precipitated by parent or youth. The presence of such a coercive cycle around diabetes management tasks is likely to interfere with adherence to treatment regimens and subsequent glycemic control.

Miscarried Helping

A related construct, that is similar to Patterson's (1982) coercion model, is the concept of miscarried helping proposed by Anderson and Coyne (1991). In miscarried helping the caregiver's behaviors (good intentions) result in interpersonal conflicts between youth with chronic health problems and their parents, further polarizing the two parties, putting the health of

the youth at greater risk (Anderson & Coyne, 1991). A key difference in perspectives is that when considering miscarried helping, it is the parent's good intentions that precipitate conflict.

Variables Related to Adherence to T1D Treatment Regimens

Demographic variables

Patient and family correlates of adherence have included child age, parent education, work status, number of children in the home, and socioeconomic status. Younger children with T1D are more likely to be adherent to medication regimens than adolescents (Anderson, Auslander, Jung, Miller, & Santiago, 1990; LaGreca, Follansbee, & Skyler, 1990). Lower socioeconomic status (SES), race, and lower parental education levels have also been correlated with nonadherence in children with T1D (Auslander, Thompson, Dreitzer, White & Santiago, 1997). Relationships have also been found between adherence and family composition, with single parent households found to be related to decreased adherence (Auslander, et al., 1997).

Illness-specific variables

In addition to demographic variables, several illness and treatment variables are also related to adherence in pediatric T1D. Greater symptom severity and longer illness duration have been found to be related to decreased adherence to pediatric T1D treatment regimens (Rapoff, 1999). In addition, nonadherent pediatric patients with T1D show an association between increased health problems and hospitalization for DKA (Geffken et al., 1997). Additionally, patients having more complex regimens are less adherent to their prescribed regimen (McCaul, Glasgow, & Schafer, 1987).

Parental stress

In general, higher levels of stress and decreased psychological functioning have been consistently documented in children with T1D and their parents, especially mothers (Hauenstein, Marvin, Snyder, & Clarke, 1989; Kovacs et al., 1985; Wysocki, Huxtable, Linscheid, & Wayne,

1989). Previous research has found that parents of children with chronic illnesses such as diabetes tend to report higher levels of general stress when compared to parents of healthy children (Hauenstein, et al., 1989). More specifically, parents of children with diabetes experience greater marital distress (Quittner et al., 1998) and greater stress related to mealtime behaviors (Wysocki, et al., 1989). Although the presence of increased stress in parents of children with T1D has been well documented, the implication of this finding in terms of adherence and glycemic control has not been adequately researched. Given the strong associations between family functioning, diabetes adherence, and health status measures, the effect of pediatric parenting stress on these constructs calls for empirical evaluation (Lewin et al., 2005; Lewin et al., 2006).

Within pediatric populations, parenting stress has historically been measured using general measures of stress (e.g., Parenting Stress Index; PSI; Abidin, 1995). However, in more recent years researchers have begun to consider the importance of measuring disease-related stress experienced by parents of children with chronic diseases, termed "pediatric parenting stress" (Streisand, Braniecki, Tercyak, & Kazak, 2001). Therefore, emphasis has been placed on assessing specific disease-related parenting stress. The Pediatric Inventory for Parents (PIP; Streisand, et al., 2001) is one such measure designed to assess the stress of parents of children with chronic diseases. Within pediatric T1D populations, pediatric parenting stress has been related to important issues such as parents' ability to learn disease-management skills (Gillis, 1993) and the child's ability to engage in successful diabetes management (Auslander et al., 1997; Hanson et al., 1996). Although parenting stress was not significantly related to glycemic control in a recent study, the authors noted that there might be "aspects of the diabetes regimen itself that causes parent stress" (Streisand, Swift, Wickmark, Chen, & Holmes, 2005, p. 518).

Goldston, Kovacs, Obrosky, and Iyengar (1995) found that greater life disruption predicted decreased glycemic control, and the relationship between life stress and glycemic control was partially mediated by adherence. In contrast, Hanson, Henggeler, Harris, Burghen, and Moore (1989) found support for a relationship between stress and reduced glycemic control, but not between stress and nonadherence. Other studies have found no association between stress and glycemic control (e.g., Hauenstein et al, 1989). For parents of children with T1D, stress also appears to be closely linked with child behavior problems. A recent study detailing a psychology consult service for children with T1D in a tertiary care clinic documented a high incidence of distress and internalizing disorders in these patients (Gelfand et al., 2004). These inconsistent findings may be due to the fact that ‘‘stress’’ is an overly general construct, and more specific variables need to be studied. Studies are needed that further elucidate the relationships among pediatric parenting stress, glycemic control, and adherence behaviors in patients with T1D.

Child Behavior Problems

Numerous family studies have shown that problematic family interactions are associated with ineffective illness management and worsened health outcomes in Type 1 diabetes (e.g., Anderson, Brackett, Ho, & Laffel, 1999; Wysocki et al., 1996). Although there is limited research examining the relationships between mental health and adherence behaviors, studies with predominantly Caucasian samples of adolescents have found that both internalizing and externalizing symptoms have been associated with decreased metabolic control in adolescents (Leonard, Jan, Savik, Plumbo, & Christensen, 2002; Lernmark, Persson, Fisher, & Rydelius, 1999). Recent work has found that the presence of youth externalizing behaviors is associated with decreased glycemic control. For example, Northam et al. (2005) found that in a sample of adolescents with T1D, those with high blood sugars had increased levels of externalizing behaviors compared to those with low blood sugars. Duke et al. (2008) found that externalizing

was related to family factors, adherence and glycemic control. Moreover, prospective research has shown that in the 10 years following diagnosis with diabetes, 27% of youths with T1D experienced an episode of major depression while 13% experienced an anxiety disorder (Kovacs, Goldston, Obrosky, & Bonar, 1997). Additionally, Leonard et al. (2002) found that participants with elevated attention problems, and aggressive and delinquent behaviors reported higher HbA_{1c} relative to those without such problems. It is intuitive to expect that the presence of externalizing behaviors and a resulting pattern of conflict with caregivers would interfere with adherence to the complex task of managing T1D. Interestingly, in a study by Cohen, Lumley, Naar-King, Partridge, and Cakan (2004) internalizing behavior problems significantly predicted lower HbA_{1c}. Problem child behaviors may also be related to executive functioning in youth engaged in complex and demanding adherence processes.

Youth Executive Functioning

Executive functioning is a term that refers to a broad set of abilities associated with the brain's frontal lobes. Executive functioning dimensions include the ability to plan, self-monitor, and use working memory. Given that diabetes self-management requires significant planning, organization, and self-monitoring, executive functioning is crucial to successful performance of T1D self-care tasks. The role of executive functioning may prove especially important in youth prescribed intensive T1D treatment regimens, given that these treatments demand increased problem-solving abilities, planning, and organizational skill than traditional T1D self-management routines (Anderson, 2003, Lorenz, et al. 1996; DCCT, 1993).

In a study by Cook, Herold, Edidin, and Briars (2002), adolescents with T1D, who were randomly assigned to a 6-week problem-solving intervention demonstrated improvements in problem-solving and glycemic control at post-treatment assessment. Hill-Briggs (2003) conducted a review of the current literature pertaining to problem solving and T1D that found

most studies have established a relationship between increased problem-solving skills and better self-management behaviors. However, in their review the relationship between problem-solving and glycemic control was not clearly delineated. In a recent pilot study, Alioto and Janusz (2004) found that for pediatric patients in an intensive treatment condition, executive functioning played more of a role in T1D self-management than did other cognitive abilities, such as math achievement or general intelligence. Within a broader sample of T1D patients using both conventional and intensive regimens, similar findings have also been found. For example, parent-reported child executive functioning on the BRIEF was significantly related to diabetes management, with poorer executive functioning associated with decreased adherence (Bagner, Williams, Geffken, Storch, & Silverstein, 2007). Given the preliminary nature of the research examining executive functioning and T1D treatment outcomes, more studies are needed in this area. In particular, this relationship has not been adequately investigated within the context of complex family relationships.

Family Variables

A body of research has investigated the relationship between family variables and outcomes in pediatric patients with T1D. Studies have found that patients experiencing higher levels of family conflict are more nonadherent or have decreased glycemic control (Hauser et al., 1990; Miller-Johnson et al., 1994). Anderson and colleagues (1990) also demonstrated that disagreements between parents and children regarding responsibility for T1D related tasks predicted worsened glycemic control. Weaker and inconsistent relationships between other family characteristics such as warmth, discipline, parenting, and adherence or glycemic control have also been found (Hauser et al., 1990; Miller-Johnson et al., 1994). Overall, these findings suggest that family factors play an important role in the management of T1D.

Research Aims

The goal of this proposal is to investigate a multivariate model of adherence that more accurately reflects real world complexity. This model will assess the contributions of parent stress related to their child's diabetes, youth behavior problems, youth executive functioning, and family factors that include youth perception of diabetes specific critical parenting, warmth and caring, and guidance and control, and parent/child responsibility for adherence tasks. The relationship of these variables to adherence and glycemic control in pediatric populations having T1D will be evaluated using multivariate methods.

General Aims.

1. A path analysis will simultaneously examine the unique contributions of parent and child variables (family factors) to predicting adherence and glycemic control (Figure 1-1).
2. Using correlation procedures, preliminary analyses will assess demographic variables for making significant contributions to the model.
3. The latent construct of "diabetes related parenting" will be examined by assessing the contributions of measures representing critical parenting, parental warmth, guidance and control, and shared responsibility for diabetes tasks.
4. The latent construct of adherence will be included in the model by assessing the contributions from measures of blood glucose testing, insulin administration, diet, and exercise.

Specific aims

The presence of mediation processes (Figure 1-2) will be evaluated using procedures outlined by Baron and Kenny (1986), as follows:

5. Proposed is to examine whether the hypothesized relationship between youth behaviors and HbA_{1c} is mediated by adherence.

6. Proposed is to examine whether a hypothesized relationship between family factors and HbA_{1c} is mediated by adherence.
7. Proposed is to examine whether a hypothesized relationship between youth externalizing behavior and adherence is mediated by parent stress.
8. Proposed is to examine whether a hypothesized relationship between metacognition and adherence is mediated by youth behaviors.
9. Proposed is to examine whether a hypothesized relationship between metacognition and adherence is mediated by critical parenting.

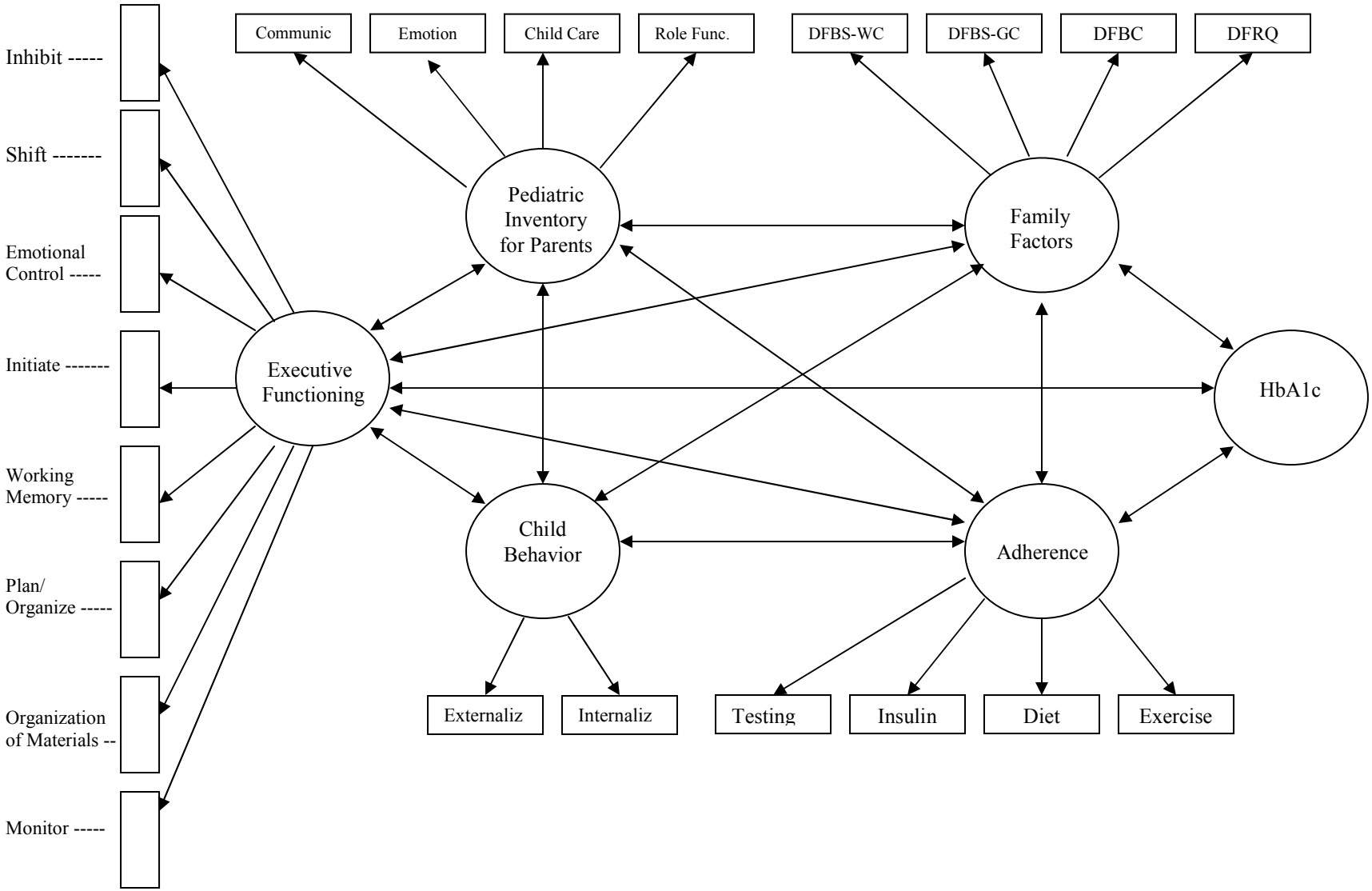

Figure 1-1. Conceptual model of possible relationships

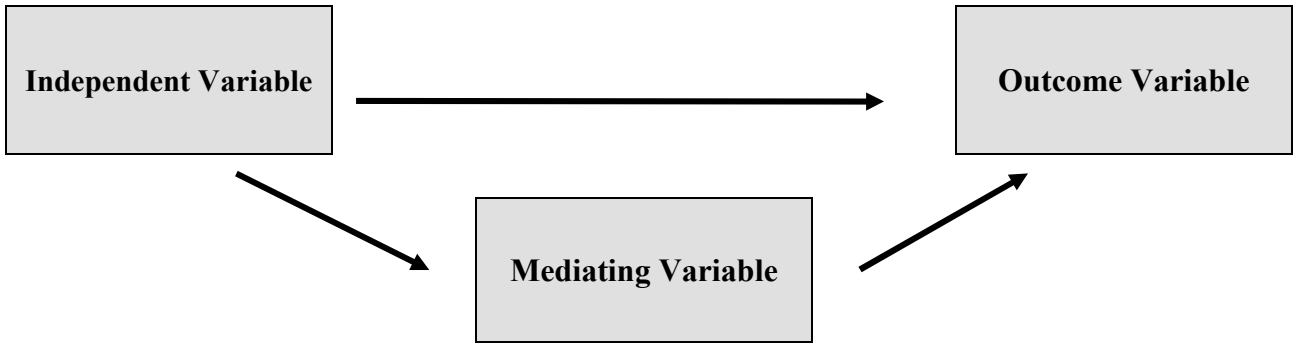

Figure 1-2 Mediation Model

METHOD

Participants

Participants were 153 youths with T1D and their primary caregivers, recruited from a tertiary Pediatric Endocrinology Clinic affiliated with the University of Florida. Inclusion criterion for youth participation were (a) aged 8-18 years, (b) the presence of T1D for at least six months duration, (c) living with and accompanied by their primary caregiver, (d) no other chronic medical conditions (e.g., cystic fibrosis), and (e) both child and primary caregiver ability to read and complete study measures (e.g., English-speaking, no mental retardation).

The current sample consisted of 92 girls and 61 boys aged 8.0 to 18.75 years (*M* = 13.6 years, *SD* = 3.1). The ethnic/racial distribution of participants was 72.5% Caucasian, 15% African American; 9.8% Hispanic, and 2.6% indicating membership in other ethnic/racial groups (Table 2-1). Participants were from predominantly two-parent families (67.4%) with mothers reporting as primary caregivers (75.8%), followed by fathers (16.3%) and other caregivers (7.9%). Participants' average duration of T1D was 4.86 years (*SD* = 3.60, range = 0.5-17.0 years). The average participant HbA_{1c} assay was 8.83% (*SD* = 1.92; Table 2-2), which is higher that the recommended target range of < 7%. Approximately 64.1% of children in the study experienced at least one episode of DKA post-diagnosis and 24.1% of children experienced 2 or more episodes of DKA (range 0-10 episodes).

Procedure

Participants were recruited during their regular visits to the pediatric endocrinology clinic as part of a larger project entitled "Assessment of Adherence and Metabolic Control in Youths with Type 1 Diabetes." Clinic endocrinologists or nurses identified patients meeting inclusion criteria and trained research staff approached patients and explained the study. Informed consent, approved by the University of Florida Institutional Review Board, was obtained from

the legal guardian of all participants while youth provided assent. The recruitment rate was approximately 85%, which is similar to past research recruitment within this clinic (Lewin et al., 2005). The most commonly cited reason for declining participation was the time commitment required to complete study measures. Most families completed the questionnaires in approximately 45 minutes. Children and their caregivers were interviewed separately regarding adherence to prescribed T1D treatment and independently completed study questionnaires. Families received a $10 gift card as an honorarium for their participation. Blood samples for assessing patient's glycemic control (HbA_{1c}) were obtained by nursing staff as part of the patients' regular clinic visit.

Measures

Demographic Information

The patient's primary caregiver completed a demographic information form that included data such as age, sex, socioeconomic status (education and occupation), and duration of T1D.

Parent Measures

The Pediatric Inventory for Parents (PIP; Streisand, et al., 2001) is a parent-report questionnaire designed to measure parenting stress related to caring for a child with a chronic illness. The PIP consists of 42 items that assess the frequency and intensity of parenting stress. Four domains that may be affected by parenting stress due to chronic illness are included: 1) communication (e.g., with their child, partner, or medical team), 2) parent's emotional functioning (e.g., impact of the child's illness on their sleep and mood), 3) child's medical care (e.g., adhering to the medical regimen), and 4) parent's role functioning (e.g., ability to work or care for other children). Parents responded by endorsing items on a 5-point Likert scale ranging from "never" (1) to "very often" (5) and how often the event occurred during the past week. The PIP yields two subscales assessing the frequency of stress (PIP-F) and the level of difficulty the

parent experiences managing stress (PIP-D). Higher scores indicate greater parenting stress. Past empirical investigations have found that PIP total scores are highly correlated with the Parenting Stress Index-Short Form, a general, non-illness specific measure of parenting stress (Streisand et al., 2001). High internal consistencies for the PIP subscales have been demonstrated for parents of children with T1D (PIP-F α = .94; PIP-D α = .94-.95; Lewin et al., 2005; Streisand et al., 2005).

Child Measures

Behavior Checklist (CBCL: Achenbach, 1991

The CBCL is a widely used, standardized, 118-item parent-report questionnaire for 4–18 years olds that exhibits excellent psychometric properties (Achenbach, 1991). Each item is scored 0 if 'not true', 1 if 'somewhat true' and 2 if 'very true' for the child. Designed to assess behavioral problems and social competencies of youth 4 - 18 years of age, the CBCL yields two broadband, higher order psychopathology scales, internalizing and externalizing. The sum of the scores on all items produces a total score that gives an overall measure of the child's emotional/behavioral adjustment (Achenbach, 1991; Cohen, Gotlieb, Kershner, & Wehrspann, 1985; Drotar, Stein, & Perrin, 1995). For the present study only the internalizing and externalizing subscales were used.

Behavior Rating Inventory of Executive Functioning (BRIEF; Gioia, et al., 2000).

The BRIEF is a widely used and validated parent report measure, which is designed to examine "children's everyday executive skills in natural settings" (Donders, 2002). Primary caregivers typically complete the BRIEF, an 86-item parent-report measure designed to assess 8 domains of executive functioning. Although the BRIEF includes 86 items, only 72 items are used in the calculation of the scale and composite scores. The additional questions are considered to be items of clinical interest. The executive functioning domains measured by the

BRIEF include the ability to solve problems flexibly (Shift scale), anticipate future events and set goals (Plan/Organize scale), the ability to control impulses (Inhibit scale), the modulation of emotional responses (Emotional Control scale), the ability to start a task (Initiate scale), the aptitude to retain information in one's mind for the completion of a task (Working Memory scale), the ability to keep materials orderly (Organization of Materials scale), and the ability to assess performance during or after a task (Monitor scale). The BRIEF also includes three indices: the Behavior Regulation Index (BRI; including the Inhibit, Shift, and Emotional Control scales), the Metacognition Index (MI; including the Initiate, Working Memory, Plan/Organize, Organization of Materials, and Monitor scales), and the Global Executive Composite (GEC; including all scales). BRIEF raw scores range from 0 to 238, with higher scores indicating poorer executive functioning. In addition, the BRIEF includes the Inconsistency and Negativity scales, which are used as measures of response validity. Reliabilities for the BRIEF subscales and indices are satisfactory in both clinical and normative samples (α = .80-.98). Test-retest reliability across clinical scales was r = .81. Previous research suggests the use of the MI, BRI, and GEC indices, as these were most strongly related to adherence in a pediatric TID sample (Bagner et al., 2007). Given the presence of alternate corresponding measures, only the MI was used in this study.

Diabetes-Specific Assessments of Family Functioning.

Diabetes Family Behavior Checklist (DFBC)

The DFBC is a measure of both supportive and unsupportive family behaviors related to the diabetes regimen, completed by both parents and youth (Schafer et al., 1986). Given the aims of this study only the seven-item negative/unsupportive subscale was used; henceforth referred to as the 'critical parenting' scale of the DFBC. The critical parenting scale has shown

acceptable to good internal consistency (.74 to .82; Schafer, personal communication, 1998). For the present study only the youth report was used.

Diabetes Family Behavior Scale (DFBS)

The DFBS is a self-report measure of perceived family support for youth with T1D (Waller et al., 1986). Given the aims of this study, only the "warmth and caring" and "guidance and control" subscales were used. The warmth/caring subscale (DFBS-WC) has shown adequate internal consistency ($\alpha = 0.79$; McKelvey et al., 1993) as has the guidance and control subscale (DFBS-GC) ($\alpha = 0.76$; Lewin et al., 2006).

Diabetes Family Responsibility Questionnaire (DFRQ)

The DFRQ is a measure of family sharing of responsibility for diabetes treatment (Anderson et al., 1990) that is completed by both parent and youth. The scale has shown marginal to good internal consistency (.69 to .85) for the three subscales (Anderson et al., 1990). This measure yields parent, child, and no-responsibility scores. For this study, only the no-responsibility scores will be used (i.e., the scores indicating that neither parent nor the child assumes responsibility).

Measures of Adherence

Diabetes Self-Management Profile (DSMP).

The DSMP is a structured interview, consisting of 23 questions having an administration time of approximately 15 to 20 minutes. Questions assess five areas of diabetes management, including: insulin administration/dose adjustment, blood-glucose monitoring, exercise, diet, and management of hypoglycemia. The scale has shown adequate to good internal consistency ($\alpha = .76$) and inter-observer agreement (94%; Harris et al., 2000). Interviews were administered by trained research assistants to both parent and child regarding the child's management of their T1D

Measure of Glycemic Control

Glycemic control (HbA_{1c})

HbA_{1c} is a biological assay of health status operationalized via a glycosylated hemoglobin HbA_{1c} test. HbA_{1c} provides an estimate of blood glucose levels over the preceding 2–3 months (American Diabetes Association, 2003). Normal HbA_{1c} ranges from 4% to 6%. Patients routinely have their blood drawn and HbA_{1c} checked as part of their regularly scheduled appointments. Blood samples were analyzed by qualified and experienced technicians using a Bayer DCA 2000+.

Data Analysis

Path Analysis

Path analysis is a general term used to describe causal modeling. These models are comprised of measured variables as some data must have been collected before the model can actually be processed. Traditionally, the label path analysis has been used to describe a causal model with only measured variables, whereas the label "structural equation modeling" (SEM) is most often used to describe a causal model that includes latent variables. By using path analysis the researcher is able to evaluate explicitly hypothesized and often relatively complex causal (predictive) relationships between the variables represented in their data (Klem, 1995). The steps researchers take in conducting path analysis include the following:

- Draw out the interrelationships of the variables in the form of a diagram.
- Indicate the hypothesized strength and direction of each variable's presumed effect on each other.
- Perform the analysis yielding the path coefficients for each path.
- Compare the obtained path coefficients with the hypothesized paths strengths and directions.

- Evaluate how well the causal (predictive) model fits the data based on the results of the analysis.

Causal modeling, in the context of path analysis, results from synthesizing the outcome of several prediction analyses.

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Structural Equation Modeling

SEM can be thought of as a union between confirmatory factor analysis and path analysis (Meyers, Gamst, & Guarino, 2006). This is because in SEM there are really two types of

models: a measurement model and a structural model. The measurement model represents the degree to which the indicator variables capture the essence of the latent factor. It is basically confirmatory factor analysis for each latent variable. It is called a measurement model because the indicator variables are measured variables used to give us some indication of the intangible, unmeasured latent construct (Meyers et al., 2006). The structural model is akin to path analysis in that we are looking at the causal relationships between the major variables of interest in the theory. Causal connections can be drawn between latent variables. For example, deficits in child executive functioning may cause decreased adherence that then causes reduced glycemic control. Once a model is proposed, (i.e., relationships between the variables have been hypothesized) a correlation/covariance matrix is created. The estimates of the relationships between the variables in the model are calculated using the maximum likelihood procedure. The model is then compared with the relationships (the correlation/covariance matrix) of the actual or observed data. SEM assesses how well the predicted interrelationships between the variables match the interrelationships between the actual and observed variables. It has the capability to assess both the measurement model (how well the measured variables define their respective construct) and the structural model (how well the latent constructs relate to each other) simultaneously. If the two matrices (the one based on the hypothesized model and the one derived from the actual data) are consistent with one another, then the structural equation model can be considered a credible explanation for the hypothesized relationships (Meyers et al., 2006). In short, the technique allows a hypothesized model to be tested statistically, in a simultaneous analysis of all the variables in the model, in order to determine if the model's covariance matrix is consistent with the collected data. SEM is confirmatory, provides explicit estimates of measurement errors, and can incorporate not only observed but also unobserved (latent) variables

in the analysis. The data analysis will be carried out using SPSS for Windows Version 15.0 and AMOS 7.

Model fit

Several indices will be used to measure the fit of the models tested. The statistics most often reported are Chi-square (X^2), CMIN/DF (chi square/degree of freedom ratio), comparative fit index (CFI), and root mean square error of approximation (RMSEA; Byrne, 2001). The X^2 statistic is an overall test of how well the hypothesized model fits the data and a significant X^2 indicates a model that does not fit the data well. Because the X^2 statistic assumes multivariate normality and is affected by large sample size (i.e. a model with relatively good fit for a large dataset can still be rejected), additional indices of fit such as Comparative Fit Index (CFI), Root Square Mean Square Error of Approximation (RMSEA) and CMIN/DF (chi square/degree of freedom ratio) must be used to make a judgment regarding the fit of the model. CFI should have a value over 0.90 (Hoyle & Pante, 1995). Interpretation of the RMSEA is often considered according to the following; 0 = perfect fit; < .05 = close fit; .05 to .08 = fair fit; .08 to .10 = poor fit; and > .10 = poor fit (Byrne, 2001). CMIN/DF is a measure of relative chi-square, also called normal chi-square. It is the chi-square fit index divided by degrees of freedom, in an attempt to make it less dependent on sample size. A chi-square/df ratio larger than 2 indicates an inadequate fit (Byrne, 1989). These goodness-of-fit statistics only give information regarding the model's lack of fit to the data used. They cannot assess if a model is plausible, hence it is important to construct a model that is based on knowledge gained from empirical research and/or theory. Before testing the whole model, constructs such as family factors, and adherence should be independently validated. Since path analysis is confirmatory and can incorporate not only observed but also unobserved (latent) variables in the analysis, this method is most applicable for

testing whether a model with latent variables (family factors and adherence) fits existing, previously collected data.

Mediation

Baron and Kenny's (1986) guidelines for mediation will be followed to assess for mediation effects. The following criteria are necessary for mediation: (I) the predictor should be significantly associated with the outcome, (II) the predictor should be significantly associated with the mediator, (III) the mediator should be associated with the outcome variable (with the predictor accounted for), and (IV) lastly, the addition of the mediator to the full model should significantly reduce the relationship between the predictor and criterion variable.

Analyses

Before testing the proposed model, the data was systematically screened for missing values and mean subscale values were used to replace missing data points. To examine for the presence of outliers in the data, Mahalanobis distance (Mahalanobis, 1936) was calculated for each variable; no significant outliers were identified. Means, standard deviations, and correlation matrices were calculated to examine the interrelationships among the model's variables (Table 2-2). Mutivariate assumptions of normality were examined by calculating skewness and kurtosis values for all variables. The variables Internalizing, Externalizing, and the Metacognition Index were found to be positively skewed and/or kurtotic (skewness or kurtosis > 1). Logarithmic transformations (log10) were conducted, which successfully normalized the distributions of these variables. After transformations, skewness and kurtosis values were within the range of acceptable normality (-1.0 to 1.0) for all variables. A model development approach was conducted using AMOS 7 to construct the model. The maximum likelihood method estimated model fit. Standardized path coefficients and their associated significance were calculated (Figure 2-1). Non-significant pathways were eliminated from the model for parsimony and for

clarity of presentation. Indices used in this analysis included chi-square goodness-of-fit statistics, CMIN/DF (chi square/degree of freedom ratio), the comparative fit index (CFI), and the root mean square error of approximation (RMSEA; Hair et al., 1998; Jaccard & Wan, 1996). Nested models were evaluated for meeting Baron and Kenny's (1986) mediation criteria using standardized estimates of path coefficients.

RESULTS

The DFBS variables, Guidance and Control, and Warmth and Caring; and the DFRQ variable, Shared Responsibility, were not significantly related to other variables of interest (Table 2-2) and therefore did not add significantly to the model. In addition, DSMP child reports of adherence did not add significantly to the model beyond that of DSMP parent report alone, therefore these variables were excluded from further analyses.

General Aims

Aim 1 The chi-square statistic indicating goodness of fit was non-significant, X2 = 9.2 (17, N=151), p = .93, suggesting excellent model fit. An examination of additional indices (CMIN = .541, CFI = 1.0, RMSEA = .000) further confirmed model fit. All path coefficients in the final model were significant ($p < .01$) and indicative of practical significance ($\beta > .30$; Figure 2-1). The squared multiple correlations for the outcome variable HbA1c equaled .59. Adherence significantly predicted HbA1c, ($\beta = -.78$, $p < .001$) and Child Behavior significantly predicted Adherence ($\beta = -.37$, $p < .001$) and Parent Stress ($\beta = .51$, $p < .001$; Figure 2-1). Surprisingly, Parent Stress was not significantly related to Critical Parenting. Metacognition significantly predicted HbA1c ($\beta = -.21$, $p = .004$) and Child Behavior ($\beta = .53$, $p < .001$; Figure 2-1).

Aim 2 The inclusion of the demographic variables family income and child age did not add significantly to the model beyond that of Duration of T1D. Duration of T1D was significantly related to adherence ($\beta = .32$, $p < .001$), and was therefore included in the analysis.

Aim 3 The manifest variable Critical Parenting was the only variable remaining from the hypothesized latent construct Diabetes Related Parenting. Alone, Critical Parenting accounted for significant variance in the latent variables Child Behavior ($\beta = .34$, $p < .001$), and Adherence ($\beta = -.38$, $p < .001$; Figure 2-1)

Aim 4 The squared multiple correlations for the latent construct Adherence equaled .476. Adherence accounted for a significant portion of the variance in HbA1c (DSMP; $\beta = -.78$, $p < .001$).

Specific Aims

Aim 5 To test Baron and Kenny's first criteria for mediation, the relationship between the latent construct of Child Behavior and HbA1c was tested and was found to be non-significant, therefore, the first criteria for mediation was not met and further analysis discontinued.

Aim 6 Nested modeling of mediation processes revealed that the relationship between Critical Parenting and HbA1c was fully mediated by Adherence (Figure 2-2).

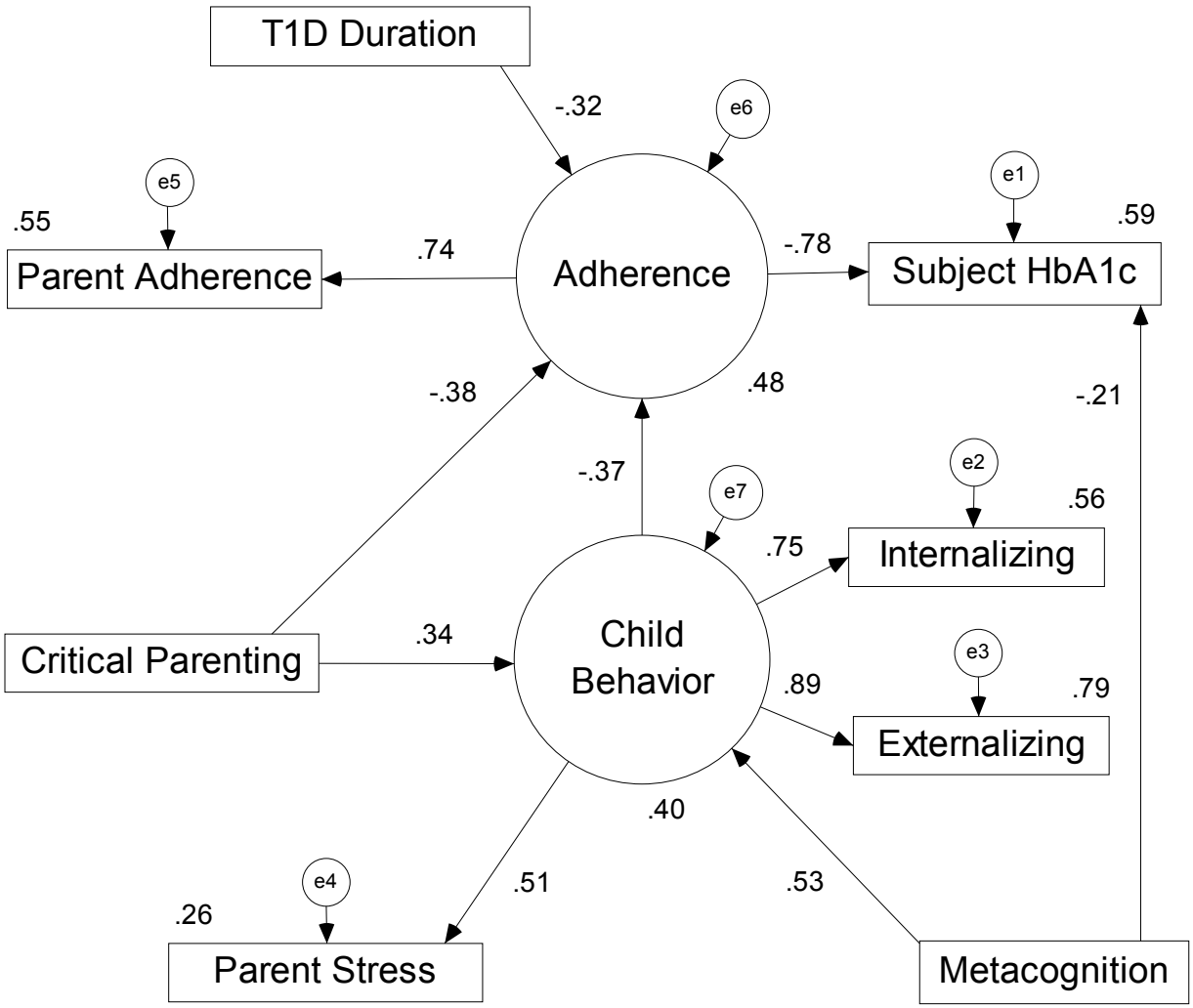
Aim 7 After meeting Baron and Kenny's first two criteria were met, the third criteria was examined and the relationship between youth externalizing behavior and adherence did not significantly change with the addition of parent stress to the model, therefore, the criterion necessary for mediation were not met.

Aim 8 To test Baron and Kenny's first criteria for mediation, the relationship between the manifest variable Metacognition and the latent construct Adherence was tested and found to be non-significant, therefore, the first criteria for mediation was not met and further analysis discontinued.

Aim 9 The validity of this test was predicated on step one of Aim 8, therefore the first criteria for mediation for this analysis was not met and further analysis discontinued.

Post Hoc Analyses.

Given the strong relationships among Critical Parenting, Adherence, and HbA1c (Table 2-1), post hoc analyses were conducted to examine whether Adherence mediated the relationship between Critical Parenting and HbA1c. This analysis met Baron and Kenny's criteria, indicating mediation processes. Adherence mediated the relationship between Duration of T1D and HbA1c (Figure 2-3). Additionally, given the presence of strong relationships among Child Behavior, Metacognition, and Parent Stress (Table 2-1), mediation analyses were conducted and a significant mediation relationship was identified, wherein Child Behavior mediated the relationship between Metacognition and Parent Stress (Figure 2-4).



Model fit: X^2 = 9.2 (17, N=151), p = .93

Figure 2-1 Structural Model

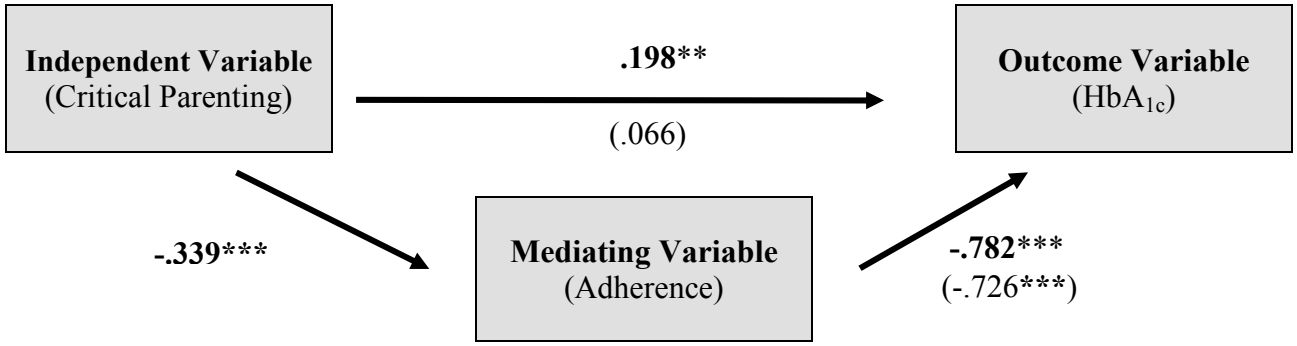


Figure 2-2 Adherence mediating the relationship between critical parents (DFBC) and HbA_{1c}

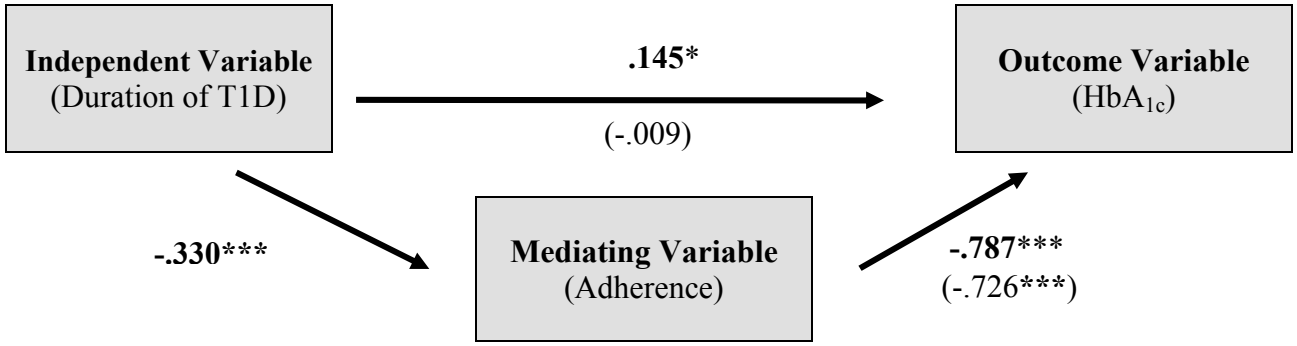


Figure 2-3 Adherence mediating the relationship between duration of T1D and HbA_{1c}

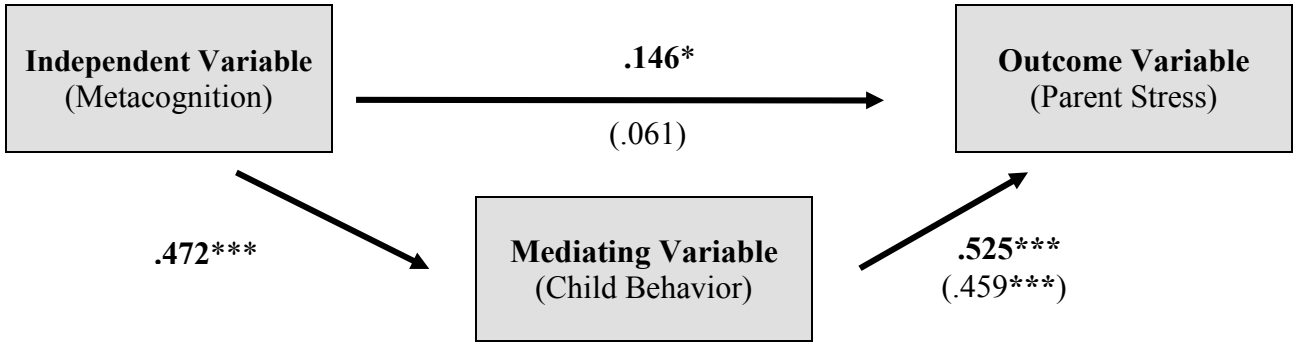


Figure 2-4 Child Behavior mediating the relationship between Metacognition and Parent Stress

Table 2-1 Demographic Characteristics

	Category	N	%
Sex			
	Male	61	40.4
	Female	90	59.6
Ethnicity			
	Caucasian	109	72.2
	African American	23	15.3
	Hispanic	15	9.9
	Other	4	2.6

Table 2-2 Correlations

	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Child Age	13.58	2.93	-	-.082	.150	-.238**	.028	-.019	-.077	.090	-.026	-.373**	-.078	-.187*	-.136	.148
2. Family income	48.2K	34.7K		-	.012	-.140	-.016	-.156	-.095	-.162	.034	.109	-.067	.204*	.246**	-.181*
3. T1D Duration	58.66	43.43			-	.079	.025	.039	-.021	.081	-.056	.076	-.066	.259**	-.114	.266**
4. Parent Stress	185.75	53.72				-	.316**	.419**	.368**	.140	-.137	.006	-.085	-.204*	.031	.144
5. Meta-cognition	33.89	20.88					-	.460**	.344**	.187*	-.131	-.075	-.025	-.192*	-.189*	-.008
6. Internal-izing	7.74	7.01						-	.618**	.335**	-.258**	-.138	-.097	-.299**	-.202*	.180*
7. External-izing	8.38	8.26							-	.618**	-.200*	-.100	-.015	-.323**	-.323**	.176*
8. Critical Parenting	15.08	5.55								-	-192*	-.094	-.102	-.384**	-.331	.418**
9. Warmth & Caring	52.93	10.18									-	-.080	-.104	.132	.063	.030
10. Guidance & Control	43.88	8.66										-	.028	.054	.043	-.061
11. Critical Parenting	2.22	2.14											-	.043	-.052	.022
12. Adherence-Parent	57.14	11.35												-	.470**	-.550**
13. Adherence-Youth	57.98	9.64													-	-.362**
14. HbA_{1c}	8.83	1.92														-

** Correlation is significant at the .01 level.
* Correlation is significant at the .05 level.

DISCUSSION

This study was an attempt to more closely model real-world ecological complexity. Although the importances of the included variables have been independently validated, this is the first known study to simultaneously examine the combined interrelationships among child behavior, metacognition, parent stress, critical parenting, adherence and HbA_{1c}. For our first aim, the model exhibited excellent fit to the data, supporting the validity of the proposed interrelationships. The model's validity was also supported by accounting by yielding a significant R-squared for HbA_{1c}. In addition, the effect sizes for the latent constructs of Adherence and Child Behavior further confirmed the validity of the model. Congruent with intuition and expectations, Child Behavior predicted Parent Stress, i.e. increases in problematic Child Behavior increased parental stress. In addition, increased Child Behaviors predicted decreased Adherence. Child behaviors are integral to the effective implementation of complex T1D management tasks. Child internalizing and externalizing symptoms are likely to increase parental stress directly as well as through interference with diabetes management tasks (Adherence). In support of clinical observations, Adherence significantly predicted HbA_{1c}, such that better adherence predicted decreased HbA_{1c}. Although expected, Parent Stress did not predict Critical Parenting, suggesting that the tendency to use punitive and criticizing control strategies occurs independent of stress. Metacognition significantly predicted HbA_{1c} and Child Behavior. Considering that the Metacognition Index is comprised of the ability to initiate tasks, working memory, the ability to plan and organize, materials organization, and self-monitoring, this is a logical finding. These abilities are clearly related to both the parent's perception of the youth's behavior and to in vivo control of HbA_{1c}. It was surprising that Metacognition was not significantly related to Adherence. It could be that those with better cognitive functioning compensate in ways that are unmeasured in this study.

For our second aim, the demographic variable duration of diabetes added significantly to the model. The presence of a relationship between the duration of T1D and adherence is well established in the literature (Chisholm et al., 2006; Johnson, & Meltzer, 2002). The increasingly complex social and academic demands inherent through the developmental period are likely to increase the risk of nonadherence. In particular, adolescence is a period of escalating responsibility and increased risk-taking. The process of individuation from parents and the accompanying sense of invincibility (Elkind, 1967) are also likely to interfere with the complex management of type 1 diabetes for many youth.

Although for aim 3, a latent construct comprised of a cluster of family factors related to diabetes management was expected, critical parenting emerged as the only meaningful predictor of this proposed construct. Considering the mean participant age of 13.58 years, this finding is not inconsistent with the extant literature, which suggests that in adolescent populations the relationship between parental guidance/control and HbA_{1c} is not as strong (McKelvey et al., 1993; Waller et al., 1986). Adolescents are more likely to be seeking autonomy and less likely to seek or accept guidance and control from adults. Critical parenting was found to be a strong predictor of both adherence and child behavior. This is congruent with expectations and in keeping with Patterson's (1982) coercion model. A related alternate explanation is miscarried helping proposed by Anderson and Coyne (1991). A key difference between these is who precipitates the coercive cycle. In the coercion model it is generally considered to be a reciprocal process, but in miscarried helping it is the parent who precipitates conflict. Although this pattern is considered reciprocal, it is most likely initiated by the parent and its effectiveness as a strategy learned by the child over time. Such maladaptive strategies are likely to have a generational

component (i.e. learned from parents and passed on to their children through experiential and modeling processes).

For aim 4, Adherence accounted for a significant portion of the variance in HbA_{1c}. Although this is an intuitive finding, past research has often found inconsistent or weak relationships between adherence, family factors and glycemic control. It is likely that the use of diabetes specific measures of adherence and critical parenting strengthened this study's ability to detect these relationships.

For aim 5, Child Behavior was related to adherence, but it was not related to HbA_{1c}. Although we expected Adherence to relate directly to HbA_{1c}, in this study child behavior was related to adherence, while having little relationship to HbA_{1c}. Given the mean age of 13.58 in this sample, it may be that insulin resistance, corresponding to the onset of puberty, obfuscated the relationship between Adherence and HbA_{1c}.

For aim 6, Adherence mediated the relationship between Critical Parenting and HbA_{1c}. Youth, who reported more critical caregiver behavior regarding diabetes management (Critical Parenting), experienced worsened HbA_{1c}. Further, the significantly mediated relationship implied that Critical Parenting caused decreased Adherence which in turn caused worsened HbA_{1c}. This suggests that youth resistance to critical (coercive) parents may manifest as non-adherence to their treatment regimen leading to worsened glycemic control (HbA_{1c}).

For aim 7, the hypothesized relationship between Parent Stress and Adherence was not identified. It may be that Parent Stress did not manifest in ways that interfere with the youths' adherence. For aims 8 and 9 the hypothesized relationship between Metacognition and Adherence was not present. It may be that this model lacked the power necessary to detect these

relationships or that our measure of metacognition is too general to adequately measure the specific cognitive requirements of adherence to T1D treatment regimens.

Post hoc analyses found that the relationship between duration of T1D and HbA1c was mediated by Adherence. This suggests that as Duration of Diabetes increased, Adherence decreased which caused HbA1c values to rise. This may be partially due to the increasing maturational demands and individuation processes previously posited, but may also be in part due to weakening of resolve over time and a need for the youth to feel normal. Clinically, children often express that they often pretend they don't have T1D. This likely serves a self-protective function, but often leads to ineffective glycemic control (HbA1c). The final post hoc analysis found that Child Behavior mediated the relationship between Metacognition and Parent Stress. This is a logical and intuitive finding that suggests parent perception of metacognitive functioning and their evaluation of their child's behaviors are congruent, such that they perceive youth decreased ability to use metacognitive strategies as related to behavior problems, which in turn led to parent stress.

It is important to note limitations of this study. First, due to the cross-sectional nature of data collection, statements regarding causality and directionality can only be inferred. The causal implications of future research could be strengthened by utilizing a longitudinal approach to examining factors influencing adherence. Second, model development approaches, necessarily post-hoc, and having been created based on the uniqueness of a population (in this case largely rural and low SES), may not generalize to other settings. Third, while participants were informed that no parent or physician would see their results and were encouraged to be as truthful and accurate as possible, there exists potential for reporting bias on questionnaires and during interviews. Fourth, this sample was relative small for path analysis. A larger sample may

have identified smaller effects, reduced type 2 errors, and identified hypothesized mediation processes.

Within these limitations, this study found important interrelationships between parenting, parent stress, adherence, youth behaviors, youth metacognition, and HbA_{1c}. These findings suggest that clinical evaluation of these factors may inform interventions designed for non-adherent youth with T1D. A preventative approach to intervention for youth may lead to timely and specifically targeted interventions, thereby reducing the risk associated with poorly controlled diabetes. Of particular importance is ameliorating ineffective parental responses to child behavior problems that may promote and maintain argumentative interaction patterns regarding diabetes management. Continued intervention research is critical for expanding the effectiveness of psychological interventions with youth with T1D. Modeling of parenting, parent stress, adherence, cognitive functioning, child behaviors, and glycemic control warrant ongoing research as these and similar complex models may further inform intervention studies. In particular, an important avenue of investigation should be examining causes of critical parenting. Future research should also target other predictors of glycemic control that are potentially mediated by adherence, such as parent and youth depression or anxiety.

LIST OF REFERENCES

Abidin, R. R. (1995). *Parenting Stress Index - Manual*. (3rd ed.) Charlottesville, VA: Pediatric Psychology Press.

Achenbach, T. M. (1991). *Manual for the Child Behavior Checklist 4/18 and 1991 Profile.* Burlington: University of Vermont Department of Psychiatry.

Alioto, A. & Janusz, J. A. (2004). *The role of executive functioning in adolescents' self-management of type 1 diabetes.* Poster presented at the Child Health Conference. Charleston, SC.

American Diabetes Association. (2006). Redefining diabetes control. *Diabetes & Cardiovascular Disease Review, 1*, 1-8.

American Diabetes Association (2005). Standards of medical care in diabetes (Position Statement). *Diabetes Care, 28,* (Suppl. 1), S4–S36.

American Diabetes Association (1997). Position statement: Standards of medical care for patients with diabetes mellitus. *Diabetes Care, 20,* 22-31.

Amiel, S. A., Sherwin, R. S., Simonson, D. C., Lauritano, A. A., & Tamborlane, W. V. (1986). Impaired insulin action in puberty: A contributing factor to poor glycemic control in adolescents with diabetes. *New England Journal of Medicine, 315,* 215-219.

Anderson, B. J. (2003). Who Benefits From Intensive Therapy in Type 1 Diabetes? A fresh perspective, more questions, and hope. *Diabetes Care, 26,* 2204-2206.

Anderson, B. J. (2004). Family conflict and diabetes management in youth: Clinical lessons from child development and diabetes research. *Diabetes Spectrum, 17*, 22-26.

Anderson, B. J. (1995). Childhood and adolescent psychological development in relation to diabetes mellitus. In C. Kelnar (Ed.), *Childhood and Adolescent Diabetes* (pp. 107-119). London: Chapman and Hall.

Anderson, B. J., Auslander, W. F., Jung, K. C., Miller, J. P., & Santiago, J. V. (1990). Assessing family sharing of diabetes responsibilities. *Journal of Pediatric Psychology, 15,* 477-492.

Anderson, B. J., Auslander, W. F. (1980). Research on diabetes management and the family: A critique. *Diabetes Care, 3,* 696-702.

Anderson, B. J., Brackett, J., Ho, J., & Laffel, L. M. (1999). An office-based intervention to maintain parent-adolescent teamwork in diabetes management: Impact on parent involvement, family conflict, and subsequent glycemic control. *Diabetes Care*, *22*, 713-721.

Anderson, B. J., Coyne, J. C. (1991). 'Miscarried helping' in families of children and adolescents with chronic diseases. In: Johnson, J. H., Johnson, S. B. (eds), *Advances in Child Health Psychology*. Gainesville: University of Florida Press.

Auslander, W. F. Anderson, B. J., Bubb, J., Jung, K. C., & Santiago, J. V. (1990). Risk factors to health in diabetic children: A progressive study from diagnosis. *Health and Social Work, 15,* 133-142.

Auslander, W. F., Thompson, S., Dreitzer, D., White, N. H. & Santiago, J. V. (1997). Mothers' satisfaction with medical care: Perceptions of racism, family stress, and medical outcomes in children with diabetes. *Health & Social Work, 22*, 190-199.

Bagner, D. B., Williams, L. B., Geffken, G. R., & Storch, E. A. (2007). The relationship between executive functioning and adherence in pediatric patients with type 1 diabetes. *Children's Health Care, 36*, 169-179.

Bender, B. G, Milgrom, H., Rand, C., & Ackerson, L. (1998). Psychological factors associated with medication nonadherence in asthmatic children. *Journal of Asthma, 35,* 347–353.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology, 52*, 1173-1182.

Bloch, C. A., Clemens, P. S., & Sperling, M. A. (1987). Puberty decreases insulin sensitivity. *Journal of Pediatrics, 110,* 481-487.

Bronfenbrenner, U. (1979). *The Ecology of Human Development: Experiments by Design and Nature.* Cambridge, MA: Harvard University Press.

Brown, R. T. (2002). Society of pediatric psychology presidential address: Toward a social ecology of pediatric psychology. *Journal of Pediatric Psychology, 27,* 191–201.

Byrne, B. M. (1998). *Structural Equation Modeling with LISREL, PRELIS and SIMPLIS: Basic Concepts, Applications, and Programming.* Mahwah, New Jersey: Lawrence Erlbaum Associates Inc.

Barbara N. Byrne (2001). *Structural Equation Modeling with AMOS.* Rahwah, NJ: Lawrence Erlbaum Associates, 2001.

Chisholm, V., Atkinson, L., Donaldson, C., Noyes, K., Payne, A., & Kelnar, C. (2006). Predictors of treatment adherence in young children with type 1 diabetes. *Journal of Advanced Nursing, 57*, 482-493.

Chui, M., Deer, M., Bennett, S., Tu, W., Oury, S., Brater, D., et al. (2003). Association between adherence to diuretic therapy and health care utilization in patients with heart failure. *Pharmacotherapy, 23,* 326–332.

Clark, C. M., & Lee, D. A. (1995). Prevention and treatment of the complications of diabetes mellitus. *New England Journal of Medicine, 332,* 1210-1217.

Cohen, N.J., Gotlieb, H., Kershner, J., & Wehrspann, W. (1985). Concurrent validity of the internalizing and externalizing profile patterns of the Achenbach Child Behavior Checklist. *Journal of Consulting and Clinical Psychology, 53*, 724–728.

Cohen, D, M., Lumley, M. A., Naar-King, S., Partridge, T., & Cakan, N. (2004). Child behavior problems and family functioning as predictors of adherence and glycemic control in economically disadvantaged children with type 1 diabetes: A prospective study. *Journal of Pediatric Psychology, 29,* 71–184.

Cook, S., Herold, K., Edidin, D. V., & Briars, R. (2002). Increasing problem solving in adolescents with type 1 diabetes: The Choices diabetes program. *The Diabetes Educator, 28*, 115-123.

Davidson, M. B. (1998). *Diabetes Mellitus Diagnosis and Treatment. 4th ed*. (pp. 365-375). Philadelphia, PA: WB Saunders Company.

Delamater, A. M., Albrecht, D., Postellon, D., & Gutai, J. (1991). Racial differences in metabolic control of children and adolescents with Type 1 diabetes mellitus. *Diabetes Care, 14,* 20-25.

Delamater, A. M., Applegate, B., Eidson, M. & Nemery, R. (1998). Increased risks for poor metabolic controlin minority youths with type 1 diabetes. *Diabetes, 47 (Suppl. 1),* A326.

DeMatteo, D. (2004). Variations in patients' adherence to medical recommendations: a quantitative review of 50 years of research. *Med Care, 42,* 200-209.

Diabetes Control and Complications Trial Research Group (1993). The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. *New England Journal of Medicine, 329*, 977-986.

Diabetes Control and Complications Trial Research Group. (1994). Effect of intensive diabetes treatment on the development and progression of long-term complications in adolescents with insulin-dependent diabetes mellitus: Diabetes Control and Complications Trial. *The Journal of Pediatrics, 125,* 177-188.

Diabetes Control and Complications Trial Research Group. (2005). Intensive diabetes treatment and cardiovascular disease in patients with type 1 diabetes. New *England Journal of Medicine, 353,* 2643-2653.

Donders, J. (2002). The Behavior Rating Inventory of Executive Function: Introduction. *Child Neuropsychology, 8*, 229-230.

Drotar, D., Stein, R.E., & Perrin, E.C. (1995). Methodological issues in using the Child Behavior Checklist and its related instruments in clinical psychology research. *Journal of Clinical Child Psychology, 24*, 184–192.

Duke, D. C., Geffken, G. R. Lewin, A. B., Williams, L. B. Storch, E. A., & Silverstein, J. H. (2008). Glycemic control in youth with type 1 diabetes: Family predictors and mediators. *Journal of Pediatric Psychology* (In Press).

Elkind, D. (1967). Egocentrism in adolescence. *Child Development, 38*, 1025-1034.

Ellis, D., Naar-King, S., Frey, M., Rowland, M., & Gregor, N. (2003). Case study: Feasibility of multisystemic therapy as a treatment for urban adolescents with poorly controlled type 1 diabetes. *Journal of Pediatric Psychology, 28,* 287-293.

Ellis, D. A., Podolski, C. L., Frey, M., Naar-King, S., Wang, B., Moltz, K. (2007). The role of parental monitoring in adolescent health outcomes: Impact on regimen adherence in youth with type 1 diabetes. *Journal of Pediatric Psychology* (in press).

Farber, H., Capra, A., Finkelstein, J., Lozano, P., Quesenberry, C., Jensvold, N., et al. (2003). Misunderstanding of asthma controller medications: Association with nonadherence. *Journal of Asthma, 40*, 17–25.

Fite, P. J., Colder, C. R., Lochman, J. E., & Wells, K. C. (2006). The mutual influence of parenting and boys externalizing behavior problems. *Applied Developmental Psychology, 27*, 151-164.

Geffken, G. R., Lewis, C., Johnson, S. B., Silverstein, J. H., Rosenbloom, A. L., & Monaco, L. (1997). Residential treatment for youngsters with difficult-to-manage insulin dependent diabetes mellitus. *Journal of Pediatric Endocrinology and Metabolism, 10,* 517-527.

Gelfand, K., Geffken, G., Halsey-Lyda, M., Muir, A., & Malasanos, T. (2004). Intensive telehealth management of five at-risk adolescents with diabetes. *Journal of Telemedicine and Telecare, 9,* 117-121.

Gillis, J.S. (1993). Effects of life stress and dysphoria on complex judgments. *Psychological Reports, 72,* 355-363.

Gioia, G. A., Isquith, P. K., Guy, S. C., & Kenworthy, L. (2000). *The Behavior Rating Inventory of Executive Functioning*. Lutz, FL: Psychological Assessment Resources.

Glasgow, R. E., & Anderson B. J. (1995). Future directions for research on pediatric chronic disease management: Lessons from diabetes. J*ournal of Pediatric Psychology, 20,* 389-402,

Golden, M. D., Herold, A. J., & Orr, D. P. (1985). An approach to prevention of recurrent diabetic ketoacidosis in the pediatric population. *Journal of Pediatrics, 92,* 195-200.

Goldston, D. B., Kovacs, M., Obrosky, D. S., & Iyengar, S. (1995). A longitudinal study of life events and metabolic control among youths with insulin-dependent diabetes mellitus. *Health Psychology, 14,* 409–414.

Gonder-Frederick, L. A., Cox, D. J., & Ritterband, L. M. (2002). Diabetes and behavioral medicine: The second decade. *Journal of Consulting and Clinical Psychology, 70,* 611–625.

Gruppuso, P. A. (2003). Achieving glycemic control in young children with type 1 diabetes: Approaches, pitfalls and new technologies. *Medicine and Health Rhode Island, 86 (4).*

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate Data Analysis (5th edition).* Upper Saddle River, NJ: Prentice Hall.

Hanson, C. L., De Guire, M. J., Schinkel, A. M., Kolterman, O. G., Goodman, J. P., & Buckingham, B. A. (1996). Self-care behaviors in insulin-dependent diabetes: evaluative tools and their associations with glycemic control. *Journal of Pediatric Psychology, 21,* 467-482.

Hanson, C. L., Henggeler, S. W., Harris, M. A., Burghen, G. A., & Moore, M. (1989). Family system variables and the health status of adolescents with insulin-dependent diabetes mellitus. *Health Psychology, 8,* 239–254.

Hanson, C. L., & Onikul-Ross, S. R. (1990). Developmental issues in the lives of youths with insulin-dependent diabetes mellitus. In S. B. Morgan & T. M. Okuwumba (Eds.), *Child and Adolescent Disorders: Developmental and Health Psychology Perspectives* (pp. 201-240). Hillsdale, NJ; Erlbaum.

Harris M.A., Wysocki T., Sadler M., Wilkinson K., Harvey L.M., Buckloh L.M., Mauras N., & White N.H. (2000). Validation of a structured interview for the assessment of diabetes self-management. *Diabetes Care, 23,* 1301-1304.

Hauenstein, E. J., Marvin, R. S., Snyder, A. L., & Clarke, W. L. (1989). Stress in parents of children with diabetes mellitus. *Diabetes Care, 12,* 18-23.

Hauser, S. T., Jacobson, A. M., Lavori, P., Wolfsdorf, J. I., Herskowitz, R. D., Milley, J. E. et al. (1990). Adherence among children and adolescents with insulin-dependent diabetes mellitus over a four-year longitudinal follow-up: II. Immediate and long-term linkages with the family milieu. *Journal of Pediatric Psychology, 15,* 527-542.

Hill-Briggs, F. (2003). Problem solving in diabetes self-management: A model of chronic illness self-management behavior. *Annals of Behavioral Medicine, 25*, 182-193.

Hoyle, R. H., & Panter, A. T. (1995). Writing about structural equation models. In R. H. Hoyle (Ed.), *Structural Equation Modeling: Concepts, Issues and Applications* (pp. 158-176). Thousand Oaks, CA: Sage Publications.

Jaccard, J. & Wan, C. K. (1996). *LISREL Approaches to Interaction Affects in Multiple Regression.* Thousand Oaks, CA: Sage.

Johnson, S. (1992). "Methodological issues in diabetes research." *Diabetes Care 15,* 1658-1667.

Johnson, S. B., & Meltzer, L. J., (2002). Disentangling the effects of current age, onset age, and disease duration: Parent and child attitudes toward diabetes as an exemplar. *Journal of Pediatric Psychology, 27*, 77-86.

Klem, L., (1995). Path analysis. In L. G. Grimm & P. R. Yarnold (Eds.), *Reading and Understanding Multivariate Statistics* (pp. 65-98). Washington, DC: American Psychological Association.

Kovacs, M., Finkelstein, R., Feinberg, T. L., Crouse-Novak, M., Paulauskas, S., & Pollock, M. (1985). Initial psychological responses of parents to the diagnosis of insulin-dependent diabetes mellitus in their children. *Diabetes Care, 8,* 568-575.

Kovacs, M., Goldston, D., Obrosky, D. S., & Bonar, L. K. (1997). Psychiatric disorders in youths with IDDM: Rates and risk factors. *Diabetes Care, 20*, 36-44.

Kovacs, M., Goldston, D., Obrosky, D. S., & Iyengar, S. (1992). Prevalence and predictors of pervasive noncompliance with medical treatment among youths with insulin dependent diabetes mellitus. *Journal of the American Academy of Child and Adolescent Psychiatry, 31,* 1112-1119.

Kurtz, S. (1990). Adherence to diabetes regimens: Empirical status and clinical applications. *The Diabetes Educator*, *16,* 50-56.

Laffel, L. M. B., Connell, A, Vangsness, L., Goebel-Fabbri, A., Mansfield, A., & Anderson, B. J. (2003). General quality of life in youth with type1 diabetes. *Diabetes Care, 26*, 3067-3073.

La Greca, A. M., Follansbee, D. M., & Skyler, J. S. (1990). Developmetnal and behavioral aspects of diabetes management in youngsters. *Children's Health Care, 19,* 132-139.

Lasagna, L., & Hunt, P. B. (1991). Health care, research, and regulatory impact of noncompliance. In J.A Cramer & B. Spilker (Eds.), *Patient Compliance in Medical Practice and Clinical Trials* (pp. 393-403). New York: Raven.

Leonard, B. J., Yuh-Pyng, J., Savik, K., Plumbo, P. M., & Christensen, R. (2002). Psychosocial factors associated with levels of metabolic control in youth with type 1 diabetes. *Journal of Pediatric Nursing, 17*, 28-37.

Lernmark, B., Persson, B., Fisher, L., & Rydelius, P. A. (1999). Symptoms of depression are important to psychological adaptation and metabolic control in children with diabetes mellitus. *Diabetic Medicine*, *16*, 14-22.

Lewin, A. B., Heidgerken, A. D., Geffken, G. R., Williams, L. B., Storch, E. A., Gelfand, K. M., & Silverstein, J. H. (2006). The relation between family factors and metabolic control: The role of diabetes adherence. *Journal of Pediatric Psychology, 31*, 174-183.

Lewin, A. B., Storch, E. A., Silverstein, J. H., Baumeister, A. L., Stawser, M. S., & Geffken, G. R. (2005). Validation of the Pediatric Inventory for Parents in mothers of children with type 1 diabetes: An examination of parenting stress, anxiety, and childhood psychopathology. *Families, Systems, & Health, 23,* 56-65.

Lorenz, R. A., Jannasch, K., Bubb, J., Kramer, J., Davis, D., et al. (1996). Changing behavior: Practical lessons from the Diabetes Control and Complications Trial. *Diabetes Care, 19*, 648-652.

Madsbad, S., McNair, P., Faber, O. K., Binder, C., Christiansen, C., & Transbol J. (1980). Beta-cell function and metabolic control in insulin treated diabetics. *Acta Endocrinology, 43,* 196-200.

Mahalanobis, P. C. (1936). On the generalized distance in statistics. *Proceedings of the National Institute of Science of India, 12,* 49-55.

McCaul, K. D., Glasgow, R. E., & Schafer, L. C. (1987). Diabetes regimen behaviors. Predicting adherence. *Medical Care, 25,* 868-881.

McKelvey, J., Waller, D. A., North, A. J., Marks, J. F., Schreiner, B., Travis, L. B., et al. (1993). Reliability and validity of the Diabetes Family Behavior Scale. *The Diabetes Educator, 19,* 125-132.

Meyers, L. S., Gamst, G., & Guarino, A. J. (2006). *Applied Multivariate Research: Design and Interpretation.* Thousand Oaks, CA: Sage Publications.

Miller-Johnson, S., Emery, R. E., Marvin, R. S., Clarke, W., Lovinger, R., & Martin, M. (1994). Parent-child relationships and the management of insulin-dependent diabetes mellitus. *Journal Counseling and Clinical Psychology, 62,* 603-610.

Northam, E. A., Matthews, L. K., Anderson, P. J., Cameron, F. J., & Werther, G.A. (2005). Psychiatric morbidity and health outcome in Type 1 diabetes – perspectives from a prospective longitudinal study. *Diabetic Medicine, 22*, 152-157.

National Institute of Diabetes and Digestive and Kidney Diseases (2005). *National diabetes statistics fact sheet: General information and national estimates on diabetes in the United States*. Bethesda, MD: U.S. Department of Health and Human Services, National Institute of Health, 2005.

Patterson, G. R. (1982). *Coercive family processes*. Eugene, OR: Castalia.

Patterson, G. R. (1995). Coercion as a basis for early age of onset for arrest. In J. McCord (Ed.), *Coercion and Punishment in Long-Term Perspectives*, (pp. 81-105). New York; Cambridge University Press.

Patterson, G. R., Reid, J. B., & Dishion, T. (1992). *Antisocial Boys.* Eugene, OR: Castilia.

Pfeifer, M. A. (1998) Chronic Complications of Diabetes: An Overview. In: Funnell, M. M., (ed.) *A Core Curriculum for Diabetes Education. 3rd ed.* Chicago, Il: American Association of Diabetes Educators; 1998: 659-675.

Quittner, A. L., Opipari, L. C., Espelage, D. L., Carter, B., Eid, N., & Eigen, H. (1998). Role strain in couples with and without a child with a chronic illness: associations with marital satisfaction, intimacy, and daily mood. *Health Psychology, 17,* 112-124.

Rapoff, M. A. (1999). *Adherence to Pediatric Medical Regimens.* New York: Kluwer Academic/Plenum Publishers.

Rapoff, M. A. (2002). Assessing and enhancing adherence to medical regimens for juvenile rheumatoid arthritis. *Pediatric Annals, 31,* 373–379.

Reid, J. B., Patterson, G. R., & Snyder, J. (2002). *Antisocial Behavior in Children and Adolescents: A Developmental Analysis and Model for Intervention.* Washington, DC: American Psychological Association.

Schafer, L. C., McCaul, K. D., & Glasgow, R. E. (1986). Supportive and nonsupportive family behaviors: Relationships to adherence and metabolic control in persons with type 1 diabetes. *Diabetes Care, 9,* 179-185.

Sclar, D. A., Skaer, t. l., Chin, A., Okamoto, M. P., & Gill, M. A. (1991). Utility of a transdermal delivery system for antihypersensitive therapy: Part 1. *American Journal of Medicine, 91,* 50S-56S.

Streisand, R., Braniecki, S., Tercyak, K. P., & Kazak, A. E. (2001). Childhood illness-related parenting stress: The pediatric inventory for parents. *Journal of Pediatric Psychology, 26,* 155-162.

Streisand, R., Swift, E., Wickmark, T., Chen, R., & Holmes, C. S. (2005). Pediatric parenting stress among parents of children with type 1 diabetes: The role of self-efficacy, responsibility, and fear. *Journal of Pediatric Psychology, 30,* 513-521.

Svoren, B. M., Volkening, L. K., Butler, D. A., Moreland, E. C., Anderson, B. J., Laffel, L. M. (2007). Temporal trends in the treatment of pediatric type 1 diabetes and impact on acute outcomes. *Journal of Pediatrics, 150*, 279-85.

Swanson, M., Hull, D., Bartus, S., & Schweizer, R. (1992). Economic impact of noncompliance in kidney transplant recipients. *Transplantation Proceedings, 24,* 27-32.

Tebbi, C. K. (1993). Treatment compliance in childhood and adolescence. *Cancer, 71 (Suppl.),* 3441-3449.

Trachtenbarg, D. E. (2005). Diabetic Ketoacidosis. *American Family Physician, 71,* 1705-1714.

Waller, D. A., Chipman, J. J., Hardy, B. W., Hightower, M. S., North, A. J., Williams, S. B., & Babick, A. J. (1986). Measuring diabetes-specific family support and its relation to metabolic control: A preliminary report. *Journal of the American Academy of Child Psychiatry, 25,* 415-418.

Weissberg-Benchell, J., Glasgow, A. M., Tynan, W. D., Wirtz, P., Turek, J., & Ward, J. (1995). Adolescent Diabetes Management and Mismanagement. *Diabetes Care. 18*, 77-82.

Wolpert, H. A., Anderson, B. J. (2001). Management of diabetes: Are doctors framing the benefits from the wrong perspective? *British Medical Journal, 323*, 994-996.

Wysocki, T., Greco, P., & Buckloh, L. M. (2003). Childhood diabetes in psychological context. In M. C. Roberts (Ed.), *Handbook of Pediatric Psychology, Third Edition*. New York: Guilford Press.

Wysocki, T., Huxtable, K., Linscheid, T. R., & Wayne, W. (1989). Adjustment to diabetes mellitus in preschoolers and their mothers. *Diabetes Care, 12,* 524-529.

Wysocki, T., Taylor, A., Hough, B. S., Linscheid, T. R., Yeates, K. O., & Naglieri, J. A. (1996). Deviation from developmentally appropriate self-care autonomy: Association with diabetes outcome. *Diabetes Care*, *19*, 119-125.

BIOGRAPHICAL SKETCH

Danny was born in 1954 in Redlands, California. The oldest of three children, he spent his early youth living in Yucaipa and later in Placerville, California, where he graduated from El Dorado High School in 1972. He has been married to his beautiful wife Vicki since 1973, and they have two children, Erin and Ryan. He owned and operated a successful landscape contracting business that operated in the greater Sacramento, California area from 1973 until 2004. He earned his B.A degree in psychology from California State University, Sacramento in 2002 and plans to complete his Ph.D. in clinical psychology and to pursue teaching, clinical, and research interests in pediatric psychology.