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Parental Memory Predictors of Children's Daily Diabetes Management and Metabolic Control

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Parental Memory Predictors of Children's Daily Diabetes Management and Metabolic Control

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ABSTRACT

PARENTAL MEMORY PREDICTORS OF CHILDREN'S DAILY DIABETES MANAGEMENT AND METABOLIC CONTROL

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A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science at Virginia Commonwealth University

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This study examined, for the first time, specific links between parents' memory and children's diabetes behaviors and metabolic control. Data revealed that parental memory and responsibility predicted children's percentage of calories from fat and carbohydrates, and metabolic control, accounting for 7.3% of the variance in calories from fat and 18.5% of the variance in metabolic control for the total sample. These effects were stronger when limited to dietary behaviors of younger youth; parental memory accounted for 30.3% and 33.6% of the variance in percentage of calories from fat and carbohydrates, respectively, for younger children. Level of parent responsibility, with memory, moderated younger children's percentage of calories from fat and carbohydrates, and children's metabolic control. Parents with higher memory scores and more responsibility had disease indictors that were closer to ADA recommendations. Results suggest intervention to enhance parent memory may improve diabetes care and health status for youths with IDDM.

Introduction

Insulin-dependent diabetes mellitus (IDDM) is a chronic illness that most often develops during childhood and has no cure. Approximately one in every 400 to 500 youths has IDDM, the most common chronic endocrine condition in children and adolescents (American Diabetes Association, 2000). Type 1 diabetes is a condition that affects how the body handles glucose, an important energy source for the body. Blood levels of glucose are controlled primarily by the hormone insulin. With IDDM, the child's own immune system attacks and destroys the beta cells in the pancreas that produce insulin. Once these cells are destroyed, the pancreas cannot replace them. As beta cells die, insulin levels in the blood drop. Insulin is responsible for allowing glucose to permeate the cellular membrane and to become bioavailable to organs in the body for energy, most importantly the brain. Without the presence of insulin there will be variability in blood glucose levels, which at the extreme may result in hypoglycemia or hyperglycemia. When there is too little glucose in the bloodstream due to an excess of insulin, inadequate caloric intake, or unforeseen exercise, a condition called hypoglycemia can occur. If extreme, hypoglycemia can lead to loss of consciousness or coma. Other, less severe symptoms of hypoglycemia can include shakiness, sweating, loss of motor coordination, nausea, and confusion (Wertlieb, Jacobson, & Hauser, 1990). On the other hand, hyperglycemia can occur if there is too little insulin. Hyperglycemia can produce symptoms such as dehydration, excessive urination, electrolyte imbalance, and increased heart-rate.

The primary treatment objective of IDDM is to maintain near-normal, stable blood glucose levels and to avoid disease complications through daily disease-management behaviors. In order to attain adequate metabolic control, the management of IDDM includes blood glucose testing throughout the day, multiple insulin injections (via subcutaneous shot or pump), and careful monitoring of diet and exercise (American Diabetes Association, 2000). The diabetes regimen can be complicated and time-consuming because children and/or their parents must perform and monitor disease management behaviors daily.

Diabetes care behaviors such as blood glucose testing, insulin administration and attention to diet and exercise can be measured as behavioral indicators of disease management. Another way to track diabetes control is the glycosolated hemoglobin assay. This is a physiological measure of metabolic control that represents the average blood glucose concentration over the past 90 to 100 days by measuring the percentage of glucose molecules that bind to the outside of red blood cells (Cox et al., 1994). If a child does not adhere to the behaviors required in the daily regimen, glycosolated hemoglobin levels will rise with significant long-term consequences. For example, elevated glycosolated hemoglobin levels can lead to kidney damage (nephrology), which can cause renal failure and can also reduce filtration ability. In addition, poorly controlled diabetes can result in retinopathy, significant eye damage that can lead to blindness. Neuropathy, or nerve damage, can result from poor metabolic control and cause loss of sensation in the fingers and toes. Diabetes also carries an increased risk of hypertension, heart attack, stroke, and complications related to poor circulation (Wertlieb et al., 1990). These long-term complications are quite serious, and if good metabolic control is not maintained, complications may lead to a premature death.

Diabetes Care Behaviors

The multi-faceted nature of diabetes management makes it a difficult construct to measure (Miller-Johnson et al., 1994). The 24-hour assessment interview (Johnson, Silverstein, Rosenbloom & Cunningham, 1986) is commonly used to measure diabetes-related behaviors and has many assets. This interview technique uses a discrete and recent time interval, the previous 24 hours, to obtain information about observable, highly specific and time-limited information. Unlike many checklists, a respondent is not required to summarize behaviors over large intervals of time, eliminating one source of measurement error. A child with diabetes and their parent is interviewed separately, providing corroboration of diabetes management behaviors. In addition, the interviewer asks the respondent about all events of the day in temporal order, rather than just probing for specific diabetes behaviors only, which reduces social desirability and self-report bias.

Johnson et al. (1986) defined 13 separate diabetes care behaviors based on data derived from multiple 24-hour Assessment Interviews. Factor analysis revealed that these behaviors could be grouped into 5 factors that accounted for 70.6% of the variance. The 5 factors were: exercise (frequency, duration, type), diet type (percentage of calories from fat and carbohydrates), diet amount (total calories and concentrated sweets consumed), frequency (eating and blood glucose testing), and injection behaviors (Johnson et al., 1986). Glasgow, McCaul, and Schafer (1987) also demonstrated the multi-dimensionality of diabetes care behaviors in an adult sample of 93 IDDM patients.

Freund, Silverstein & Thomas (1991) extended information on the reliability of the 24-hour Assessment Interview and the multi-faceted nature of diabetes management with a sample of 78 six to 19 year olds. Importantly, data based on nine interviews for each parent-child pair indicated that 12 of 13 diabetes care behaviors remained significantly stable over the course of three months. Dietary behaviors and glucose testing were the most consistent over time. Reliability coefficients for glucose testing frequency over three months ranged from .72 to .76, while the reliability coefficients for various dietary behaviors were in the .50-.77 range. In comparison, other injection and exercise behaviors had reliability coefficients as low as .06 and .37 over three months.

Johnson et al. (1992) replicated these findings in a longitudinal study with 193 children and adolescents with IDDM and found that many diabetes care behaviors continued to have acceptably high reliability coefficients during the course of almost two years. Dietary behaviors and blood glucose tests again demonstrated relatively higher levels of stability as constructs across time. Reliability coefficients for dietary behaviors ranged from .37 to .38, and testing frequency was .45 compared to other injection and exercise behaviors that had reliability coefficients as low as .05 and .09. Because diabetes care is multi-dimensional, individuals may vary in their performance of different diabetes care behaviors. Competence with one task does not necessarily indicate competence with a different diabetes care task.

Parental Involvement

Parents often feel ultimate responsibility for their children's diabetes care, and are frequently held accountable by doctors (Drotar & Ievers, 1994). Given this duty, it is not surprising that parents believe a childhood chronic illness can be demanding and stressful for families (Bouma & Schweitzer, 1990). Parents hold multiple and demanding roles, including their responsibility to parent other children and manage family life, and also regulate disease-related concerns for their child with diabetes. Parents of youths with IDDM are faced with concerns about the risk of severe insulin reaction, potential medical complications and possible hospitalizations.

Seiffge-Krenke (1998) suggests that continuous parental monitoring of diabetes care behaviors is necessary, for both optimal regimen adherence (Hanson, Henggler, & Burghen, 1987) and metabolic control (Seiffge-Krenke, 1998). Previous literature shows that less parental involvement in youth diabetes care is associated with poorer diabetes outcomes, (Anderson, Auslander, Jung, Miller, & Santiago, 1990; Ingersoll, Orr, Herrold, & Golden, 1986) and when parents allow children to control the treatment regimen too early, poorer metabolic control results (Gowers, Jones, Kiana, North, & Price, 1995).

Given the complexity of the medical regimen for IDDM, most professionals believe disease care is too demanding for younger children to execute adequately without consistent support and assistance from parents (Davis et al., 2001). Before the age of 12, children may not be cognitively and/or physically capable of the demands of optimal disease care. Therefore, younger children have less responsibility in disease management than older children with IDDM (Allen, Tennem, McGrade, Affleck, & Ratzan, 1983;

Dashiff, 2003; Davis et al., 2001; Drotar & Ievers, 1994), and as children get older, they assume increasingly more responsibility for their own diabetes management (Anderson et al., 1990). LaGreca, Follansbee, & Skyler (1990) found that research recommends children assume the majority of diabetes care responsibility between 12 and 13 years of age, but before that parents have should primary disease care responsibility.

In a study of 100 youth with IDDM, Wysocki et al. (1996) combined a measure of family division of 17 aspects of diabetes responsibility and parents' ratings of their child's mastery of 38 diabetes care behaviors into a composite of self-care autonomy. A Psychological Maturity Index assessed cognitive functioning, social-cognitive development, and academic maturity. The Autonomy/Maturity Ratio (AMR) measured the extent to which each child exhibited developmentally appropriate diabetes care autonomy compared to assessments of the individual's psychological maturity. Scores on the AMR were assigned to one of three groups: constrained, appropriate, and excessive self-care autonomy. Youths in the constrained group were younger and had more parental involvement in diabetes management compared to the other groups. Constrained self-care autonomy was associated with more favorable outcomes in terms of treatment adherence and diabetic control compared with that reported for children with both developmentally appropriate and excessive levels of self-care autonomy. This study represented an attempt to include cognitive factors in predicting which youths will best manage metabolic control. Although younger youths whose parents retained disease control experienced better diabetic control, little effort has been made to assess similar cognitive skills in parents to ensure optimal management of their children's diabetes when they are under 12 years old.

Memory abilities and medical treatment.

The complexity of the diabetes treatment regimen (Holmes, 1987; Johnson et al., 1986) requires substantial utilization of memory skills, and the distinctly different aspects of daily care present the possibility that different types of memory may underlie different facets of care. Daily diabetes management necessitates ongoing recall and working memory for type and quantity of dietary intake, especially carbohydrate grams (Gillespie, Kulkarni, & Daly, 1998; New England Diabetes and Endocrinology Center, 1997). Rote memory is required to initiate blood glucose tests (Soutor, Chen, Streisand, Kalpowitz, & Holmes, 2004). Longitudinal research shows that IDDM can result in memory difficulties for some children (Kovacs, Ryan, & Obrosky, 1994; Hershey, White, Bhargava, Craft, & Sadker, 1999; Rovet & Ehrlich, 1999; Soutor et al., 2004; Wolters, Yu, Hagen, & Kail, 1996). Disrupted memory is a concern because rote and quantitative verbal memory have been related to adolescents' dietary behaviors and blood glucose testing frequency (Soutor et al., 2004).

Soutor et al. (2004) showed memory predicted disease care behaviors in a sample of 224 nine to 17 year olds with IDDM. Quantitative working memory predicted calories consumed from carbohydrates in the oldest adolescents (> 14 years) who presumably have more independence for food selection outside of parents, in contrast to younger youths. Similarly, for adolescents, but not pre-adolescents, rote verbal memory predicted blood glucose testing frequency. Adolescents who were over 12.5 years of age performed significantly more blood glucose tests without parental involvement. These age-related differences in the predictive role of memory were likely found because older adolescents have more independence for their diabetes management. Despite the documented importance of memory in diabetes care, it appears that no studies have examined the relative importance of parental memory in the management of their child's diabetes, even though parents have significant disease management responsibility, especially for younger children.

Ross, Frier, Kelnar, & Deary (2001) found a significant positive correlation (r = .28) between mothers' IQ and children's metabolic control (HbA1c), indicating that parent mental ability is important in the management a child's IDDM. Despite the significant correlation, parent IQ only accounted for 7% variance in HbA1c and this effect may be partially attributable to SES. Its low explanatory power also may result from the only moderate correlation between global cognitive ability (i.e., IQ) and specific cognitive skills such as memory (Wechsler, 1997). A measure of general cognitive abilities may be too diffuse, and a more targeted measure of cognitive skill, such as memory, may prove to be more a potent predictor. Additionally, Ross et al. (2001) only used metabolic control as an outcome variable, and did not use detailed, multi-factorial assessment of disease care behaviors (such as 24-hr Assessment Interview) despite the fact that previous research (Johnson et al., 1992) has shown a poor correlation between psychological predictors and bio-medical outcomes. Therefore, it may be more appropriate to have a psychological variable, memory, predict psychological outcomes, such as disease care behaviors, as in the present study.

Memory has been frequently examined as an important component in medical regimens for adults with a variety of chronic conditions. Dunbar-Jacob and Mortimer-Stephens (2001) found that the most common reason for missing medications given by adult patients with a variety of chronic health conditions is "forgetting." Conway, Pond, Hamnett and Watson (1996) studied the complex daily drug regimens of cystic fibrosis with 80 adult participants. The most common reason given for omitting medication in a questionnaire about their daily compliance was "forgetfulness," comprising 34.5% of all the reasons given.

Memory also can be a significant factor in daily care even when a medical condition is associated with more immediate and terminal outcomes. Walsh, Horne, Dalton, Burgess, & Gazzard (2001) examined reasons for missed doses in prescribed treatment for 178 HIV (human immunodeficiency virus) positive adults. Participants filled out a questionnaire about adherence and missed doses. Patients who responded that they had missed doses answered 20 additional questions detailing reasons for missed medication and also completed a semi-structured interview. Information was also gathered from the patient's physician and computerized pharmacy records were used to estimate adherence. Forgetfulness accounted for 12.6% of the total variance for treatment non-compliance. Samet et al. (1992) also surveyed a sample of adult patients diagnosed with HIV to determine the variables associated with non-compliance to drug therapy. Compliance was based on responses provided in questionnaires compared to treatment recommendations made in patient charts. Fifty-one percent of the participants reported "forgetting" as the reason for missing a dose of medication during the past week. HIV, like diabetes, can be associated with neurocognitive deficiencies (Hardy, Castellon, & Hinkin, 2004).

Another study apropos to diabetes because of its associated increased risk of cardiovascular disease complications explored the relationship between memory and adherence to a cholesterol-lowering treatment in 158 generally healthy adults aged 24 to 60 with LDL (low density lipoproteins) cholesterol levels of 160mg/dl or higher (Stilley, Sereika, Muldoon, Ryan, & Dunbar-Jacob, 2004). The authors assessed verbal memory with the Rey Auditory Verbal Learning Test, a list of unrelated words presented over four trials, with an intervening distracter list before a fifth recall trial. A 20 minute delay recall condition also was used. Nonverbal memory was measured with the Rey Complex Figure Test in which participants copied a complex figure, and immediate and delayed recall was later assessed. Nonverbal memory was significantly related to medication adherence during treatment ($r = .19, p <.05$).

Further, recall of disease care behaviors may be more difficult when physical cues are absent (Soutor et al., 2004). Once symptom-free, patients often simply forget to take their medication despite normal intelligence (Kardas, 2002; Miller, Hill, Kottke, & Ockene, 1997). Kardas (2002) examined factors influencing medical compliance in short-term antibiotic therapy for respiratory tract infections. Across studies, he found that, in addition to forgetting, one reason for prematurely stopping medication during antibiotic treatment was symptomatic relief occurred before the recommended treatment time elapsed (Kardas, 2002). Once symptoms no longer serve as an external cue, people may forget to take their medication.

This situation is magnified when the role of parental management of children's disease care is examined because parents who are without a chronic illness are, of course, asymptomatic. Thus, despite appropriate parental memory, parents with the best intentions for their children's care may be impeded in their execution of modification of lifestyle behaviors (Miller et al., 1997). Patients must be able to monitor their Children's disease care behavior over the course of a day, to update working memory and remember which parts of their treatment have and have not been completed, which may be more difficult when the person responsible for disease care is asymptomatic (Dunbar-Jacob et al., 2000).

Like IDDM, medical management of cystic fibrosis includes lifestyle factors such as exercise and physiotherapy. Abbot, Dodd, Bilton and Webb (1994) designed a questionnaire to measure compliance with four treatment components in adults with cystic fibrosis: physiotherapy, exercise, pancreatic enzymes, and vitamins. Sixty adults completed a compliance questionnaire, and a psychologist interviewed a close companion (usually a romantic partner) using the same questionnaire to validate accuracy of the interview. Adherence results showed that regardless of the individual treatment component, forgetting was the predominant reason for poorer compliance to physiotherapy (22%), to enzyme regimen (45%), to exercise treatment (29%), and to vitamin treatment (58%).

Additional Factors

State Anxiety and Memory. State anxiety is a transient condition that is characterized by feelings of tension, apprehension, and worry, as well as symptoms of increased physiological arousal (Spielberger, Gorsuch, & Lushene, 1983). It is the anxiety experienced at a particular moment in time. The processing efficiency theory (Eysenck & Calvo, 1992) proposes that anxiety may interfere with demanding cognitive tasks, such as measures of working memory, because distracting thoughts or worry characteristic of state anxiety compete for limited resources. Thus, highly state anxious subjects may have a smaller capacity to devote to cognitive tasks because they engage in more task-irrelevant processing (worry) than non-anxious counterparts. State anxiety is associated with lower performance on a variety of cognitive tasks (Cumming & Harris, 2001; Eysenck, 1985; Eysenck & Calvo, 1992; Hill & Vandervoort, 1992; Wetherell, Reynolds, Gatz, & Pedersen, 2002).

Parental responsibility for their children's diabetes, especially for children under the age of 12, may lead to increased stress and distress (Drotar & Ievers, 1994; Krulik et al., 1999). Beyond parenting stress, parents may feel anxious when confronted with the cognitive demands of optimal diabetes care, such as the need to recall fat or carbohydrate grams from a previous meal and to add it to their child's daily tally of ingested nutrients. These cognitive requirements may be more anxiety provoking in a pressured situation such as when in line at a fast-food restaurant. Consideration of parental state anxiety in addition to memory skills/capacity may provide an indication of the complex cognitive and emotional interplay that occurs when parents make disease care decisions.

Digit Span, a Wechsler scale measure of rote recall, has been widely used in assessing the relationship between state anxiety and cognitive performance (Wechsler, 1997). For example, Rankin, Gilner, Gfeller, & Katz (1994) found high-anxious individuals, as determined by scores on the State scale of the State-Trait Anxiety Inventory (STAI) recalled less information than low-anxious individuals on Digits Forward ($p < .03$). Similarly, West, Boatwright, & Schleser (1984) found that higher state anxiety on the STAI was significantly related to poorer recall as measured by the Digit Span task ($r = -.29$, $p < .01$).

Darke (1988) administered the Digit Span subtest to participants with upper extreme scores on the Test Anxiety Scale (TAS) and participants with lower extreme scores. As expected, the lower anxiety group scored significantly higher on the memory test ($M = 10.4$) than the high anxiety group ($M = 8.8$), $p < .025$. Darke assessed an additional 32 volunteers to test the relationship between state anxiety and cognitive performance using a complicated word span task that required subjects to actively process written information as well as maintain target items. This task is similar to the working memory demands of the Arithmetic subtest on the WAIS in that they both require processing of language, dismissal of extraneous information, and memory of target information. Again, as expected, highly state anxious participants had poorer working memory than their low anxious counterparts. This work was extended to a medical population of adults with elevated LDL (low density lipoproteins) cholesterol levels. State anxiety was related to poorer nonverbal memory on the Rey Complex Figure Test ($r = -.17$, $p < .05$), beyond other studies which have primarily utilized measures of verbal memory difficulty (Stilley et al., 2004).

Socio-economic status (SES). Current literature indicates that health related behaviors and disease management skills are linked to demographic factors such as SES.

In a National Health Survey, Lowry, Lann, Collins, & Kolber, (1996) found that unhealthy behaviors such as a sedentary lifestyle, insufficient consumption of fruits and vegetables, and excessive consumption of foods high in fat were inversely related to SES in a large epidemiological sample of healthy adolescents. These same behaviors can have an adverse effect in diabetes. Similarly, Auslander, Thompson, Dreitzer, White, and Santiago (1997) found a significant association between adherence to diet and blood glucose testing and parent education and financial resources in 146 youths with IDDM and their mothers. Youths living in lower SES homes consumed a higher percentage of calories from fat, ate fewer fruits and vegetables, and were more sedentary (Auslander et al., 1997). Delamater et al. (1999) found poor glycemic control in children with IDDM who are receiving state funded aid or Medicaid. Since SES is related to health care behaviors and poorer metabolic control (Auslander et al., 1997; Delamater et al., 1999; Lowry et al., 1996), it is an important variable to consider in the evaluation of disease management behaviors and metabolic control. In addition, SES also is strongly correlated with memory performance (Wechsler, 1997) but it has been rarely considered in previous studies.

Statement of the Problem.

Insulin dependent diabetes mellitus is a chronic illness that develops most often in childhood and results in the inability to produce endogenous insulin. Lack of insulin can lead to large variations in blood glucose levels and can cause memory difficulties for some children with IDDM (eg: McCall & Figlewicz, 1997; Rovet & Ehrlich, 1999). Previous literature indicates that as children with diabetes or their parents must constantly monitor injection and meal timing, acquire and be able to retrieve a large body of disease-management knowledge, and calculate diet and calorie consumption over the course of a day, adequate rote verbal memory and quantitative verbal working memory would appear essential for successful disease care.

Preliminary research by Soutor et al. (2004) indicates that adolescent rote and quantitative verbal memory predicts diabetes management. Better memory skills were linked to more daily blood glucose tests, more meals/snacks ingested, and a higher percentage of calories from carbohydrates. These behaviors in turn were related to less variability in metabolic control. Importantly, Soutor et al. (2004) found memory did not predict diabetes behaviors for younger children who have relatively little autonomy for their diabetes care behaviors (eg: Dashiff, 2003; Ingersoll et al., 1986). Because parents maintain primary responsibility for the care of children under the age of 12, parental memory may predict aspects of disease care for these younger children.

Although it is clear that the diabetes regimen calls for extensive use of memory skills and that parents are often in control of diabetes care, the role of parental memory in managing children's IDDM has not been examined. Only one study (Ross et al., 2001) has examined the relationship between general parent mental ability and child metabolic control, finding that mother's IQ is significantly correlated with the child's metabolic control. The relation was relatively weak, perhaps because global cognitive skills are too vague and nonspecific. A more narrowly defined measure of cognitive skills, such as memory, may be a more powerful predictor.

Existence of a link between parent memory and child disease care may provide an opportunity for intervention to enhance parent memory (Korol, 2002; Leon-Carrion, 1997; Moely, Hart, Santulli, & Leal, 1986) and thus enhance diabetes care and health status for youths with IDDM. Improved disease care can reduce the chance of long-term complications with major organs such as the eyes, kidneys and heart caused by elevated glycosolated hemoglobin levels.

A parent with a diabetic child might feel anxious about completing memory tasks as they have already been shown to feel elevated levels of distress (Drotar & Ievers, 1994; Krulik et al., 1999). Higher state anxious individuals have been reported to exhibit decreased recall performance compared to lower-anxious individuals (eg: Wetherell et al., 2002), which may relate to diabetes care demands such as updating a child's continuous tally of fat calories with information from a recent meal. A measure of state anxiety, along with a working memory task, may more accurately reflect the complexity of human behavior in "real-world" situations. Therefore, a measure of state anxiety will be used to better clarify the relationship between parent memory and disease management behavior.

In the present study, well-standardized and reliable measures such as the 24-hour assessment interview, WMS-III Digit Span and WAIS-III Arithmetic were used to assess disease care and verbal memory and quantitative verbal working memory (arithmetic skills) of parents with children with IDDM. Parent memory and arithmetic ability was then used to predict particular diabetes care behaviors for a sample of pre-adolescents and adolescents with diabetes ages 9-16. The STAI was used to assess parental state anxiety concurrent with memory assessment to explore if anxiety plays a role in the relationship between parent memory and child's diabetes care.

Hypotheses:

1. Parental memory effects will be more detectable in the disease care behaviors of younger children for whom parents maintain primary responsibility of diabetes care.

   a. Parents' rote verbal memory (Digit Span scores) will predict children's eating frequency.

   b. Parents' rote verbal memory (Digit Span scores) will predict children's blood glucose testing frequency.

   c. Parents' quantitative working memory (Arithmetic scores) will predict children's percentage of calories from fat.

   d. Parents' quantitative working memory (Arithmetic scores) will predict children's percentage of calories from carbohydrates.

2) Parental state anxiety may play an explanatory role in clarifying the relationship between parent memory and child's diabetes care behaviors.

Method

Participants

Fifty-eight youths with IDDM and their parents were recruited from an ongoing longitudinal study of memory and learning in children with type 1 diabetes. Participants in the longitudinal study were originally recruited from pediatric endocrine clinics in Richmond, VA and Washington, D.C. An explanation of the study was sent to a family prior to an upcoming medical appointment, and possible participants received a follow-up phone call explaining the study.

The study sample was restricted to children who have had type 1 diabetes for over six months, were free of other chronic medical conditions, had not experienced head trauma requiring medical attention, and were not taking medications that affect the central nervous system. The majority of the assessments took place on the day of a child's medical appointment, or as close to their medical appointment as possible. Prior to testing, a parent gave informed consent and a child gave informed assent. The appropriate institutional ethics committees approved the protocol.

Parents of youths who have previously agreed to participate in a larger, longitudinal study of memory and learning in children with type 1 diabetes mellitus were recruited when scheduling their child's testing appointments. They were informed that their participation would entail completing five additional psychosocial questionnaires and completing two brief memory subtests. These additions to the longitudinal adolescent study required approximately 30-40 minutes. Parents received $10 for their participation, in addition to the $45 -75 remuneration provided to youths for their portion of the research study.

Measures

Information on the measures used in this study is summarized in Table 1.

Table 1

Measures Used in This Study

Construct	Measures Used	Measures Sources	Number of Items	Alpha
Parent Quantitative Working Memory	Arithmetic subtest	Weschler Adult Intelligence Scale-III (Weschler, 1997)	up to 17	.88
Parent Working Verbal Memory	Digit Span subtest	Weschler Memory Scale-III (Weschler, 1999)	up to 17	.90
Parent State Anxiety	State subscale	Spielberger State Trait Anxiety Inventory (Spielberger, 1983)	20	.93
Diabetes Care Behaviors	Dietary Intake Testing Frequency	24-Hour Assessment Interview (Bennet-Johnson et al., 1986)	--	.50-.77
Socioeconomic Status	Parent Interview Form	Hollingshead Four Factor Index (Hollingshead, 1975)	--	--
Diabetes Care Responsibility	Parent Responsibility	Diabetes Family Responsibility Questionnaire (Anderson et al., 1990)	17	.83 - .92

Each participant completed a battery of self-report questionnaires and two brief memory tests, which included the following:

Parent Quantitative Working Memory. The Arithmetic subtest from the Weschler Adult Intelligence Scale-III (WAIS-III; Wechsler, 1997) is a well-standardized and widely used measure to evaluate quantitative verbal working memory (Sattler, 2001). The WAIS-III was standardized on 2,450 adults aged 16 to 89. The standardization sample was stratified geographically and ethnically to reflect the 1995 Census data. The Arithmetic subtest of the WAIS-III consists of up to 17 orally presented math problems which must be completed without the use of paper and pencil. The subtest measures the ability to follow verbal directions, attend to relevant parts of presented information, retain numerical information, and perform numerical operations. Scaled scores are standardized by age, ranging from 1 to 16 ($M = 10$, $SD = 3$). Scores between 7 and 13 are in the Average range. Arithmetic is a reliable subtest ($r = .88$), with reliability coefficients at or above .77 for all 13 age groups (Sattler, 2001).

Parent Rote Verbal Memory. The Digit Span subtest from the Weschler Memory Scale – III (WMS-III; Wechsler, 1997) is a well-standardized instrument designed to measure rote verbal memory. The WMS-III was standardized on 1,250 individuals aged 16 to 89. The standardization sample was stratified geographically and ethnically to reflect the 1995 U.S. Census data. The Digit Span subtest has two parts: Digits Forward and Digits Backwards. Digits Forward requires the test taker to repeat a series of orally presented random numbers in correct sequence. The digit series range from 2 to 9 digits.

Digits Backwards requires the test taker to reproduce in reverse order a series of numbers ranging in length from 2 to 8 digits. Digit Span is a reliable subtest (r = .90), with reliability coefficients at or above .84 for all 13 age groups (range .84 to .93).

Parent State Anxiety. To provide an index of parents' subjective experience of anxiety under the conditions of an on-demand memory task, parents will complete the State subscale from the Spielberger State Trait Anxiety Inventory (STAI; Spielberger et al., 1983). The STAI is a brief self-report assessment designed to measure and differentiate between anxiety as a state and as a trait. State anxiety fluctuates and is a function of impinging stressors on an individual. The STAI State scale consists of 20 statements that query feelings at a particular moment in time on a four- point intensity scale ranging from "not at all" to "very much so." The median reliability coefficient for state anxiety is .93 (Spielberger et al., 1983).

Diabetes Care Behaviors. A trained graduate student interviewed a parent and the child separately using the 24-hour Assessment Interview technique (Johnson et al., 1986) to assess diabetes care behaviors during the previous day. One set of interviews for parent and child was performed at the time of the clinic visit and assessment, and a follow-up interview was conducted for each separately by phone within the following two weeks. During the interview, a parent and child was asked to recall the previous day in temporal sequence, beginning at the time the child awakened and ending at the time the child went to sleep. If the respondent did not spontaneously report diabetes care behaviors, the interviewer prompted with specific questions to attain the information. It was emphasized that parents and children should report typical daily behaviors and not what they believe should be done to ideally manage diabetes.

Previous research has demonstrated adequate reliability for multiple, 24-hour recall interviews (Freund et al., 1991; Johnson et al., 1986; Johnson et al., 1992). Further, significant correlations have been found between parent and child report on the interviews (ranging from .42 to .78). During a diabetes camp the 24-hour assessment interviews yielded excellent concordance rates between child and observer reports of the incidence or non-incidence of diabetes care behaviors during camp (Reynolds, Johnson, & Silverstein, 1990). In addition, estimates of parent-child agreement have adequate stability over a three-month time period (Freund et al., 1991), as well as almost two years later (Johnson et al., 1992) suggesting significant test-retest reliability.

Children's Metabolic Control. Long-term metabolic control was assessed by the glycosylated hemoglobin (HbA1c) assay. The HbA1c assay is widely accepted as an index of average blood glucose concentration over the prior 90 to 120 days. With a normal range of 4-6%, higher scores reflect poorer metabolic control (Alberti & Zimmet, 1998). The American Diabetes Association recommends that youth with diabetes maintain HbA1c levels of less than 7.0% (Silverstein et al., 2005). The average of three HbA1c values (six months prior, three months prior, and the current medical appointment) represented children's mean metabolic control.

SES. The Hollingshead Four Factor Index (Hollingshead, 1975) was used to determine a SES score for participants based on parent-reported highest educational level attained and the occupation for each parent. The Hollingshead Four Factor Index computes an SES score that reflects the occupational category and educational attainment achievement achieved by each parent. With a range of eight to 66, higher scores indicate higher status. Scores in the 29-47 range indicate middle socioeconomic status.

The Hollingshead is one of the most widely used scales in psychological research (Gottfried, 1985). Hollingshead SES scores are significantly correlated with prestige scores developed by the National Opinion Research Center (Hollingshead, 1975), which suggests convergent validity. It is also significantly correlated with the Seigle Prestige Scale, and SES classifications as determined by the Revised Duncan Scale (Gottfried, 1985).

Diabetes Care Responsibility. Parents filled out the Diabetes Family Responsibility Questionnaire (DFRQ) (Anderson et al., 1990). This measure was used to determine the diabetes-related responsibility of adolescents and their parents. The DFRQ is a 17-item questionnaire that measures how well parents and adolescents divide responsibility for 17 diabetes management tasks. The response format calls for a rating of 1-3 where 1 indicates that the parent was predominantly in charge of the task and 3 indicates that the child has assumed primary responsibility for the diabetes related task. The content for the questionnaire was derived from interviews with health care providers, professional diabetes educators, and families with diabetic children aged six to 20 years. The internal consistence of the scale ranges from .83 (Anderson et al., 1990) to .92 (Drotar & Ievers, 1994).

Procedure

Parents were sent a packet of demographic forms and psychosocial questionnaires, including the DFRQ and the STAI, after an assessment was scheduled. Parents were requested to bring the completed forms to the testing session or to complete them during their child's assessment. After completing a cognitive assessment with the child (see Soutor et al., 2004 for a more detailed description of the adolescent study procedures) a trained graduate student conducted 24-hour assessment interviews with both the parent and the child, separately, at the time of testing. Then the Arithmetic and the Digit Span subtests were administered to the parent. These two subtests take approximately 15 minutes. Within two weeks of the cognitive assessment, a trained graduate student completed another 24-hour assessment separately with both the parent and the child over the telephone. Parents were paid $10 for their participation in addition to the payment provided to the adolescent for participation.

Results

Descriptive Results

The study sample consisted of 58 youths with type 1 diabetes and one of their parents. See Table 2 for demographic and disease characteristics of the sample.

Table 2

Demographic and Disease Characteristics for the Sample

	Children			Parents		
	N	%		*N*	%	
Female	30	51.7		50	94.3	
Caucasian	51	87.9		46	86.8	
	M	SD	Range	M	SD	Range
Age	12	1.4	9.4-15.8	44.8	5.0	33-56
SES	48.5	11.4	23.5 - 66	48.5	11.4	23.5-66
Mean HbA1c (%)	8.2	1.6	5.3 – 14.0			

On average, participants were from middle and upper-middle-class families, with an ethnic distribution similar to metropolitan diabetes clinics (24% ethnic minority) (Glascow, Weissberg-Benchell, Tynan, Epstein, Turek, et al., 1991). With a non-diabetic range of 4-6% (Alberti & Zimmet, 1998), and American Diabetes Association recommendations for an ideal HbA_{1c} level less than 7.0% for individuals with diabetes (Silverstein et al., 2005), children in the current study had mean HbA1c values of 8.2%, indicative of relatively good metabolic control.

A summary of all study variables, including parent predictors and children's disease care behaviors, are reported in Table 3. Occasional missing data were imputed based on variable means.

Table 3

Mean Disease Care and Parent Predictor Variables for the Full Sample

Scale	*N*	*M*	*SD*	Observed	Range Possible
Parent Arithmetic	58	10.8	1.8	7.0-13.0	1.0 – 19.0
Parent Digit Span	58	10.1	1.9	7.0-13.0	1.0 – 19.0
Parent State Anxiety (*X*)	57	1.6	.5	1.0 – 2.7	1.0 – 4.0
Parent Responsibility	57	12.0	2.0	8-18.0	0 - 51
Child Eating Frequency	58	4.6	.8	3.0 – 6.0	---
Child Testing Frequency	58	3.6	.9	1.0 – 5.0	---
Child Fat Calories (%)	58	36.9	8.6	19.0 – 66.3	---
Child Carb Calories (%)	58	48.1	9.0	22.3 – 65.5	---

The nutrition recommendations of the American Diabetes Association suggest that less than 30% of calories should be from fat and approximately 50-60% should be from carbohydrates (Franz et al., 2002). For this reason, and also to standardize diet composition across the individuals within the sample, fat and carbohydrate consumption were calculated for each child or adolescent as a percentage of total calories ingested.

The correlations among all variables included in this study are shown in Table 4. The percentage of calories from fat and percentage of calories from carbohydrate variables were the most highly correlated variables (r = .92), not surprisingly, given the manner in which they were calculated. All other correlations were in the low to moderate range, and varied in absolute value from .01 to .49.

Table 4

Correlation Coefficients of the Study Variables

Variable	1	2	3	4	5	6	7	8	9	10
1. Arithmetic	--	--	--	--	--	--	--	--	--	--
2. Digit Span	.49**	--	--	--	--	--	--	--	--	--
3. DFRQ	.22	.21	--	--	--	--	--	--	--	--
4. % Fats	-.30*	-.13	-.29*	--	--	--	--	--	--	--
5. % Carbs	.25	.15	.19	-.92**	--	--	--	--	--	--
6. Mean HbA1c	-.01	-.36*	-.14	-.09	.07	--	--	--	--	--
7. STAI	-.02	-.18	-.01	.17	-.14	-.10	--	--	--	--
8. Testing freq	.14	.20	.10	.01	-.02	-.15	.14	--	--	--
9. Eating freq	-.15	.07	-.13	.18	-.15	-.32*	.09	.03	--	--
10. Child age	.10	-.01	.45**	-.03	-.07	.03	-.11	.00	-.44**	--
11. SES	.50**	.24	-.01	-.09	.02	-.14	.00	.19	-.01	.07

*is significant at the $p < .05$ level; ** is significant at the $p < .01$ level

Predictive Results

Separate hierarchical multiple regressions were used to determine the predictive power of parent memory for children's diabetes care behaviors. For all models, SES was entered in the first step to control its effects on health care behaviors and health status (Adler et al., 1994). The specific, hypothesized memory ability and level of parent responsibility for diabetes care were added in the second step of each model to explore their main effects, and their product term was entered in a final step of each regression to evaluate moderation effects. Exploratory analyses with parent state anxiety (STAI) followed the same format with the exception that STAI scores were added in the second step, and an anxiety moderator was added in the final step.

Hypothesis 1: Parent memory effects will be more detectable in the disease care behaviors of younger children for whom parents maintain primary responsibility for diabetes care.

a. Children's eating frequency will be predicted by parents' rote verbal memory (Digit Span scores).

For the total sample, the overall regression model did not significantly predict children's eating frequency, F (4, 56) = 1.59, p = .19.

b. Children's testing frequency will be predicted by parents' rote verbal memory (Digit Span scores).

In a similar analysis, the regression model for the total sample did not predict children's blood glucose testing frequency, F (4, 56) = 1.64, p = .18.

c. Children's percentage of calories from fat will be predicted by parents' quantitative working memory (Arithmetic scores).

An overall regression model significantly predicted children's percentage of calories from fat for the total sample, F (4, 52) = 2.67, $p < .05$ and accounted for 20% of the variance in predicting fat intake. See Table 5.

Table 5

Hierarchical Regression of Predictors of Children's Percentage of Calories from Fat for the Total Sample

Predictor	*B*	*SE B*	Standardized ß	R^2	F
Step 1				.01	.20
SES	-.05	.11	-.06		
Step 2				.14	2.96*
SES	.06	.12	.08		
DFRQ general parent	-.94	.56	-.22		
Parent quantitative memory	-1.38	.73	-.29		
Step 3				.20	3.14*
SES	.08	.11	.10		
DFRQ general parent	-7.06	3.41	-1.67*		
Parent quantitative memory	-7.84	3.63	-1.63*		
Parent quantitative memory X DFRQ general parent	.55	.30	2.19		

* = $p < .05$

The second step of the regression model was significant, F (3, 53) = 2.96, $p < .05$, but had no significant individual predictors. However in the final step of the model, parent quantitative memory was a significant predictor of percentage of fat consumed, β = -1.63, t (52) = -2.16, $p < .05$, and uniquely accounted for 7.3% of the variance. Better parent quantitative memory predicted a smaller percentage of children's caloric intake from fat, and conversely, lower parent quantitative memory predicted a higher percentage of caloric intake from fat. Parent responsibility (DFRQ general parent) was also a significant predictor of percentage of fat consumed in the final step of the model, $\beta = -1.67$, $t\ (52) = -2.07$, $p < .05$, and uniquely accounted for 6.8% of the variance. With lower DFRQ scores as an indication of more parent responsibility, higher parental responsibility for children's diabetes care behaviors predicted a higher percentage of calories from fat, and lower parental responsibility predicted a lower percentage of fat intake.

When the analysis was limited to children under 12, for whom parents likely maintain more diabetes responsibility, the overall regression significantly predicted children's percentage of calories from fat, $F\ (4, 19) = 7.78$, $p = .001$ and accounted for 62% of the variance. See Table 6.

Table 6

Hierarchical Regression of Predictors of Children's Percentage of Calories from Fat for Children under 12

Predictor	*B*	*SE B*	Standardized ß	R^2	F
Step 1				.13	3.36
SES	-.27	.15	-.37		
Step 2				.35	3.65*
SES	-.16	.17	-.22		
DFRQ general parent	-2.22	1.04	-.39*		
Parent quantitative memory	-1.65	1.04	-.35		
Step 3				.62	7.78***
SES	-.18	.13	-.24		
DFRQ general parent	-25.06	6.45	-4.29***		
Parent quantitative memory	-24.59	6.45	-5.35**		
Parent quantitative memory X DFRQ general parent	2.12	.58	6.00**		

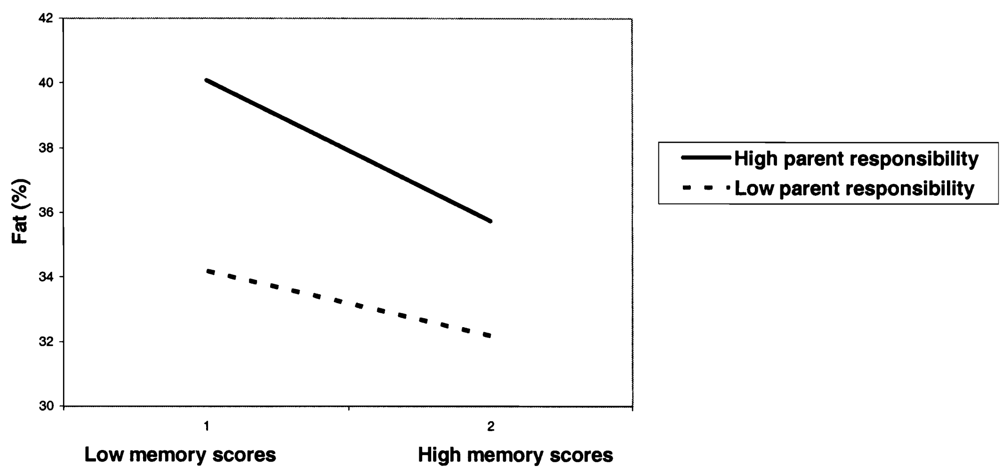
* = $p < .05$

** = $p < .01$

*** = $p = .001$

The total model accounted for 62% of the variance, and, again, parent quantitative memory was a significant predictor, $\beta = -5.35$, $t\,(19) = -3.89$, $p = .001$, uniquely accounting for 30.3% of the variance. Among youth under age 12, better parent quantitative memory predicted a smaller percentage of children's caloric intake from fat, and conversely, lower parent quantitative memory predicted a higher percentage of caloric intake from fat. Parent responsibility (DFRQ general parent) was also a significant predictor in the second step, $\beta = -.39$, $t\,(20) = -2.13$, $p < .05$, and in the final step of the model, $\beta = -4.29$, $t\,(19) = -3.99$, $p = .001$, and uniquely accounted for 31.4% of the variance in the final step. As with the total sample, more parental responsibility for children's diabetes care behaviors predicted a higher percentage of calories from fat, and lower parental responsibility predicted a lower percentage of children's caloric intake from fat. However, unlike the total sample, the parent responsibility X memory moderator was significant for youth under 12 years of age, $\beta = 6.00$, $t\,(19) = 3.66$, $p < .01$, and uniquely accounted for 27.0% of the variance above and beyond the main effects. As can be seen in Figure 1, children with parents who maintain high responsibility for diabetes care and whose parents have better memory ingest a lower percentage of fat calories that is more in keeping with the ADA recommended levels of 35%. Parents with higher responsibility for their children's disease care and lower memory scores have children who consume a higher percentage of calories from fat. As expected, under conditions of low parent responsibility, parent memory matters less in predicting their children's fat calories, and in fact, children ingest less fat, probably because they are self restricting fat calories.

Figure 1



Parent Responsibility Moderates the Effect of Parent Memory on Children's Percentage of Calories from Fats, Children under 12

d. Children's percentage of calories from carbohydrates will be predicted by parents' quantitative working memory (Arithmetic scores).

For the total sample, the overall regression model did not significantly predict children's percentage of calories from carbohydrates although there was a trend in that direction, $R^2 = .14$, $F\ (4, 52) = 2.19$, $p = .08$.

However when limited to children under 12, for whom parents are likely to maintain primary control of diabetes care, the overall regression model significantly predicted children's percentage of calories from carbohydrates, $F\ (4, 19) = 6.87$, $p = .001$ and accounted for 59% of the variance. See Table 7.

Table 7

Hierarchical Regression of Predictors of Children's Percentage of Calories from Carbohydrates for Children under 12

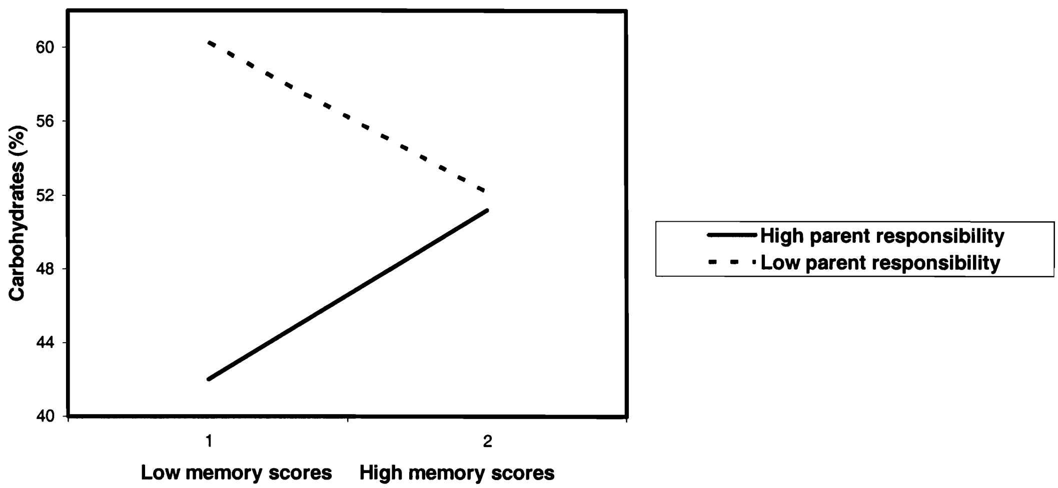
Predictor	*B*	*SE B*	Standardized ß	R^2	F
Step 1				.11	2.75
SES	.26	.16	.33		
Step 2				.28	2.63
SES	.18	.19	.23		
DFRQ general parent	2.16	1.15	.36		
Parent quantitative memory	1.36	1.15	.36		
Step 3				.59	6.89***
SES	.206	.14	.25		
DFRQ general parent	27.27	6.69	4.55***		
Parent quantitative memory	27.65	7.00	5.65***		
Parent quantitative memory x DFRQ general parent	-2.38	.63	-6.44***		

*** = *p* = .001

The total model for children under 12 accounted for 59% of the variance, and parent quantitative memory was a significant predictor of children's percentage of calories from carbohydrates, $\beta = 5.65$, $t\ (19) = 3.89$, $p = .001$ that uniquely accounted for

33.6% of the variance. Better parent quantitative memory predicted a higher percentage of children's caloric intake from carbohydrates, and conversely, lower parent quantitative memory predicted a lower percentage of caloric intake from carbohydrates. Parent responsibility (DFRQ general parent) was also a significant predictor in the final step of the model, $\beta = 4.55$, $t\ (19) = 4.55$, $p = .001$, uniquely accounting for 36.0% of the variance. Lower parent responsibility for children's diabetes behaviors predicted a higher percentage of children's caloric intake from carbohydrates, and vise versa. The parent responsibility X memory moderator also was significant in this model, $\beta = -6.44$, $t\ (19) = -3.79$, $p = .001$, and uniquely accounted for 31.4% of the variance above and beyond the main effects. Parents with lower memory scores who maintain higher disease care responsibility have children with a lower percentage of calories from carbohydrates, below the ADA's recommendations. In contrast, children of parents with lower memory scores who have lower responsibility have the highest percentage of calories from carbohydrates in the current sample, at the uppermost range of ADA's recommendations. Parents with higher memory scores, regardless of their level of responsibility, have children whose percentage of calories from carbohydrates is within the ADA's range of recommendation. See Figure 2.

Figure 2



Parent Responsibility Moderates the Effect of Parent Memory on Children's Percentage of Calories from Carbohydrates, Children under 12

Exploratory Analysis: Child Glycosylated Hemoglobin and Parent Memory

For the total sample, an overall regression model with parent quantitative memory did not significantly predict children's average metabolic control, F (4, 46) = .83, p = .51.

However, when parent quantitative memory was replaced by rote memory, the overall regression model was significant, F (4, 52) = 3.78, p <.01, and the overall model accounted for 23% of the variance in children's average metabolic control. See Table 8.

Table 8

Hierarchical Regression of Predictors of Children's Average Metabolic Control for the Total Sample

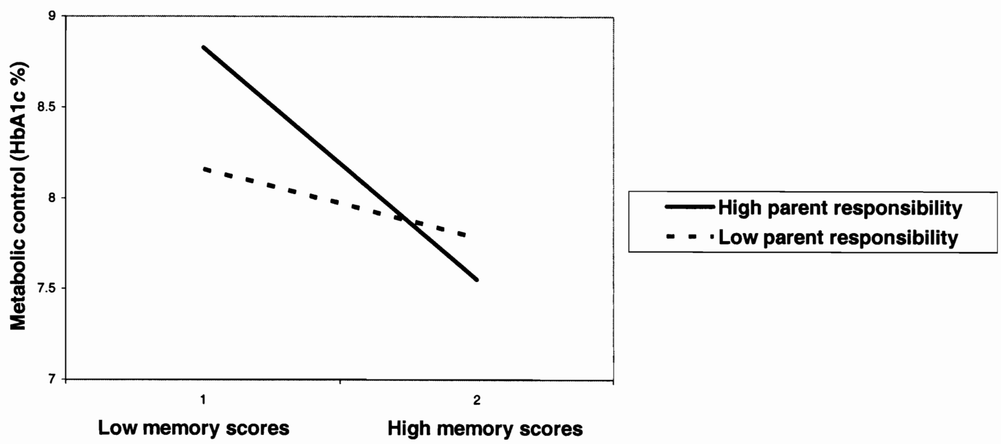
Predictor	*B*	*SE B*	Standardized ß	R^2	F
Step 1				.02	.83
SES	-.02	.02	-.12		
Step 2				.14	2.90*
SES	-.01	.02	-.03		
Parent rote memory	-.29	.11	-.35*		
DFRQ general parent	-.05	.10	-.07		
Step 3				.23	3.78**
SES	-.01	.02	-.02		
Parent rote memory	-.47	.13	-.57**		
DFRQ general parent	-.46	.20	-.60*		
Parent rote memory x DFRQ general parent	.02	.01	.69*		

* = $p < .05$

** = $p < .01$

Parent rote memory was the only significant predictor in the second step of the model, $\beta = -.35$, t (53) = -2.55, $p < .05$, and uniquely accounted for 10.2% of the variance in average metabolic control. Parent rote memory was also significant in the final step of the model, $\beta = -.57$, $t\ (52) = -3.55$, $p < .01$ and uniquely accounted for 18.5% of the variance. Better parent memory predicted a lower average of three HbA1c values (indicating better metabolic control), and lower parent rote memory predicted a higher HbA1c average (poorer metabolic control). Parent responsibility (DFRQ general parent score) was also a significant predictor in the final step of the model, $\beta = -.60$, $t\ (52) = -2.35$, $p < .05$ that accounted for 8.4% of the variance in children's mean metabolic control. Higher parent responsibility for diabetes behaviors predicted poorer metabolic control for children, and vise versa. However, the parent responsibility moderator (parent Digit Span score X DFRQ general parent) was also a significant predictor, $\beta = .69$, $t\ (52) = 2.38$, $p < .05$ and uniquely accounted for 8.4% of the variance in children's mean metabolic control above and beyond main effects. As can be seen in Figure 3, parents with higher rote memory scores have children with better overall metabolic control, and vise versa. Importantly, as predicted, children of parents with lower memory scores who retain high responsibility for disease care have the poorest metabolic control in the current sample. Conversely, parents with higher memory scores who maintain higher responsibility have children with the best overall metabolic control in the sample.

Figure 3



Parent Responsibility Moderates the Effect of Parent Memory on Children's Average Metabolic Control, Total Sample

For adolescents under 12, a similar overall regression with rote memory was not significant, F (4, 19) = 2.42, p = .08.

Exploratory Analyses: Parent Anxiety, Parent Memory and Children's Fat Intake and Metabolic Control.

Additional exploratory analyses were conducted in order to determine if parent memory effects were moderated by level of parent state anxiety. Analyses were limited to the significant overall regression models previously explained in order to minimize type 1 error.

Parent Anxiety: Calories from Fat, Total Sample: For the total sample, an overall regression model did not significantly predict children's percentage of calories from fats, although there was a trend in this direction, $F\ (5, 50) = 2.14$, $p = .08$. However, the second step of the model approached significance, $F\ (4, 51) = 2.54$, $p = .05$. See Table 9.

Table 9

Parent Anxiety: Hierarchical Regression of Predictors of Children's Percentage of Calories from Fat for the Total Sample

Predictor	*B*	*SE B*	Standardized ß	R^2	F
Step 1				.01	.21
SES	-.05	.11	-.06		
Step 2				.17	2.54
SES	.06	.12	.08		
DFRQ general parent	-.94	.56	-.22		
Parent quantitative memory	-1.36	.75	-.28		
Parent anxiety	2.71	2.21	.16		
Step 3				.18	2.14
SES	-.12	.17	-.16		
DFRQ general parent	-.92	.56	-.22		
Parent anxiety	3.48	2.42	.20		
Parent quantitative memory	-.78	1.06	-.16		
Parent quantitative memory x parent anxiety	-.01	.01	-.17		

Parent Anxiety: Calories from Fat, Youth under 12: When limited to youth under 12, for whom parents maintain primary disease care responsibility, the overall regression model with parent anxiety included significantly predicted children's percentage of calories from fats, $F\ (5,\ 17) = 3.79$, $p < .05$ and accounted for 53% of the variance. See Table 10.

Table 10

Parent Anxiety: Hierarchical Regression of Predictors of Children's Percentage of Calories from Fat for Children under 12

Predictor	*B*	*SE B*	Standardized ß	R^2	F
Step 1				.14	3.31
SES	-.28	.15	-.37		
Step 2				.50	4.48*
SES	-.15	.16	-.21		
DFRQ general parent	-2.05	.97	-.36*		
Parent quantitative memory	-1.70	1.00	-.36		
Parent anxiety	6.29	2.71	.39*		
Step 3				.53	3.79*
SES	-.16	.16	-.21		
DFRQ general parent	-1.84	.99	-.32		
Parent anxiety	7.32	2.91	.45*		
Parent quantitative memory	-.84	1.31	-.18		
Parent quantitative memory x parent anxiety	-.01	.01	-.25		

* = $p < .05$

The total model for children under 12 accounted for 53% of the variance. Parent responsibility (DFRQ general parent score) was a significant predictor in the second step of the model, $\beta = -.36$, t (18) = -2.11, $p < .05$, and uniquely accounted for 12.3% of the variance in children's percentage of calories from fat. However, the main effect of parent responsibility was not significant in the final step of the model. Parent anxiety (mean STAI score) was a significant predictor in the second step, $\beta = .39$, t (18) = 2.31, $p < .05$, and uniquely accounted for 15.2% of the variance of children's percentage of calories from fat. Parent anxiety was also significant in the final step of the model, $\beta = .45$, t (17) = 2.52, $p < .05$ and uniquely accounted for 17.6% of the variance. Higher parent anxiety predicted a higher percentage of calories from fats for youth under age 12, and conversely, lower parent state anxiety scores predicted a lower percentage of calories from fats for youth under 12.

Parent Anxiety: Calories from Carbohydrates, Youth under 12: When limited to youth under 12, the overall regression model did not predict children's percentage of calories from carbohydrates, but step 2 and step 3 both approached significance, F *(4, 18)* = 2.89, p = .05, and F *(5, 17)* = 2.76, p = .05, respectively. See Table 11.

Table 11

Parent Anxiety: Hierarchical Regression of Predictors of Children's Percentage of Calories from Carbohydrates for Children under 12

Predictor	*B*	*SE B*	Standardized ß	R^2	F
Step 1				.12	2.74
SES	.27	.16	.34		
Step 2				.39	2.89
SES	.18	.18	.23		
DFRQ general parent	1.99	1.16	.33		
Parent quantitative memory	1.34	1.15	.27		
Parent anxiety	-5.68	3.12	.27		
Step 3				.45	2.76
SES	.18	.18	.23		
DFRQ general parent	1.69	1.12	.28		
Parent anxiety	-7.24	3.28	-.43*		
Parent quantitative memory	.08	1.48	.02		
Parent quantitative memory x parent anxiety	.02	.02	.36		

* = $p < .05$

The only significant predictor in the overall model was parent anxiety, $\beta = .45$, t $(17) = -2.21$, $p < .05$, which uniquely accounted for 16.0% of the variance in percentage of calories consumed by carbohydrates for youth under age 12. However, this is only a suggestive trend given that the overall model was not significant.

Parent Anxiety: Average Metabolic Control, Total Sample: An overall regression model did not significantly predict children's mean metabolic control, but approached significance in its second step, F (4, 51) = 2.49, $p = .06$. See Table 12.

Table 12

Parent Anxiety: Hierarchical Regression of Predictors of Children's Mean Metabolic Control for the Total Sample

Predictor	*B*	*SE B*	Standardized ß	R^2	F
Step 1				.01	.78
SES	-.02	.02	-.12		
Step 2				.16	2.49
SES	-.002	.02	-.01		
DFRQ general parent	-.05	.10	-.12		
Parent rote memory	-.31	.12	-.37*		
Parent anxiety	-.54	.41	-.17		
Step 3				.17	2.07
SES	-.003	.02	-.02		
DFRQ general parent	-.05	.10	-.07		
Parent anxiety	-.66	.44	-.21		
Parent rote memory	-.40	.17	-.47*		
Parent rote memory x parent anxiety	.002	.002	.14		

* = $p < .05$

Parent rote memory is the only significant predictor in the model. In step 2 it was a significant predictor, $\beta = -.37$, $t\ (51) = -2.66$, $p < .05$ and uniquely accounted for 11.6%

of the variance. Parent memory was also significant in step 3, $\beta = -.47$, $t(50) = -2.35$, $p < .05$, uniquely accounting for 9.0% of the variance in children's mean metabolic control. However, these trends for parent rote memory should be considered suggestive given that the overall model was not significant.

Discussion

Parental memory effects were examined to determine their effects on the diabetes care behaviors of younger children for whom parents retain primary disease care responsibility. Research has traditionally focused on psychosocial predictors of children's disease care such as family conflict (Anderson et al., 2002), maternal stress (Bouma & Schweitzer, 1990), depression (Kovacs et al, 1990), and parent-child relationships (Miller-Johnson et al., 1994). Previously, only global parental cognitive abilities or IQ has been examined as a predictor of youth metabolic status (Ross et al., 2001); specific parental memory abilities and children's disease care behaviors have not been evaluated. In the present study, parental memory predicted children's disease care behaviors for the first time. Level of parent responsibility also predicted children's disease care, and along with memory, significantly moderated many disease care outcomes, including metabolic control. In contrast, parent anxiety did not moderate parent memory or responsibility predictors of disease care behaviors or metabolic control in exploratory analyses.

As expected, parent quantitative memory and level of parent responsibility were both important predictors of children's dietary behaviors. Both variables significantly predicted children's percentage of calories from fat for the total sample, as well as percentage of calories from fat and from carbohydrates for children under 12. As hypothesized, parent quantitative memory and level of parent responsibility significantly predicted children's percentage of calories from fats for the total sample in a model that accounted for 19.5% of the variance. Parent quantitative memory uniquely accounted for 7.3% of the variance. In the current sample, parents with higher quantitative memory scores had children with a lower percentage of total calories from fats, congruent with the ADA's recommendation that less than 30% of calories be from fats (Franz, 2002). Children of parents with lower memory scores consumed over the recommended percentage of calories from fat. Level of parent responsibility was also a significant predictor that accounted for 6.8% of the variance in the overall regression model. Interestingly, higher parent responsibility for children's disease behaviors predicted a higher percentage of calories from fats for children. Parents with more responsibility may increase their children's dietary intake in order to avoid hypoglycemia and loss of consciousness or coma. Alternatively, perhaps parents with more disease care responsibility encourage greater fat consumption to ensure healthy growth and development (Hardy & Kleinman, 1994; Lifshitz & Tarim, 1996).

Previous research indicates that parents are more involved with diabetes care for youth under 12 than for youth over 12 who may be more independent in their disease care (Drotar & Ievers, 1994; Ingersoll et al., 1986; LaGreca et al., 1990; Soutor et al., 2004). In support of those findings, the current study demonstrated that the magnitude of parental quantitative memory and parental responsibility effects become even stronger when the sample is limited to youth under 12, as expected. In an overall model that accounted for 62.1% of the variance in predicting children's percentage of calories from fat, parent quantitative memory was a significant predictor that accounted for 30.3% of the variance. Similarly, parent responsibility accounted for 31.4% of the variance in predicting fat intake for children under 12. Importantly, for children under 12, parent responsibility and parent memory together significantly moderated the prediction of children's fat intake. As expected, children of parents who maintain more responsibility for their children's diabetes care and who have higher quantitative memory scores consume a percentage of fat that is congruent with ADA's recommendations. Conversely, parents with lower memory scores who maintain high responsibility have children with the highest percentage of calories from fats, perhaps reflecting that in lieu of careful tracking of children's fat consumption, parents would rather err on the higher side of ensuring adequate intake. In contrast, in families where parents have less responsibility for their children's diabetes care, children uniformly consumed a lower percentage of calories from fat, regardless of parental memory. See Figure 1. Maybe these parents feel their children are more mature or cognitively capable to manage this aspect of their diet with more autonomy, or alternatively these children, who have more disease care responsibility, may be voluntarily restricting their fat intake for weight loss purposes. Despite the lower percentages of fat consumed for these two lower parent responsibility groups (i.e., 32% and 34%), these levels could not be considered precipitously low percentages of fat intake that could jeopardize physical growth and development (Hardy & Kleinman, 1994). In general, it is important to keep in mind that the range of difference in the percentages for children's fat intake in all groups is relatively small (about 8%), and group differences, although detectable, probably do not have a major clinical impact, at least in the short run.

The pattern of more pronounced parental memory and responsibility effects in youth under 12 was replicated for percentage of calories from carbohydrates. In a significant overall model, parent quantitative memory and level of parent responsibility again were significant predictors of carbohydrate percentages for children under age 12, accounting for 33.6% and 36.0% of the variance, respectively. As with percentage of calories from fats, parent responsibility and memory together significantly moderated the relationship with percentage of carbohydrates consumed. Parents with the lower memory scores who maintain higher disease care responsibility have children with the lowest percentage of calories from carbohydrates (about 42%), well below the ADA's recommendations. See Figure 2. In contrast, children of parents with lower memory scores who maintain lower responsibility have the highest percentage of calories from carbohydrates in the current sample (about 60%), at the uppermost range of ADA's recommendations. Parents with higher memory scores, regardless of their level of responsibility, have children whose percentage of calories from carbohydrates is more moderate and within the ADA's range of recommendation.

When carbohydrate consumption is combined with fat intake, parents who have lower responsibility for their children's disease care and who have lower memory scores have children who consume approximately 42% of their calories from carbohydrates and 40% from fat. Presumably the remainder of their percentage of calories, about 18%, are from protein. Should this dietary pattern be consistent over an extended time, there may be cause for some concern. Freund et al. (1991) have found considerable stability in self-care behaviors for up to a 3 month period, and Johnson et al. (1992) found diabetes care behaviors to be relatively stable over a 2 year period. Further, camp studies suggest that 24-hour interview data is a reasonably accurate portrayal of actual dietary behaviors as reported by pediatric campers and camp counselors (Reynolds et al., 1990). Although the effect of SES is statistically accounted for in all of the regressions, the constellation of disease care data associated with lower parental responsibility and lower parental memory suggest that less parental diabetes knowledge or more parental stress may enter into these results. This may be an important issue for future research to explore.

Parental rote memory was also an important predictor in the current study. Although it did not predict specific diabetes care behaviors as hypothesized, parental rote memory predicted children's average metabolic control. An overall model for the total sample accounted for 22.5% of the variance in children's average metabolic control, with parent rote memory a significant predictor that accounted for 18.5% of the variance. Poorer parent rote memory related to poorer metabolic control in youth, and better parent rote memory indicated better metabolic control in youth. This memory finding corroborates previous research of a link between mother's intelligence and children's average metabolic control (Ross et al., 2001). However, Ross et al. (2001) found that parent intelligence only accounted for 7.6 % of the variance, in contrast to 18.5% of the variance accounted for by memory in the present study. Together, these results suggest that, as hypothesized, parent general intelligence is probably too global of a predictor of children's disease care behaviors and ultimately, metabolic control. The more narrowly defined skill of rote memory appears to be a more pertinent predictor of metabolic control across studies. As hypothesized, parent memory appears to be the more apropos cognitive skill that better reflects the cognitive demands of maintaining better metabolic control, presumably through better daily disease care.

In the current study, parent memory and responsibility together moderated the effects of each individual factor in the prediction of children's average metabolic control. As predicted, parents with higher memory scores and higher responsibility for their children's diabetes care have children with the better average metabolic control in the current sample. Equally importantly, children of parents who had lower memory scores yet maintained high responsibility of their children's disease care had the poorest average metabolic control in the sample. This moderating effect accentuates an opportunity for clinical intervention. Enhancement of parent rote memory through cognitive training or through compensatory aids such as wristwatches with alarms, could lead to improved metabolic control for this subsample of children, which in turn is related to higher quality of life and better health outcomes for youth with diabetes.

Exploratory analyses on the role of anxiety alone or in conjunction with memory failed to reach significance as predictors of disease care behaviors or metabolic control. Interestingly, suggestive trends indicate that when substantial parental anxiety is present, particularly in younger children under the age of 12, it may supercede all other predictors including memory, parental responsibility and their combined effects in explaining disease care behaviors and metabolic control. See suggestive results in Table 12.

For the first time, parent memory is related to children's diabetes management, specifically to dietary behavior and metabolic control. Further, unique relationships exist between specific types of parental memory and children's disease behavior and metabolic control. Parent quantitative memory, which enables an individual to maintain a fund of basic information, monitor meal dietary content, and track quantitative totals ingested throughout the day, was a predictor of children's dietary behavior in several regression models. Notably, parents retain responsibility longer for dietary care, transferring it gradually throughout adolescence (LaGreca et al., 1990), which may be why parent quantitative memory is such a powerful predictor of dietary variables, even in such a small sample. Although parent rote memory did not significantly predict specific diabetes care behaviors in the present study, it exerted a direct and significant effect on longer-term metabolic control and highlights an important potential for clinical intervention.

Strengths and Clinical Implications

For the first time, specific parental memory predictors were found to predict specific disease care behaviors as well as metabolic control for youth with IDDM. These findings help to increase the understanding of interrelationships between potentially 'modifiable' parent memory, children's disease behaviors, and metabolic control, a longer-term indicator of disease outcome in children with IDDM. It is important to remember that this is preliminary research conducted with a relatively small sample size and consequently relatively limited statistical power. With that in mind, significant effects, especially interaction effects, are likely to be quite powerful effects to be detected under these constraints. Although these predictors and the nuances of their interrelations may be better described in a larger sample that can better yield more definitive recommendations for clinical care in the field of pediatric psychology, results from the current study offer suggestions for clinical intervention. For example, existence of a link between parent memory and child disease care may provide an opportunity for intervention to enhance parent memory (Korol, 2002; Leon-Carrion, 1997; Moely, Hart, Santulli, & Leal, 1986), which may be an especially important point of intervention for parents of youth under 12 who depend more fully on their parents for disease management. Hopefully this intervention would in turn improve diabetes care behaviors and glycosolated hemoglobin levels for youth with IDDM to improve quality of life and to reduce the chance of long-term complications with major organs such as the eyes, kidneys and heart. This is especially important as pediatric patients with IDDM are living longer (NIDDK, 1995).

Study Limitations and Future Directions

Results of these preliminary pilot data are promising, but not without limitations. Restricted time and funding for pilot data limited the scope of the current project. For example, only two brief memory measures were administered in the present study. A more thorough sample of parent memory would perhaps lead to more robust findings. Additionally, time and funding mandated that the research design be cross sectional and not longitudinal, which restricts conclusions that can be drawn from the findings. Further, the small sample size limited the manifestation of potential predictor variables. However, because parental memory predictors and level of parent responsibility were significant in such a small sample of pilot data, their potential predictive effects in larger samples is promising and should be explored.

In future studies, measures of parent state anxiety would be better administered to parents immediately before cognitive testing instead of its administration separated in time and location, as it was the present study. Similarly, further exploration of the relationship between level of parent responsibility and children's calories from fats as well as children's average metabolic control may provide insight into the seemingly counterintuitive relationships. Additional information regarding children's total calories consumed and the possible role of fear of hypoglycemia may shed further light on these somewhat counterintuitive relations.

Finally, the cohort of this study predominately represents Caucasian, middle and upper-middle class families, mothers, and children who are in relatively good metabolic control. To facilitate generalization to other patient samples, researchers should seek to replicate these findings with more demographically diverse diabetes samples, and evaluate the relationship between parent memory and children's diabetes-care behaviors prospectively.

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Appendix A

The following is a list of measures that were administered in the current study.

24-Hour Assessment Interview

Johnson, S.B., Silverstein, J., Rosenbloom, A., Carter, R., & Cunningham, W. (1986). Assessing daily management in childhood diabetes. *Health Psychology, 5*, 545-564.

Diabetes Family Responsibility Questionnaire

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.

Hollingshead Four Factor Index of Social Status

Hollingshead, A.B. (1975). *Four factor index of social status.* Unpublished manuscript, Yale University, New Haven, CT.

Spielberger State-Trait Anxiety Inventory

Spielberger, C.D., Gorsuch, R.L., & Lushene, R.E. (1983). *Manual for the State-Trait Anxiety Invertory.* Palo Alto, CA: Consulting Psychological Press.

Wechsler Adult Intelligence Scale- Third Edition; Arithmetic subtest

Wechsler, D. (1997). *Manual for the Wechsler Adult Intelligence Scale- Third Edition.* San Antonio, TX: The Psychological Corporation.

Wechsler Memory Scale- Third Edition; Digit Span subtest

Wechsler, D. (1997). *Manual for the Wechsler Memory Scale- Third Edition.* San Antonio, TX: The Psychological Corporation.

Vita

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