INTERACTIVE EFFECTS OF MATERNAL AFFECT

AND NUTRITION ON PARENTING

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CHAPTER I

INTERACTIVE EFFECTS OF MATERNAL AFFECT AND NUTRITION ON PARENTING

There have been numerous studies from various professional disciplines documenting the

relations between maternal nutrition and affect (e.g., Bodnar & Wisner, 2005; Hurley, Caulfield,

Sacco, Costigan, & Dipietro, 2005) and between maternal affect and parenting practices (e.g.,

Albertsson-Karlgren, Graff, & Nettelbladt, 2001; Anderson, Fleming, & Steiner, 1994; Berkule,

2007; Hubbs-Tait, Culp, Culp, & Miller, 2002; Lovejoy, Graczyk, O'Hare, & Neuman, 2000).

Despite the advent of a few, more recent, empirical studies investigating the direct relation between

maternal nutrition and parenting practices, only one study within the extant literature addressed a

model linking all three variables (e.g., maternal nutrition, affect, and parenting; Wachs, 2009). This

study suggested that maternal affect mediates the relation between nutrition and parenting, but no

studies could be found that investigate moderation or the interaction of maternal nutrition and affect

in relation to parenting. However, this interaction has vast implications for theoretical models used

within research, as well as practical significance related to treatment within mental healthcare settings

and interventions targeting populations at risk for malnutrition.

Therefore, the current study investigated these interaction effects with variables that have

been shown to be related most consistently within the extant literature. The maternal nutrition

measures focused on iron and included several nutrient biomarkers of iron status (i.e., hemoglobin,

transferrin receptors, and ferritin concentrations) in addition to an estimation of iron intake derived

from the Diet History Questionnaire (DHQ), which is a food frequency questionnaire from the

National Cancer Institute (NCI; Diet History Questionnaire, Version 1.0, 2007). Maternal affect focused on depressive symptomology, which was measured via the Symptom Checklist-90-Revised (SCL-90-R). Parenting style was measured utilizing the Parenting Styles and Dimensions Questionnaire (PSDQ), which results in the three scale scores of authoritarian, permissive, and authoritative parenting.

Data collection began in October of 2008 and was completed in January of 2011, resulting in a total sample size of 105 participants, all of whom were women currently breast-feeding 3-month-old infants. Results revealed that there were significant interactions between iron status and depressive symptomology in predicting authoritarian parenting style and significant interactions between iron intake and depressive symptomology in predicting authoritarian parenting style, but that these two interactions were in different directions. Specifically, for those with poorer iron status (hemoglobin levels below 14.0g/dL), those with more depressive symptomology had more authoritarian parenting style. Conversely, for those with higher estimated dietary iron intake (above 20.90mg), those with more depressive symptomology had more authoritarian parenting style. However, the latter finding is thought to be due to mothers in the study taking high doses of iron supplementation perhaps because of poor iron status.

Results suggest that standards for iron insufficiency/deficiency may need to be re-conceptualized in lactating women. In addition, screening for poor iron status and depressive symptomology in postpartum women may help to identify those at risk for authoritarian parenting. Furthermore, interventions to enhance iron status may diminish relations between depressive symptomology and negative parenting. The differences in relations between iron status and intake should also be considered in future studies, especially if mothers are taking high doses of iron supplementation because of interventions for iron deficiency or anemia. Follow-up investigations are needed to replicate study findings and fill in gaps in the literature.

CHAPTER II

INTERACTIVE EFFECTS OF MATERNAL AFFECT AND NUTRITION ON PARENTING

Studies support bivariate relations between each set of the following variables: maternal nutrition, affect, and parenting, but few have investigated integrated models of all three. Literature regarding integrated models has been theoretical (Wachs, 2009), rather than empirical and is very preliminary, highlighting the need for more studies. Though current integrated models have focused on mediation, studies also suggest that nutrition and affect may interact to predict parenting style. Therefore, this study investigated these effects using a sample of postpartum breastfeeding women. Postpartum women are at elevated risk for nutritional and affective difficulties. Studies support the utility of specific measures of nutrition (iron, e.g., [Beard et al., 2005; Perez et al., 2005]), affect (depression, e.g., [Edwards, 2004; Wachs, 2009]), and parenting (permissive and authoritarian parenting styles, e.g., [Drescher, 2008; Rudy & Grusec, 2006]) in examining interaction effects within an integrated model.

The Postpartum Period

Postpartum mood disorders are one of the most common problematic consequences of pregnancy. Approximately 50-85% of women will experience subclinical postpartum mood disturbances, while 7-20% will meet full diagnostic criteria for postpartum depression (PPD) within 6 months postpartum (Chen, Lan, Yang, & Juang, 2006; Miller, 2002). Postpartum depression is historically under-recognized (i.e., upwards of 50% of all cases go unrecognized; Silverman et al., 2007) with resulting negative consequences. These may include long-term cognitive, behavioral, emotional, and social difficulties for depressed mothers

(Haapasalo & Petäjä, 1999; McMahon, Barnett, Kowalenko, & Tennant, 2005) and their children (Miller, 2002). Additionally, during lactation, recommended dietary allowances (RDAs) are increased. For lactating women, an extra 300 calories and 30g of daily protein are proposed above and beyond pre-pregnancy RDAs (Institute of Medicine, 2006). It is also recommended that during lactation, women should consume diets that are highly nutrient dense with vitamin D, folic acid, iron, and vitamin C. The effects of nutrition on mood, the literature for which is reviewed below, are also more pronounced within pregnant and postpartum women, given the physiological strain and hormonal changes in their bodies (Bodnar & Wisner, 2005).

Maternal Nutrition and Affect

Nutrition and affect have been associated in a number of different ways. Some studies have demonstrated alleviation of mood symptoms via supplementation (Richardson, 1993). Others have noted relations between nutritional deficiencies, like iron, and mood symptoms (e.g., Beard et al., 2005). Still others have investigated the impact that disruptions in mood have on dietary intake (Hurley et al., 2005). Wurtman and Wurtman (1986), for example found that low serotonin, a monoamine whose under-activity in the brain is an etiological contributor to the development of depression, is also related to carbohydrate cravings and the consumption of 30% or more of the total daily calories via sweet and/or starchy snacks.

A review article regarding nutrition and depression in women of childbearing age (Bodnar & Wisner, 2005) found that: (1) Omega-3 fatty acid deficiency is a risk-factor for depression, (2) fish oil and folic acid alleviate depression, (3) folate, vitamin B-12, iron, zinc, and selenium deficiencies are more common among depressed individuals, and (4) antioxidant consumption reduces depressive symptomology in clinical and non-clinical samples. A review of studies utilizing samples within the postpartum period (Leung & Kaplan, 2009) found similar relations between postpartum depression and the following vitamins and minerals: folate, vitamin B-12, calcium, iron, selenium, zinc, and n-3 fatty acids. Regarding iron in particular, several studies have found relations between iron deficiency and depression among lactating women in

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the postpartum period (Beard et al., 2005; Corwin, Murray-Kolb, & Beard, 2003) using different indicators of iron status (i.e., hemoglobin, mean corpuscular volume, and transferrin saturation). Given studies supporting relations between iron and depression, several iron measures were used within the current study (i.e., ferritin, transferrin receptors, hemoglobin, and estimated dietary iron intake and supplementation).

Maternal Affect and Parenting

A plethora of studies have documented relations between maternal affect and parenting (e.g., Berkule, 2007; Degroat, 2003; Hubbs-Tait et al., 2006; Leiferman, Ollendick, Kunkel, & Christie, 2005). Negative affect has been shown to be related to authoritarian (Rudy & Grusec, 2006) and permissive parenting (Drescher, 2008). Several studies have investigated interaction effects utilizing maternal depression and parenting style variables. Topham and colleagues (2010) found that maternal depression and socioeconomic status (SES) moderated relations between permissive parenting and children's obesity. For mothers with relatively more depressive symptomology, more permissive parenting was related to obesity, whereas this was not the case for mothers with relatively less depressive symptomology. These same relations between permissive parenting and children's obesity were significant for higher SES mothers, but not lower SES mothers. In addition, Edwards (2004) found that mothers' beliefs in control over parent-child interactions moderated relations between depression and parenting style. If mothers thought their children had more control than them, lower depression scores were associated with more authoritarian parenting. However, this pattern was opposite for mothers that believed they had more control over parent-child interactions. The same pattern was found for permissive parenting. Given the robust associations between depression and authoritarian and permissive styles, this was the focus of the current study, as opposed to other maternal psychopathological variables and positive parenting styles. These studies also provide support that depression may interact with other variables in predicting parenting style.

Maternal Nutrition and Parenting

Two studies were found that examined relations between maternal nutrition and parenting. The first, conducted by Azizi-Egrari, Neumann, Bourque, Harrison, and Sigman (2004), utilized a Kenyan population of anemic mothers and found that non-anemic mothers held babies longer than their anemic counterparts. They also found that 36% ($p < 0.01$) of holding behavior was explained by maternal anemia, infant birth weight, household SES, and the amount of time that oldest sisters spent holding the infant. All variables except infant birth weight significant predicted maternal holding behavior.

The second study by Perez et al. (2005) investigated young South African mothers with full-term, normal birth weight infants. The study was a prospective, randomized, controlled trial of the effects of iron supplementation on mother-infant interactions from the time the infants were 10 weeks to 9 months of age. This included a non-anemic control, an anemic placebo control group, and an anemic treatment group. Iron supplementation included 125mg $FeSO_4$ daily. Mother-infant interactions were assessed using the Parent/Caregiver Involvement Scale (PCIS; Perez et al., 2005) to code 20-minute videotaped sessions.

Results demonstrated that both groups of anemic mothers were less responsive and more controlling of infants than non-anemic controls. At 9 months, mothers in the anemic placebo group displayed significantly more negative interactions with their infants, fewer goal-setting behaviors, and less responsiveness than the non-anemic and anemic supplementation groups. The non-anemic control and anemic supplementation groups were also more similar to one another than the anemic placebo control group on all 11 scales of the PCIS (goal, negative, positive, relation, directiveness, control, teaching, play, responsive, verbal, and physical aspects of the mother-infant interaction; Perez et al., 2005). Both studies provide evidence of a direct relation between iron and parenting, though neither examined maternal affect. Collectively, the studies found that poorer iron status was associated with less emotional responsiveness (less holding and engaging with infants positively) and more maternal controlling behavior of infants, suggesting

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that poorer iron status may also be related to more authoritarian parenting. Furthermore, Perez et al. (2005) found that mothers with worse iron status had less structured parenting style (less directive with less goal-setting), indicating that poorer iron status may be related to more permissive parenting as well. No studies were found investigating maternal nutrition and parenting in US samples or sample with less severe iron deficiency (i.e., non-anemic).

Integrated Model

No known studies have directly assessed an integrated model of maternal nutrition, affect, and parenting as described above. As noted previously, Wachs (2009) presented a multivariate theoretical model to explain how nutritional deficiencies are related to the mental health of mothers and children. He explained that insufficient nutrition may lead to depression because of an inadequacy of biochemical precursors for monoamine neurotransmitters. Inadequate nutrition may lead mothers to have less energy to cope with other bioecological and psychosocial risk factors for depression and for women who are malnourished, maternal depression may lead to worse parenting. Maternal depression may impact parenting because of a greater risk for insecure attachment.

Collectively, previous studies support a link between depressive symptomology and problematic parenting style that may be exacerbated (moderated) by poor iron status. For those with poorer iron status, relatively more depressive symptomology may be related to greater authoritarian and permissive parenting. These mothers may have decreased mental energy and strength to inhibit negative thoughts and emotions, which contribute to more negative parenting styles manifested as insufficient emotional support/nurturing (authoritarian) or discipline/structure (permissive).

The significant theoretical and practical implications of these previous studies also justify the importance of the current study. Support of the moderator model (i.e., positive relations between maternal depressive symptomology and poor parenting styles will be exacerbated or moderated by poorer iron status) would imply that future research investigating relations between

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maternal nutrition and parenting should consider the effects of maternal affect. This may result in clearer or more robust findings between these variables, which will inform the assessment and treatment of clinical disorders such as PPD and the negative and long-lasting effects that poor parenting practices related to these conditions may have. This is especially important given that PPD is commonly under-diagnosed and has far-reaching and long-lasting effects, as described previously. Overall, this is a historically understudied but extremely important area of study with considerable theoretical, clinical, practical, and social implications.

Hypotheses

1. Maternal depressive symptomology will be related to authoritarian parenting style, as suggested by Rudy and Grusec (2006) and others. However, maternal iron variables (hemoglobin, transferrin receptors, ferritin, and iron intake) will moderate this relation, given that the effects of depression on parenting style should be more pronounced in those with poorer iron status (Wachs, 2009). Specifically, only mothers who have poorer iron status will show positive relations between depressive symptomology and authoritarian parenting style.

2. For the same reasons presented in hypothesis #1, maternal iron variables will moderate the relation between depressive symptomology and permissive parenting style (Drescher, 2008). Only mothers who have poorer iron status will have positive relations between depressive symptomology and permissive parenting style.

CHAPTER III

INTERACTIVE EFFECTS OF MATERNAL AFFECT AND NUTRITION ON PARENTING

Participants

Data were collected from adult (M_{AGE} = 28.16 years, SD_{AGE} = 4.69 years), breastfeeding

mothers (n = 105) approximately 3 months (13 ± 2 weeks) postpartum. Of the 105 mothers that

agreed to participate in the study, one was removed from analyses with authoritarian parenting

style because her score was an outlier. Participants with elevated inflammation markers (α_1-acid

glycoprotein or AGP levels greater than 1.2g/L) were removed from ferritin analyses, leaving the

sample size in these analyses at 81. Missing data on several other measures occurred because of

improper administration (i.e., 2-sided measures were only completed on one side for 5

participants) or discontinuation by the participant due to measure length (most prominently the

Diet History Questionnaire with 12 incomplete data sets). Sample sizes for each measure can be

seen in Table 2 (p. 48) and inferred from analyses based on degrees of freedom.

Most participants were Caucasian/White American (89%), though several other racial

categories were represented (see Table 1, p. 47). Most mothers were college graduates with a

bachelor's degree (25%) or higher (40%), most were unemployed at the time of data collection

(54%), and the vast majority were married at the time of data collection (91%). Approximately

half (49%) of participants had annual incomes greater than $40,000, but there was variability in

annual income within the sample (see Table 1, p. 47).

Procedure

Subject selection methodology involved convenience sampling within the surrounding

community. Recruitment of participants occurred via advertisements in pre-approved public and private organizations that had access to the desired sampling population, which targeted women within Payne County, Oklahoma. Additionally, a short description of the study, including contact information of the research team, was posted on the Oklahoma State University online participant pool system for students. Data collection began December 2008 and was completed in January 2011.

Mothers or mothers-to-be indicating an interest in the study via e-mail or telephone were screened for inclusion criteria (i.e., adult, pregnant or new mothers that primarily breastfeed [< 28oz. of formula/week] and have single, non-complicated births), given a short description of the project, and queried for their contact information. This information was stored in a secure, password-protected e-mail site and used to contact mothers for scheduling purposes. After participants confirmed their interest in the study, they were contacted approximately 6 weeks postpartum to see if they were still interested in participating and still met inclusion criteria. Then a scheduling call was made at approximately 11 weeks postpartum. The mothers were generally scheduled to enter the lab on OSU's campus with their infants between 11 and 15 weeks postpartum.

During this visit, participants were asked to complete several non-randomized measures in varying formats. More specifically, mothers completed an online version of the Diet History Questionnaire (DHQ), as an estimate of the mother's dietary intake within the last 12 months. This took place on secure website accessed from a password-protected computer located in a locked room within the lab. Computerized data were stored in a database devoid of personally identifying information, but containing a subject number. Mothers were also asked to complete two paper-and-pencil measures, including: the 32-item Parenting Styles and Dimensions Questionnaire (PSDQ; Appendix E) assessing overarching parenting styles and the 90-item Symptom Checklist-90-Revised (SCL-90-R) used to measure the affective variable depression (See Appendix F). These data were stored in a locked filing cabinet within the lab. At the end of

the session, participants were transported to the University Health Services Center where trained phlebotomists extracted two separate intravenous blood samples. One sample was sent to the Nutritional Sciences Laboratory and stored for later data analyses and another was sent to the Stillwater Medical Center Laboratory. Laboratory technicians in the former conducted the transferrin receptor and ferritin analyses, while technicians in the latter laboratory conducted complete blood count (CBC) analyses including hemoglobin concentrations. Mothers received their CBC results via mail. A copy of these results including a subject number, but no name was also kept within a locked filing cabinet. See Appendix B for an estimation of participants' temporal investment for each measure.

Participants received an honorarium of $40 for participation. Participants that were students receive an additional ½ credits, within designated courses, for every ½ hours of time they spent within the study. Appendix B contains a copy of the informed consent narrative and includes additional information related to the larger study into which the present study was embedded, namely the *Maternal Dietary Nutrients and Neurotoxins in Infant Cognitive Development Project*. All participants and their data were treated in accordance with the "Ethical Principles of Psychologists and Code of Conduct" (American Psychological Association, 2002) and the Oklahoma State University's Institutional Review Board (IRB; See Appendix C for a copy of *Maternal Dietary Nutrients and Neurotoxins in Infant Cognitive Development Project* IRB approval).

Measures

Diet History Questionnaire (DHQ). The Diet History Questionnaire (DHQ) is a food frequency questionnaire that was developed within the National Institutes of Health (NIH) to measure the intake of multiple nutrients (e.g., total fat, iron, etc.). More specifically, the questionnaire utilized within the following study is a modification of the questionnaire developed by Block et al. (1986) as part of the Health Habits and History Questionnaire. It was originally a paper-and-pencil survey of 99 food items, but has since been converted into an electronic format

(Diet History Questionnaire, Version 1.0, 2007). The electronic version used within this study included responses encompassing the original 99 food items in addition to other items intended to describe a greater variety of foods, vitamin supplements, and mineral supplements. Participant responses included an estimation of portion sizes based upon daily, weekly, or monthly consumption. Several pilot studies with large sample sizes demonstrated that the measure takes approximately one hour to complete (Subar, Thompson, et al., 2001; Subar, Ziegler, et al., 2001).

Research regarding the DHQ has demonstrated that the measure has adequate to good convergent validity when compared to other food frequency questionnaires (correlations with the Daily Food Report ranged from .64-.91 for non-specific food categories like milk or bread), diet records (correlations with the 4-day diet record were in the 0.50-0.70 range; correlations with a 2-day diet record were in the .50-.90 range with a median of 0.70 in women), and unbiased biological markers of nutrient intake (correlations with DHQ ranged from .46-.79; Block, Woods, Potosky, & Clifford, 1990; Mares-Perlman, Klein, & Klein, 1993; Subar et al., 2003; Subar, Thompson, et al., 2001; Thompson et al., 2002). These results have also generalized to Canadian samples (Jain, 1989; Jain, Howe, Johnson, & Miller, 1980; Jain, Howe, & Rohan, 1996). Specifically, average energy-adjusted correlations between the DHQ and a 7-day food record were .48 for macronutrients and .54 for micronutrients in women. The measure was not included in the Appendices due to its length, but can be accessed via the following web address: http://riskfactor.cancer.gov/DHQ/webquest/index.html. The online version of the questionnaire was analyzed via software created by the National Cancer Institute (Diet*Calc Analysis Program, 2005) to yield an estimate of iron intake, including dietary iron and supplementation.

Blood samples. Intravenous blood samples were drawn from mothers at the University Health Services Center on campus. Sarstedt (Sarstedt Inc., Newton, NC) sterile safety-multifly needles were used to take two samples. The first sample was used for the analysis of **hemoglobin** concentration. This sample also was contained within a trace-element-free Sarstedt EDTA KE monovette 1.2mL syringe. This sample was used for a complete blood count (CBC) analysis and

hemoglobin was analyzed using an ABX Pentra 120 Retic Hematology instrument using standard

clinical protocols. The whole blood used to identify concentrations of **soluble transferrin**

receptor (sTfR) in serum and serum **ferritin** was collected in Sarstedt monovette 7.5mL LH-

Metall-Analytik syringes with no EDTA for plasma. These samples were aliquoted and stored for

future analysis. The sTfR was assessed using Ramco enzyme-linked immunosorbent assays

(ELISA). Serum ferritin was determined using Ramco radioimmunoassays. To control for biased

measures of ferritin as a function of infection (Droke, Kennedy, & Hubbs-Tait, 2006), α_1-acid

glycoprotein (AGP) was assessed using ELISA kits from Bio-Quant, Inc., San Diego CA.

Participants with AGP levels greater than 1.2g/L were not included in ferritin analyses (Paracha,

Jamil, Northrop-Clewes, & Thurnham, 2000). All blood sample analyses completed by the

Nutritional Sciences Laboratory were run in duplicate to ensure reliable analysis.

  Parenting Styles and Dimensions Questionnaire (PSDQ). The Parenting Styles and

Dimensions Questionnaire (PSDQ) is a 32-item questionnaire used to broadly assess parenting

styles that may have an effect on children's behavioral outcome and is based on the original, 62-

item Parenting Practices Questionnaire (PPQ; Robinson, Mandleco, Olsen, & Hart, 1995). Hart et

al. (2000) differentiated between parenting practices and parenting styles by explaining that the

former includes strategies that parents use to obtain goals within particular contexts/situations,

whereas the latter can be thought of as aggregate collections of behavior that are typical of parent-

child interactions across many situations.

  The PSDQ includes self-report and spousal-report items to capture similarities and

differences between parenting styles within the home, although much less research has been done

to solidify the psychometric properties of the latter (Winsler, Madigan, & Aquilino, 2005).

Therefore, maternal self-report is the only scale used within the current study. Participants

complete the questionnaire by answering statements about the frequency of particular parenting

practices within the home on a 5-point Likert scale, ranging from 1 (Never) to 5 (Always). This

yields three separate scale scores based on Baumrind's (1971) theory of parenting styles,

including authoritative, authoritarian, and permissive parenting styles (Robinson et al., 1995). Scale scores are calculated by taking the mean rating for all items on the scale, where greater scores indicate a greater presence each particular parenting style. The 27-item authoritative scale includes the subscales of warmth and involvement, reasoning/induction, democratic participation, and good natured/easy going. The 20-item authoritarian scale includes subscales verbal hostility, corporal punishment, non-reasoning/punitive actions, and directiveness. The 15-item permissive scale includes the subscales lack of follow-through, ignoring misbehavior, and self-confidence (Winsler et al., 2005).

Research investigating the psychometric properties of the PPQ has revealed that the measure has good internal consistency in that Cronbach's alpha ranged from .75-.91 for the three scales (Robinson et al., 1995). Further, the PPQ/PDSQ has been successfully adapted and used within multiple cultures including: Chinese (Nelson, Hart, Yang, Olsen, & Jin, 2006; PDSQ), Russian (Hart et al., 2000; PDSQ), and African American (Coolahan, McWayne, Fantuzzo, & Grim, 2002; PPQ).

Symptom Checklist-90-Revised (SCL-90-R). The SCL-90-R is a 90-item standardized, self-report questionnaire that serves as a widely-accepted measure of several psychological difficulties and psychopathological symptoms (Derogatis, 1994). The measure was derived from an earlier measure known as the Hopkins Symptom Checklist created in the 1970s, which was derived from the Woodworth Personal Data Sheet created in the early 20th century (Groth-Marnat, 2003). The 90 items of the SCL-90-R are statements of psychological symptoms to which the respondent indicates their severity over the past 7 days, including the day of administration. Responses are scored on a 5-point Likert scale ranging from 0 (Not at all) to 4 (Extremely). The measure takes approximately 15 minutes to complete and yields nine symptom dimension and three global index scores. This includes the following nine dimensions: Somatization, Obsessive-Compulsive, Interpersonal Sensitivity, Depression, Anxiety, Hostility, Phobic Anxiety, Paranoid

Ideation, and Psychoticism. It also includes the following three global indexes: Global Severity, Positive Symptom Total, and Positive Symptom Distress (Derogatis, 1994).

These scores can be interpreted by converting raw scores to T-scores with a mean of 50 and standard deviation of 10 using non-patient norms for the current sample (Derogatis, 1994), such that clinical elevations are marked by a T-score equal to or exceeding 70. Raw scores on the SCL-90-R can be converted based on four different sample norms (e.g. psychiatric inpatients and outpatients, non-patient adults, and non-patient adolescents) from large standardization samples and have been applied in numerous settings (e.g., inpatient [Ro, Martinsen, Hoffart, & Rosenvinge, 2003] and outpatient therapeutic settings[Starcevic, Bogojevic, & Marinkovic, 2000], college student samples [Marschark, Richtsmeier, Richardson, Crovitz, & Henry, 2000], community non-patients, and primary care health settings [Aikens, 1998], to name a few) and for a variety of reasons.

Some of the most compelling attributes of the measure include its quick administration time, ease of understanding administration instructions (6th grade reading level), ease of interpretation, and good psychometric properties (Groth-Marnat, 2003). Regarding the latter, the SCL-90-R has been shown to be consistently reliable over several separate investigations with different samples (Groth-Marnat, 2003). Internal consistency from several reports ranged from .71 to .90 (Groth-Marnat, 2003). Internal consistency within the current sample was .87. Test-retest reliability coefficients with a one week retest interval have ranged from .78 to .90 and for a 10 week interval have ranged from .68 to .83. Most often test-retest reliabilities are in the mid-.80 range (Groth-Marnat, 2003). Groth-Marnat (2003) reported that there have been more than 1, 000 studies investigating the validity of the SCL-90-R. Several have noted the good convergent validity with the SCL-90-R and similar scales on the Minnesota Multiphasic Personality Inventory (MMPI; correlations ranged from .50-.75; Derogatis, Rickels, & Rock, 1976), Brief Psychiatric Rating Scale (BPRS; $r = .45$; Margo, Dewan, Fisher, & Greenberg, 1992), and Beck

Depression Inventory (BDI; $r = .69$; Margo et al., 1992) and good divergent validity with expected constructs (e.g., anxiety and depression; Koeter, 1992).

Studies are currently equivocal regarding the factor structure of the SCL-90-R, but Derogatis and colleagues (Derogatis, 1994; Derogatis & Cleary, 1977) have supported the current factor structure of the instrument, despite several other studies documenting support for a one to six factor solution in different sample populations (Groth-Marnat, 2003). Much less equivocal are the studies documenting the sensitivity and specificity of the instrument for identifying various clinical disorders (e.g., bulimia nervosa, psychological difficulties associated with diabetes mellitus, and cluster A and B personality disorders; Groth-Marnat, 2003), further supporting the validity of the instrument.

Analyses

All regression assumptions were tested prior to conducting analyses. This included casewise diagnostics for outliers (± 3 SD), frequency histograms to investigate the normality of all variables of interest, scatterplots to ensure linearity and rule-out range restriction, intercorrelations and variance inflation factors to rule out multicollinearity, residuals plots to investigate homoscedasticity and normality of residuals, the Durbin-Watson Statistic to test for the independence of error, and correlations between the outcome variable and other potential sociodemographic mediators to rule-out these variables as confounds to the relations between the predictor (i.e., iron and depressive symptomology) and outcome variables (i.e., permissive and authoritarian parenting style). The frequencies of sociodemographic variables (see Table 1, p. 47) and means and standard deviations for primary variables (maternal hemoglobin, transferrin receptor, ferritin, depressive symptomology, authoritarian parenting style, and permissive parenting style; see Table 2, p. 48) were computed to describe the current sample. Furthermore, a correlation matrix was completed with all variables (see Table 3, p. 49).

Each hypothesis was tested using hierarchical multiple regression analyses with the first step including the two main effects and the second step including the interaction term. Prior to

completing these analyses, each variable was centered and an interactive term was computed via multiplication. The regression equations for each hypothesis took the following form: Step 1 parenting style (y) = depressive symptomology (x_1) + iron status or intake (x_2) and Step 2 parenting style (y) = depressive symptomology x iron (x_3). Follow-up analyses were completed with all significant interactions and included performing simple slopes analyses (Aiken & West, 1991). Finally, as an alternative to moderation, mediator analyses using the 4-step Baron and Kenny (1986) procedure were also conducted (see results in Appendix B) for maternal iron status, depressive symptomology, and parenting style. Theoretically, a mediation model did not apply to iron intake, so no mediation analyses were conducted using this variable.

A priori power analyses using G*power version 3.0.10 (Faul, Erdfelder, Lang, & Buchner, 2007) revealed that with a medium effect size according to Cohen's conventions ($f^2 = 0.15$; Howell, 2006), $\alpha = .05$, power = .80, and three total predictors, a sample size of 77 is required for multiple regression analyses. Therefore, the current sample of 105 is thought to be sufficient to test the current hypotheses.

CHAPTER IV

INTERACTIVE EFFECTS OF MATERNAL AFFECT AND NUTRITION ON PARENTING

Regression Assumptions

All statistical assumptions for multiple regression analyses were tested. First, casewise diagnostics revealed one outlier (± 3 *SD*) in the authoritarian parenting variable, so this case was removed from the analyses utilizing authoritarian parenting as the outcome variable. The frequency histograms revealed that three variables (depressive symptomology, authoritarian parenting, and ferritin) were positively or right skewed. After transforming each of these variables (square root), they became more normally distributed (skewness < 1) so these transformed variables were used in analyses. Scatterplots with inserted best fit lines demonstrated that relations between depressive symptomology and parenting styles were linear with no range restriction. Linear relations were not expected of iron status/intake and parenting styles, given that these variables were modeled as moderators. Variance inflation factors were all below 10, suggesting that multicollinearity was not an issue. Residuals plots did not suggest issues with homoscedasticity or non-normality of residuals. The Durbin-Watson Statistics were all between 1 and 3, suggesting that errors were independent. No significant relations were found between parenting style (permissive and authoritarian) and sociodemographic variables (i.e., race, education, employment status, income, marital status, or parity), suggesting that these variables do not mediators relations between the predictor and the outcome variables.

Descriptive Statistics and Correlations

The descriptive statistics revealed that there was limited variability in maternal race,

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education, employment status, and marital status. However, the group of participants did evidence variability in annual income. Follow-up analyses revealed that income was not related to depressive symptomology, any of the iron status variables, or parenting style, but there was a significant relation between income and iron intake ($F[4, 87] = 3.00$, $p = .023$), which took the form of a positive semi-linear trend (see Figure 1, p. 51). Post-hoc pairwise comparisons utilizing a Tukey's adjustment for Type I error inflation revealed that there was only one significant difference between groups. In particular, those in the lowest income category (< \$15,000 annually) had significantly lower iron intakes than those grossing \$40,001-\$60,000 annually (Mean difference = 14.54, $p = .009$). Despite this finding, no significant differences in authoritarian parenting were found between the lowest income category (\$15,000 annually) and those grossing \$40,001-\$60,000 annually ($t[34] = 0.72$, *ns*).

The correlation matrix (see Table 3, p. 49) revealed significant relations between parenting styles (authoritarian and permissive; $r = .32$, $p = .001$), which is to be expected given that they are derived from the same measure and therefore partially dependent. Further, the two constructs are conceptually related in that both reflect lower warmth of interaction with the mother and child. There were also significant relations between depressive symptomology and both parenting styles (authoritarian; $r = .42$, $p < .0001$ and permissive; $r = .30$, $p = .003$). None of the relations with iron status or intake were statistically significant. This further suggests that multicollinearity was not an issue.

Hypothesis 1: Maternal depressive symptomology will be related to authoritarian parenting style. However, maternal iron (hemoglobin, transferrin receptors, ferritin, and iron intake) will moderate this relation, given that the effects of depression on parenting style should be more pronounced in those with poorer iron status.

The regression equations for the first hypothesis took the following form: Step 1 authoritarian parenting style (y) = depressive symptomology (x_1) + iron (status or intake; x_2) and Step 2 authoritarian parenting style (y) = depressive symptomology x iron (status or intake; x_3).

When **sTfR concentrations** were used as the iron status variable, neither the R^2 change nor interaction term in the second model were statistically significant. Therefore, the first model was used to interpret the main effects. The model accounted for 12% of the variance in authoritarian parenting style ($F[2, 89] = 5.78$, $p = .004$) however, the only significant predictor was depressive symptomology ($\beta = .341$, $t[91] = 3.40$, $p = .001$). Similarly, the analyses using **ferritin** had a null R^2 change and interaction term. The first model accounted for 10% of the variance in authoritarian parenting style ($F[2, 74] = 3.99$, $p = .023$) but again the only significant predictor was depressive symptomology ($\beta = .318$, $t[76] = 2.82$, $p = .006$). Utilizing **hemoglobin** as the indicator of iron status, the R^2 change was statistically significant (R^2 change = 11%, $F[1, 96] = 12.89$, $p = .001$). The combination of predictors accounted for the greatest amount of variance in authoritarian parenting style (21%, $F[3, 96] = 8.29$, $p < .001$). Unlike all previous analyses, depressive symptomology ($\beta = .298$, $t[99] = 3.28$, $p = .001$) and the interaction term ($\beta = -.339$, $t[99] = -3.59$, $p = .001$) were both significant predictors.

Therefore, an online tool for calculating simple slopes was used to interpret and plot the interaction (Preacher, Curran, & Bauer, 2006). Results (see Figure 2, p. 52) demonstrated that for those with hemoglobin levels at the mean (13.7g/dL: simple slope = 0.335[0.0948], $t = 3.5352$, $p = 0.0006$) and at one standard deviation below the mean (12.9g/dL; simple slope = 0.7391(0.1299), $t = 5.6884$, $p < 0.0001$), the positive slope of relations between depressive symptomology and authoritarian parenting style significantly differed from 0. This was not the case for those with hemoglobin levels one standard deviation above the mean (14.5g/dL; simple slope = -0.0692[0.14], $t = -0.4942$, $p = 0.6223$). The lower bound region of significance for hemoglobin shows that mothers with hemoglobin levels less than 14.0g/dL demonstrate significant relations between depressive symptomology and authoritarian parenting style.

Finally, when utilizing estimated dietary **iron intake** in the regression analysis for the first hypothesis, the R^2 change significantly differed from 0 (R^2 change = 5%, $F[1, 84] = 5.02$, $p = .028$). The combination of predictors in the second model explained 17% of the variability in

authoritarian parenting style (F[3, 84] = 5.74, p = .001). There were two significant predictors, including depressive symptomology (β = .336, t[87] = 3.34, p = .001) and the interaction term (β = .227, t[87] = 2.24, p = .028). The simple slope calculator (Preacher et al., 2006) was used again to interpret and plot the interaction. Results (see Figure 3, p. 53) demonstrated that for those with iron intake at the mean (27.24mg; simple slope = 0.382[0.1095], t = 3.4872, p = .0008) and at one standard deviation above the mean (39.82mg; simple slope = 0.6713[0.154], t = 4.3579, p < 0.0001), the positive slope of relations between depressive symptomology and authoritarian parenting style significantly differed from 0. This was not the case for those with iron intake one standard deviation below the mean (14.67mg; simple slope = 0.0927[0.1461], t = 0.6344, p = 0.5275). The upper bound region of significance for iron intake suggests that those with iron intakes greater than 20.90mg demonstrate significant relations between depressive symptomology and authoritarian parenting style.

The direction of effects was opposite of what was originally hypothesized, that is, depressive symptomology and authoritarian parenting were predicted to be related for those with lower dietary iron intake, but results showed that they were related for those with higher iron intake. Therefore, several follow-up analyses were conducted to determine whether another variable may better explain variation in relations between depressive symptomology and authoritarian parenting. Suspected variables of interest (i.e., calories/kg, maternal weight change pre-pregnancy to 3 months postpartum; income; education; employment; parity; pregnancy complications such as anemia, vaginal bleeding, blood transfusions, and general pregnancy health; and birth complications such as c-section delivery) were all unrelated to the outcome variable, authoritarian parenting style. This suggests that none of these variables mediate relations between depressive symptomology and authoritarian parenting or relations between iron intake and authoritarian parenting.

However, two variables were related to iron intake including income (F[4, 87] = 3.00, p = .023) and calorie intake per kilogram (r = .472, p < .001).Therefore, moderator analyses were

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conducted testing whether either of these variables moderates relations between depressive

symptomology and authoritarian parenting using two hierarchical regression analyses (one for

each potential moderator) with both main effects in the first step and the interaction in the second

step. Neither R^2 change was statistically significant ($p = .167$ for calorie intake per kilogram and p

$= .125$ for income). Because the appropriateness of conducting regression analyses with ordinal

variables is debated, an additional multiple regression analysis was run after dummy coding the

income variable (Aiken & West, 1991). In particular, because income has 5 levels, 4 dummy

coded variables were constructed with the comparison group being designated arbitrarily as the <

$15,000 annual income level. The following model:

$$\hat{Y} = b_1D_1 + b_2D_2 + b_3D_3 + b_4D_4 + b_5\text{DEP} + b_6(D_1*\text{DEP}) + b_7(D_2*\text{DEP}) + b_8(D_3*\text{DEP}) +$$

$$b_9(D_4*\text{DEP}) + b_0$$

was statistically significant ($F[9,89] = 4.796$, $p < .001$). In other words, R^2 (.327) for all 10

predictors significant differed from 0, indicating that a significant amount of variability in

authoritarian parenting was explained by the combination of all predictors. However, none of the

4 interaction term beta weights were statistically significant. Because the large number of

predictors in the model limits the statistical power of each predictor (i.e., beta weights), an

alternative analysis was run. Specifically, depressive symptomology was categorized based on

quartiles and a between-subject's ANOVA was used to examine the interaction between income

and depressive symptomology with authoritarian parenting as the dependent variable. The

interaction omnibus effect was not significant ($F[11,80] = 1.312$, $p = .233$).

Instead of a third variable explaining the interactive relations between iron intake and

depressive symptomology to predict authoritarian parenting style, it may be that this relation

exists because mothers taking large doses of iron supplements did so because they were iron

deficient or anemic. To test this hypothesis, the iron supplement variable was divided into three

categories based on the frequency distribution of the variable in our sample (see Table 4, p. 50)

and the RDA of 9mg daily iron. The three groups ranged from (1) 0-5.14 (low iron

supplementation), (2) 12.86-21.43 (moderate iron supplementation), and (3) 34.29 (high iron supplementation). The last category was chosen because the tolerable upper intake level for iron is 45mg (Food and Nutrition Board, 2001) and all mothers in the high iron supplementation category were at or exceeding 45mg of total iron intake (total iron intake included supplements plus dietary intake of iron). Two of the three investigations of relations among iron intake and the three other iron variables were significant. In particular, iron intake was significantly related to ferritin ($F[2,69] = 4.40$, $p = .016$) and hemoglobin concentrations ($F[2,90] = 4.44$, $p = .015$). Given the predicted quadratic relation between iron intake and ferritin and hemoglobin, a trend analysis was performed for each significant relation. As hypothesized, the linear trends were not significant, but quadratic trends for ferritin ($F[1,69] = 8.15$, $p = .006$) and hemoglobin ($F[1,90] = 7.22$, $p = .009$) were both significant. As evidenced in the means plots (see Figures 4 and 5, pp. 54-55), those with low or high iron supplementation had lower ferritin and hemoglobin concentrations than those with adequate iron supplementation.

Hypothesis 2: For the same reasons presented in hypothesis #1, maternal iron (hemoglobin, transferrin receptors, ferritin, and iron intake) will moderate the relation between depressive symptomology and permissive parenting style.

The regression equations for the second hypothesis took the following form: Step 1 permissive parenting style (y) = depressive symptomology (x_1) + iron (status or intake; x_2) and Step 2 permissive parenting style (y) = depressive symptomology x iron (status or intake; x_3). None of the models were statistically significant.

Mediator Analyses

As can be seen in Appendix B, none of the mediation analyses were statistically significant for step 1, regardless of which type of iron status variable (i.e., hemoglobin, transferrin receptors, and ferritin concentrations) or parenting style variable (permissive or authoritarian) was used. Therefore, steps 2 through 4 were not conducted.

CHAPTER V

INTERACTIVE EFFECTS OF MATERNAL AFFECT AND NUTRITION ON PARENTING

Investigation of the descriptive statistics for each variable (see Table 2, p. 48) suggested that on average, the mothers in the study had adequate iron intake ($M = 27.24$ mg daily). In fact, this average intake was three times the recommended dietary allowance for lactating women between the ages of 19 and 30 years (Food and Nutrition Board, 2001). On average, hemoglobin (> 12.0 g/dL) and iron status variables (sTfR < 8.5 mg/L and ferritin > 12.0 μg/L; Pehrsson, Moser-Veillon, Sims, Suitor, & Russek-Cohen, 2001) were all within the normative range. In fact, none of the mothers in the study had hemoglobin levels below 12.0 g/dL. Mothers in the study also experienced depressive symptomology below the clinical cut-off, on average (raw score = .58, T-score = 55), although their T-scores were above average for a non-patient normative sample. This is notable given that mothers in the study did not have many socioeconomic or nutritional risk factors for developing depression. However, this finding further highlights the widespread nature and importance of assessing for PPD. On average, mothers in the study evidenced more authoritative parenting ($M = 4.23$) than permissive ($M = 2.04$) and authoritarian ($M = 1.47$) parenting styles. These results make the significant findings within the current study noteworthy because relations among these variables are likely to be quite robust in order to surface in a sample with limited variability in sociodemographic, nutritional, and health variables that had relatively few risk factors for the development of negative parenting styles.

Hypothesis 1

Hemoglobin. In particular, interactive relations existed between depressive symptomology and hemoglobin in predicting authoritarian parenting style. Mothers with more depressive symptomology had greater authoritarian parenting style, but only for those who had

hemoglobin concentrations at or below the mean (13.7g/dL). Furthermore, examination of the lower boundary region suggests that significant positive relations between depressive symptomology and authoritarian parenting style are found in mothers with hemoglobin levels below 14.0g/dL. This suggests that mothers with greater hemoglobin levels do not evidence significant relations between depressive symptomology and parenting style. Thus, hemoglobin may serve as a buffer to these negative relations. This may be because those with lower hemoglobin may have decreased energy and cognitive and emotional strength to inhibit depressive symptomology, which contributes to more negative (authoritarian) parenting styles manifested as insufficient emotional support or nurturing in the parent-child relationship. Likewise, the inverse relation cannot be ruled out given that causality cannot be inferred. In particular, perhaps decreased energy and strength related to lower hemoglobin leads one be less engaged and warm with her children, which leads to guilt, rumination, or social isolation related to depressive symptomology.

Since these relations were found in women with adequate hemoglobin based on current standards, hemoglobin concentration recommendations for lactating women may need to be studied further. Specifically, lactating women are thought to have sufficient hemoglobin concentrations at 12.0g/dL or greater. But within the current sample, significant positive relations between depressive symptomology and parenting were found for those below 14.0g/dL of hemoglobin. Given that these relations were found in mothers with sub-clinical levels of depression (all T-scores below 70) and minimal depressive symptomology, it may be important that these standards be applied broadly.

Findings also imply that screening for hemoglobin below 14.0g/dL and depressive symptomology in lactating women may help to identify those at risk for problematic parenting practices. This is important given that authoritarian parenting style has been associated with internalizing and externalizing problems (Fletcher, Walls, Cook, Madison, & Bridges, 2008) in

addition to lower cognitive and emotional competencies in children (Kohen, 1997). Within the current study, authoritarian parenting was positively and significantly related to risky parenting beliefs measured by the Adult-Adolescent Parenting Inventory-2nd Edition (AAPI-2), including: inappropriate expectations ($r = .40$, $p < .001$), low empathy ($r = .35$, $p < .001$), corporal punishment ($r = .32$, $p = .001$), role reversals ($r = .40$, $p < .001$), and restriction of power and autonomy ($r = .29$, $p = .003$) within the mother-infant relationship. Though findings within this sample are statistically significant, differences in parenting may be more pronounced in women with greater depressive symptomology and lower hemoglobin values. This may be particularly important in developing countries where malnutrition rates are greater.

Moreover, results suggest that adequate nutrition, especially with vitamins and minerals that may be related to affective disturbances (i.e., vitamins B, C, D, and E and calcium, chromium, iron, magnesium, zinc, and selenium) could minimize the relation between depressive symptomology and negative parenting. Therefore, early and sustained nutritional interventions may be advisable, with the current study supporting the efficacy of increases in hemoglobin minimizing relations between depressive symptomology and authoritarian parenting. It should be taken into consideration that several substances act as promoters to increase iron absorption (e.g., vitamin C and organic acids) or inhibitors to impede iron absorption (e.g., phyates, polyphenols, calcium, zinc, and phosphorous; New Zealand Ministry of Health, 2008). Therefore, estimated iron intake alone cannot be an adequate indicator of iron status (as indicated by non-significant relations within the current study; see Table 3, p. 49) or the effects of iron within the body. This means that mothers' diets should be examined holistically to determine whether their intake of specific vitamins and nutrients is sufficient. Again, the fact that these relations were found in mothers with sub-clinical depressive symptomology and adequate estimates of iron intake/hemoglobin suggests that these interactive effects are robust.

Estimated Dietary Iron Intake . Contrary to original hypotheses, those at or *above* the mean of estimated iron intake (27.24mg) demonstrated significant positive relations between depressive symptomology and authoritarian parenting. Inspection of the upper boundary region suggests that significant positive relations between depressive symptomology and authoritarian parenting style are found in mothers with iron intake levels above 20.90mg. Those that were experiencing greater depressive symptomology had greater authoritarian parenting, but only for those that consume *more* iron. Because the direction of effects was opposite of the originally hypothesis, it was suspected that another variable may better account for variation in relations between depressive symptomology and authoritarian parenting.

Because depressive symptomology may result in greater appetite or eating behavior, we examined relations between dietary intake of calories/kg and authoritarian parenting in addition to maternal weight change pre-pregnancy to 3 months postpartum and authoritarian parenting, both of which proved to be null. Unlike weight change, calories/kg was significantly related to iron intake. Therefore, the interactive relations of calories/kg and depressive symptomology on authoritarian parenting were tested to examine whether calories/kg may be a proxy for iron intake and better explain the interactive relations between depressive symptomology and authoritarian parenting. Because socioeconomic status may impact depressive symptomology and parenting style, we also examined bivariate relations between authoritarian parenting and the following variables: income, education, and employment. Again, none of these relations were statistically significant. However as before, income was related to iron intake. But as with calories/kg, the interaction between income and depressive symptomology to predict authoritarian parenting was not significant. Lastly, we examined relations between authoritarian parenting and several other factors that may influence parenting including: parity; complications during pregnancy such as anemia, vaginal bleeding, blood transfusions, and general pregnancy health; and birth

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complications like c-section delivery. Yet, all were unrelated to authoritarian parenting style and iron intake.

This suggests that none of the above mentioned variables mediate relations between depressive symptomology and authoritarian parenting or relations between iron intake and authoritarian parenting style. Additionally, neither of the variables that were significantly related to iron intake (i.e., calories/kg and income) proved to be significant moderators of relations between depressive symptomology and authoritarian parenting. Therefore, none of the suspected variables accounted for relations between depressive symptomology and authoritarian parenting better than iron intake.

On the other hand, the finding that those with higher iron intake demonstrated significant relations between depressive symptomology and authoritarian parenting is thought to be due to the fact that those with the highest intake of iron (largely in the form of supplements with total iron intake exceeding the tolerable upper limit of 45mg) had poorer iron status (i.e., ferritin and hemoglobin concentrations). It may be that these mothers were taking large doses of iron supplements to make up for previous iron deficiency or anemia. However, supplementation was not sufficient to eliminate group differences in iron status or relations between depressive symptomology and authoritarian parenting. Therefore, as noted above, early and long-term dietary changes should be considered for pregnant women with poor iron status.

Low iron and depressive symptomology may have partially overlapping underlying neurochemical mechanisms. For instance, a review by Kaplan, Crawford, Field, and Simpson (2007) noted that iron plays an important role in the production and binding of monoamines. For example, iron is a cofactor in producing dopamine from tyrosine and aids in binding of dopamine and serotonin to binding proteins in the frontal cortex (Kaplan et al., 2007), which are implicated in the development of mood disorders. These neurochemical mechanisms may be especially important to consider in lactating women who have greater iron requirements and are exposed to

a number of unique biological and social stressors (Brummelte, & Galea, 2009). Results suggest that studies investigating relations between depressive symptomology and parenting may want to consider the influence of biochemical and neurological factors and measure these variables, when possible.

Overall, the differences in relations between hemoglobin and iron intake should be considered when selecting measures to examine these relations and designing studies with these variables. In particular, it should not be assumed that a food frequency or related questionnaire administered at one time point is indicative of underlying biological status and researchers should consider how large doses of supplements may be taken because of previous insufficiency of a particular nutrient and that the effects of such supplementation are complex and are not immediate. Again, because calorie intake per kilogram did not better account for relations among depressive symptomology and authoritarian parenting, the study supports a unique role for iron rather than a general increase in nutrients.

Hypothesis 2

Contrary to hypotheses, interactions between hemoglobin, iron status variables, iron intake, and depressive symptomology in predicting permissive parenting style were not present. This suggests that the interaction between depressive symptomology and iron may be exhibited more in the form of decreased affection or nurturance rather than as decreased discipline or structure (permissive parenting style). Unlike previous studies, however, greater depressive symptomology was not associated with more permissive parenting style. This could be related to the fact that mothers in the current study had low levels of depressive symptomology and adequate estimated iron intake, hemoglobin, and iron status.

Hemoglobin

Another finding contrary to the original hypotheses was that only utilization of hemoglobin, as opposed to ferritin and transferring receptor concentration, resulted in a

significant interaction. This may be because the three variables measure different things biochemically. Specifically, transferrin receptors are protein complexes that facilitate transferrin intake into cells and are unaffected by fluctuations in inflammation (Marković, Majkić-Singh, Ignjatović, & Sinhh, 2007). This measure is a marker of tissue iron where greater receptor density/concentrations indicate poorer iron status. Ferritin is a protein complex containing iron, but unlike transferrin receptors, ferritin is a marker of iron storage and is affected by inflammation markers (Marković et al., 2007). Studies utilizing pregnant and lactating women have found that serum transferrin receptor (sTfR) concentrations have greater sensitivity in identifying variability in iron status in women than serum ferritin (Kuvibidila, Yu, Ode, Warrier, & Mbele, 1994). However, the use of ferritin as a marker of iron status has been shown to have greater specificity than sTfR (Mast, Blinder, Gronowski, Chumley, & Scott, 1998).

Both of these markers have been shown to have greater sensitivity than hemoglobin for assessing iron deficiency, wherein hemoglobin detects only later stages of iron deficiency (Cook, 2005). Hemoglobin is a protein complex containing iron that is responsible for the transport of oxygen and other compounds (i.e., to a much lesser degree, carbon dioxide and nitric oxide) throughout the body. Hemoglobin may play a unique neurochemical role in ensuring oxidative metabolism in the brain, which may be related to cognitive and behavioral changes related to mood and/or parenting (Kaplan et al., 2007).

Mediation

Regardless of the iron status/hemoglobin or parenting style variable used, all of the mediator analyses were null. As noted previously, Wachs (2009) noted that iron deficiency leads to impaired monoamine synthesis and binding, which then leads to depression and resulting insecure attachment in the parent-child relationship. Although the current study did not support this model, this may be due to the current study limitations.

Limitations

Implications from the current study should be interpreted within the context of study limitations. In particular, the current sample had relatively homogeneous sociodemographic characteristics (i.e., race, education, employment status, and marital status), limiting the external validity of findings. As noted previously, however findings within a sample of limited sociodemographic variability attests to the robustness of relations among study variables. The sociodemographic variable that demonstrated the most variability was annual income, which seemed to be positively related to iron intake in a linear trend that leveled off before the highest income category. Nevertheless, income was not related to depressive symptoms or parenting style, so it is not thought to mediate or moderate relations between iron and mood or parenting. A second limitation to the current study was that all of our mothers were primarily breastfeeding, so comparisons between breastfeeding and non-breastfeeding mothers could not be conducted. This is important because breastfeeding may influence mood in unique ways based on hormonal changes associated with breastfeeding. Specifically, oxytocin release from breastfeeding may enhance mood and relieve stress in addition to enhancing mother-infant relations (Mezzacappa & Katlin, 2002). Therefore, breastfeeding behavior may influence relations between study variables and should be used as a between-subjects variable in future studies. Next, depressive symptomology, iron intake, and parenting style variables were measured via self-report measures that may contain some reporting error. Lastly, although some of the underlying biochemical/neurological mechanisms related to hemoglobin/iron and depressive symptomology were theorized, measures of these processes were not included in the current study.

Future Studies

Consequently, future studies could incorporate a neuroimaging or neurochemical measure to investigate whether these underlying mechanisms explain some of the aforementioned relations. Studies may also want to use coded observations of parent-child interactions in

naturalistic settings in addition to self-report inventories. Future studies will also want to utilize

samples with greater variability in sociodemographic characteristics and breastfeeding behavior

to investigate whether some of these variables may moderate or mediate relations between

iron/hemoglobin and mood or parenting style. Additionally, follow-up studies could compare

mothers with clinical and sub-clinical depression and mothers that are iron sufficient, insufficient,

and anemic to determine whether these relations generalize or manifest differently across

samples. A particularly interesting study would investigate lactating women with clinically

elevated levels of depression and iron deficiency/anemia to determine whether adequate

hemoglobin would still buffer the negative relations between depression and parenting. Greater

theoretical support may lead the way for randomized controlled trials with dismantling designs to

investigate the efficacy of nutritional and/or psychological interventions in enhancing parenting

practices in mothers evidencing depressive symptoms. Further, more studies are needed that

investigate the mechanisms underlying the potential multigenerational transfer of

psychopathology. Overall, replication of current study findings are needed before substantive

claims about interactive relations can be made.

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Table 1

Descriptive Statistics for Sociodemographic Variables

Maternal Variable	N	*M*	*SD*
Age	105	28.16	4.69
Ethnicity		Percentage	
White/Caucasian American	93	89%	
Hispanic/Latino	2	2%	
Native American	6	6%	
Asian American	3	3%	
African American	1	1%	
Education			
Less than High School	1	1%	
High School Graduate	5	5%	
Some College	31	30%	
College Graduate	26	25%	
Post Graduate or Above	42	40%	
Employment			
Unemployed	55	53%	
Employed Part-time	17	16%	
Employed Full-time	31	30%	
Retired	1	1%	
Income (Annual)			
Under $15,000	13	13%	
$15,001-25,000	16	15%	
$25,001-40,000	24	23%	
$40,001-60,000	25	24%	
Above $60,000	26	25%	

Table 2

Descriptive Statistics for Primary Study Variables

Maternal Variable	N	*M*	*SD*
Estimated Daily Dietary Iron Intake (mg)	93	27.24	12.58
Hemoglobin (g/dL)	105	13.7	0.8
Transferrin Receptor Concentration (mg/L)	96	6.49	3.26
Ferritin Concentration (µg/L)	82	25.8	21.8
Authoritarian Parenting	100	1.47	0.38
Permissive Parenting	100	2.04	0.49
Depressive Symptomology	105	0.58	0.57

Note. The descriptive statistics for ferritin concentration were calculated after removing mothers with elevated inflammation markers ($\geq$ 1.2g/L α(1)-acid glycoprotein) that may erroneously inflate ferritin concentrations. On average, iron status variables were all within the normative range (hemoglobin > 12.0 g/dL, sTfR < 8.5 mg/L, and ferritin > 12.0 µg/L; Pehrsson, Moser-Veillon, Sims, Suitor, & Russek-Cohen, 2001). Authoritarian and permissive parenting style means range from 1 to 5, where greater scores indicate a greater tendency toward the parenting style in question. A raw score of 0.58 on the depression scale of the SCL-90-R corresponds to a T-score of 55 which is above average for non-patient normative samples, though mothers in the study were not experiencing depressive symptomology within the clinical range.

Table 3

Correlations among Primary Study Variables

		HB	TFR	FER	AUP	PEP	Depressive Symptoms
Iron Intake (mg)	*r*	0.13	-0.01	-0.04	-0.01	0.11	0.12
	p	.202	.910	.731	.960	.296	.241
	n	93	86	72	88	88	93
Hemoglobin (HB; g/dL)	*r*		0.14	0.17	-0.01	0.02	-0.01
	p		.162	.130	.942	.834	.918
	n		96	82	100	100	105
Transferrin Receptor Concentration (TFR; mg/L)	*r*			-0.09	0.02	0.06	0.11
	p			.428	.881	.598	.267
	n			74	92	92	96
Ferritin Concentration (FER; μg/L)	*r*				-0.03	0.02	-0.11
	p				.798	.893	.321
	n				77	77	82
Authoritarian Parenting (AUP)	*r*					**0.32**	**0.42**
	p					0.001	0.00001
	n					100	100
Permissive Parenting (PEP)	*r*						**0.30**
	p						0.003
	n						100

Table 4

Frequency Distribution of Iron Supplements

Iron Supplements (mg)	Frequency	Percent
0	19	20
0.3	2	2
1.19	8	9
5.14	12	13
12.86	42	45
21.43	1	1
34.29	9	10
Total	93	100

Figure 1. Estimated Dietary Iron Intake for Mothers in Each Income Level
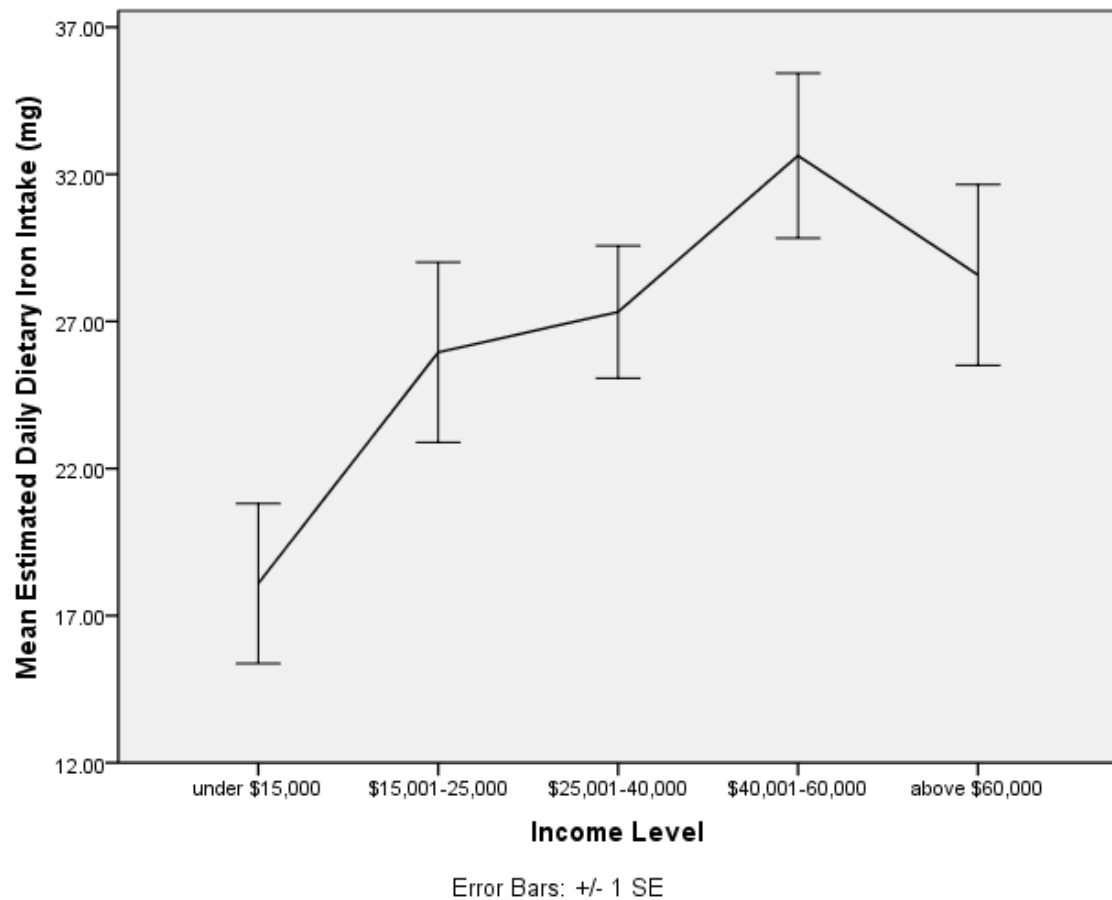

Error Bars: +/- 1 SE

Figure 1. There seemed to be a positive, relatively linear trend in estimated dietary iron intake associated with income level. However, this trend seemed to level out before arriving at the highest income level. Post-hoc pairwise comparisons utilizing a Tukey's adjustment for Type I error inflation revealed that there was only one significant difference between groups. Those in the lowest income category ($< \$15,000$ annually) had significantly lower iron intake than those grossing $40,001-$60,000 annually (Mean difference = 14.54, $p = .009$). However, no significant differences in authoritarian parenting were found across income level ($F[4,94] = 2.30$, *ns*) or between the lowest income category ($15,000 annually) and those grossing $40,001-$60,000 annually ($t[34] = 0.72$, *ns*).

Figure 2. The Interaction between Hemoglobin and Depressive Symptomology to Explain Authoritarian Parenting Style
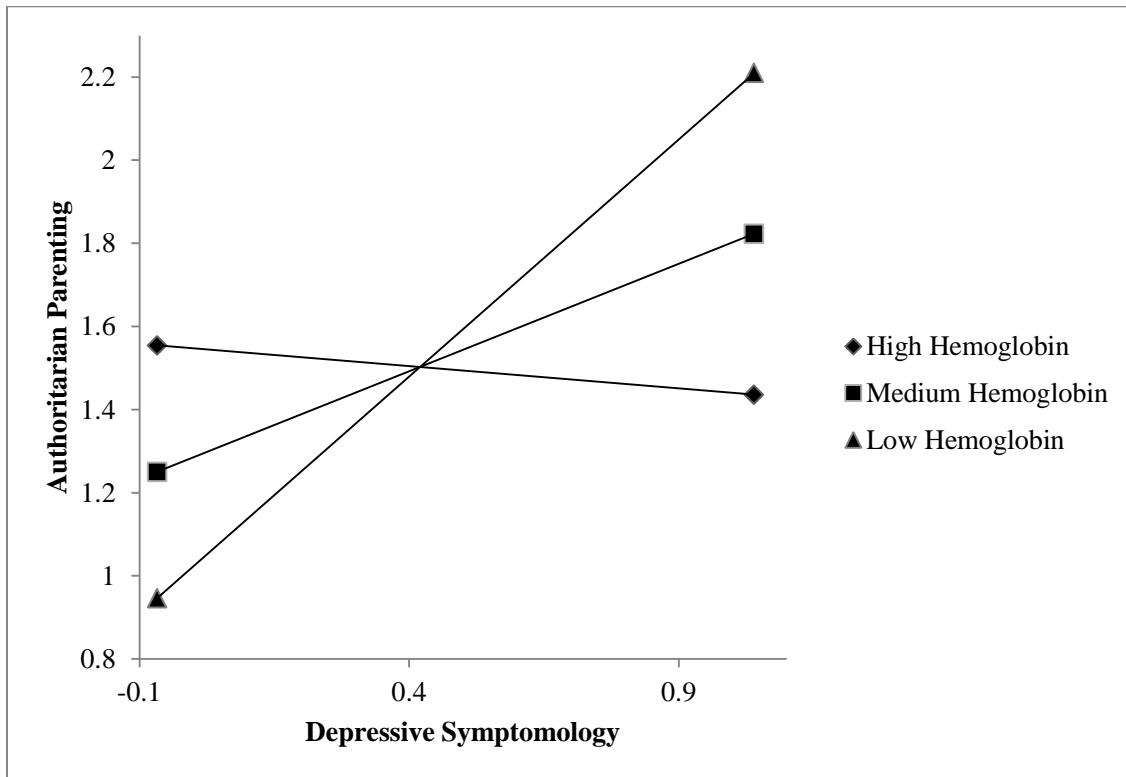

Figure 2. For those with hemoglobin levels at the mean (13.7g/dL) and at one standard deviation below the mean (12.9g/dL), the positive slope of relations between depressive symptomology and authoritarian parenting style significantly differed from 0. These relations were not significant for those with hemoglobin levels one standard deviation above the mean (14.5g/dL). Note that values in the above figure reflect analyses after each value was mean centered and do not reflect values on their original scales.

Figure 3. The Interaction between Iron Status and Depressive Symptomology to Explain
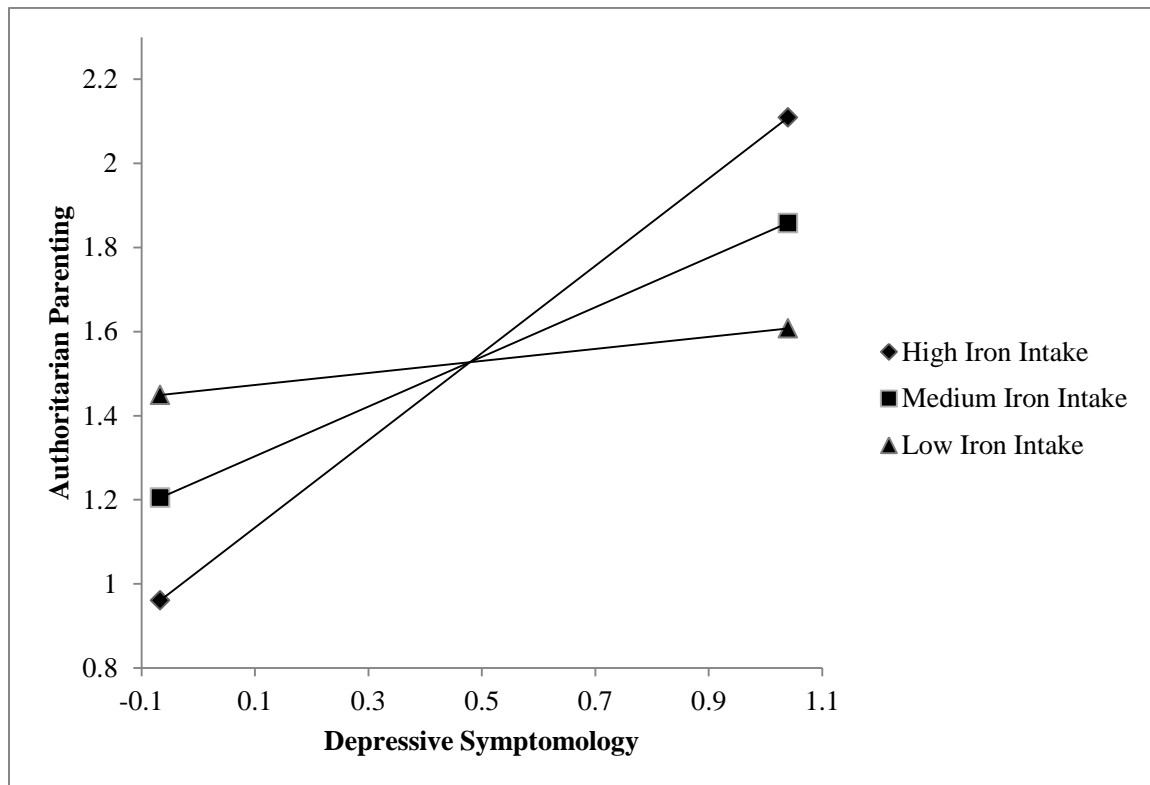
Authoritarian Parenting Style

Figure 3. For those with estimated dietary iron intake at the mean (27.24mg; simple slope

= 0.6713[0.154], t = 4.3579, p < .0001) and at one standard deviation above the mean

(39.82mg; simple slope = 0.382[0.1095], t = 3.4872, p = 0.0008), the positive slope of

relations between depressive symptomology and authoritarian parenting style

significantly differed from 0. This was not the case for those with estimated dietary iron

intake one standard deviation below the mean (14.67mg; simple slope = -0.0692[0.14], t

= -0.4942, p = 0.6223). Note that values in the above figure reflect analyses after each

value was mean centered and do not reflect values on their original scales.

Figure 4. Means Plot of Ferritin Concentration (µg/L) for each Iron Supplement Group
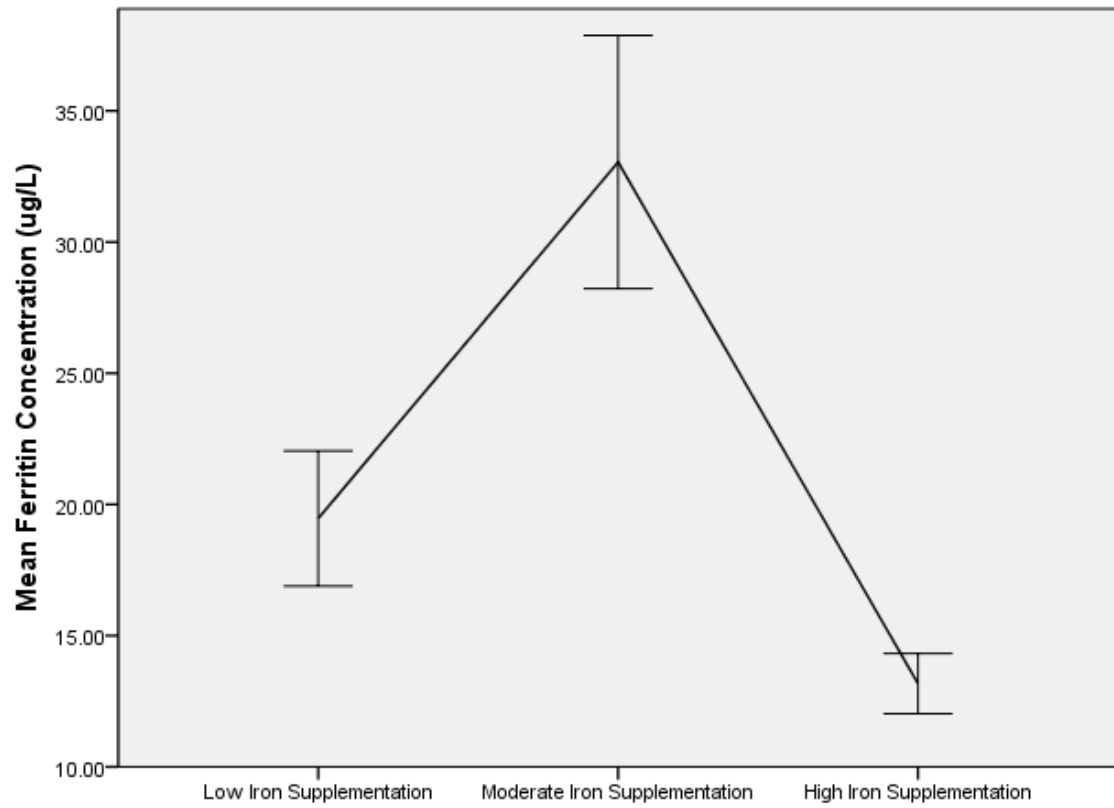
Error Bars: +/- 1 SE

Figure 4. The three iron supplementation groups ranged from 0-5.14 (low iron supplementation), 12.86-21.43 (moderate iron supplementation), and 34.29 (high iron supplementation). Those with low or high iron supplementation had lower ferritin concentrations than those with moderate iron supplementation.
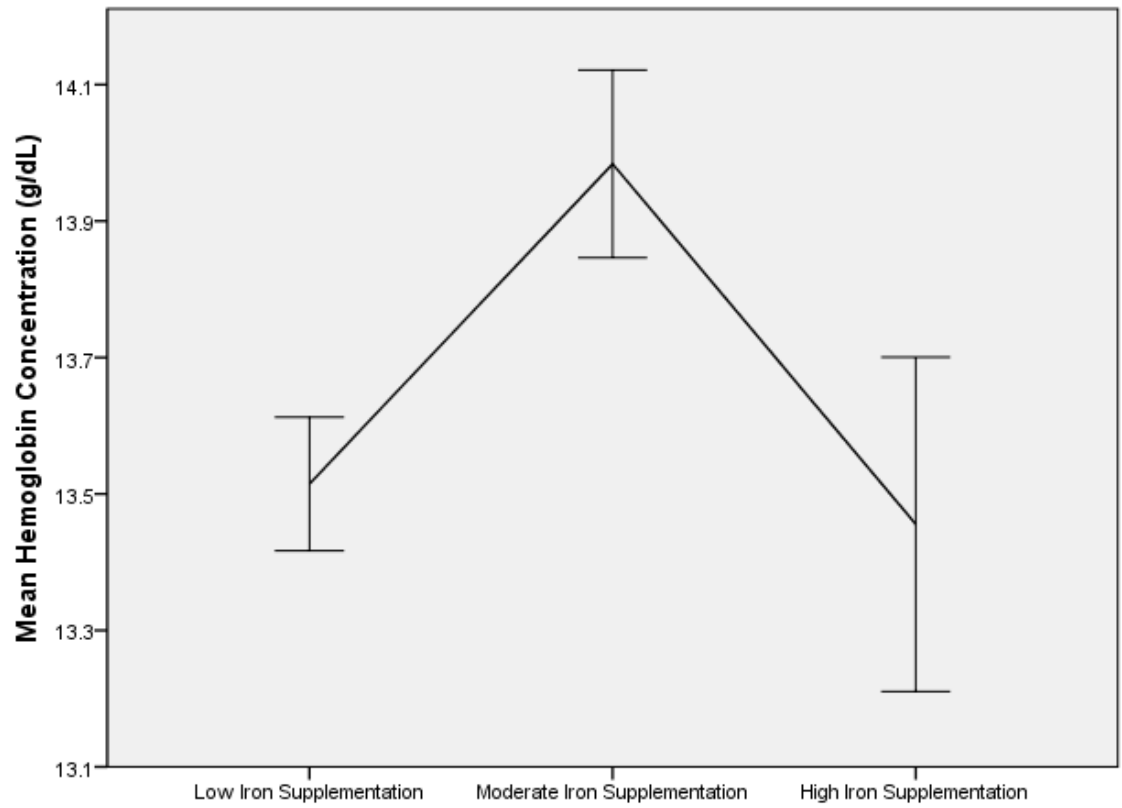
Figure 5. Means Plot of Hemoglobin Concentration (g/dL) for each Iron Supplement Group

Error Bars: +/- 1 SE

Figure 5. The three iron supplementation groups ranged from 0-5.14 (low iron supplementation), 12.86-21.43 (adequate iron supplementation), and 34.29 (high iron supplementation). Those with low or high iron supplementation had lower hemoglobin concentrations than those with adequate iron supplementation.

APPENDIX A

Full review of the literature

The following review of the literature is structured into three sections based on studies addressing the relations between maternal nutrition and affect, maternal affect and parenting, and maternal nutrition and parenting. Within these sections, the discussion begins with a broad investigation of these constructs, in order to clarify the known relations among them. Subsequently, the discussion focuses more specifically on findings related to the constructs, as they are measured within the current study (i.e., maternal iron, depressive symptomology, and permissive and authoritarian parenting styles). Lastly, the review discusses the goals, implications, and hypotheses of the current study.

Maternal Nutrition and Affect

Maternal Nutrition

Several studies have reviewed the increased micronutrient requirements for women during pregnancy and lactation, in addition to discussing negative health effects associated with poor nutritional status during pregnancy (Allen, 2005; Bendich, 2001). Included among the well-documented effects are the detrimental effects of deficiencies of vitamin B, iron, vitamin A, β-carotene, zinc, vitamin D, folic acid, and iodine. Iron and zinc deficiencies have been associated with greater risk of pre-eclampsia, general immunosupression, and preterm delivery (Allen, 2001; Bodner & Wisner, 2005; McLean et al., 1999). Folate, riboflavin, vitamin B-6, and vitamin B-12 deficiencies have been shown to be related to high plasma homocysteine concentrations, implicated as a risk factor for several negative pregnancy outcomes (e.g., placental abruption, still-birth, very low birth weight, preterm delivery, and pre-eclampsia; Allen, 2005). Vitamin B

deficiencies have also been associated with altered gene expression and resulting club-foot, spina bifida, and other neural tube defects, while vitamin D deficiencies are associated with poor fetal and infant skeletal growth and mineralization. Pregnancy also exacerbates the biochemical and physical symptoms of iodine deficiency in women.

Supplementation of these essential nutrients has been shown to decrease the prevalence of the aforementioned pregnancy and fetal difficulties. Vitamin A and β-carotene supplementatne, in particular, have been associated with a decreased rate of maternal mortality (Allen, 2005). As in pregnancy, during lactation recommended dietary allowances (RDA) are increased. For lactating women, an extra 300 calories and 30g of daily protein are proposed above and beyond pre-pregnancy RDAs (Institute of Medicine, 2006). It is also recommended that during lactation, women should consume diets that are highly nutrient dense with vitamin D, folic acid, iron, and vitamin C.

Maternal Affect

Postpartum mood disorders characterize one of the most common obstetrical difficulties. In fact, estimates of the prevalence of postpartum sub-clinical depressive symptomology have suggested approximately 50-85% of women will experience these symptoms, while about 7-20% of women will meet full diagnostic criteria for postpartum depression (PPD) within 6 months postpartum (Chen, Lan, Yang, & Juang, 2006; Miller, 2002). This is a particularly salient area of inquiry given that affective disorders like PPD are historically under-diagnosed (i.e., upwards of 50% of all cases go unrecognized; Silverman et al., 2007) and that there are negative consequences of such disorders. These may include long-term cognitive, behavioral, emotional, and social difficulties for the children of depressed mothers (Miller, 2002) in addition to an increased risk for developing depression and anxiety disorders in these children (Nomura, Wickramaratne, Warner, Mufson, & Weissman, 2002). Negative consequences may also include cognitive, marital, and interpersonal difficulties experienced by depressed mothers (McMahon, Barnett, Kowalenko, & Tennant, 2005) and an increased risk for child abuse by these mothers

(Haapasalo & Petäjä, 1999).

Relations between Maternal Nutrition and Affect

Numerous studies have supported relations between maternal nutrition and affect in different ways. For instance, some have demonstrated the alleviation of mood symptoms via nutritional supplementation (Richardson, 1993). Others have noted the correlations between nutritional deficiencies, such as iron, and mood symptoms (Beard et al., 2005; Perez et al., 2005). Still others have investigated the impact that disruptions in mood have on dietary intake and micronutrient status during pregnancy (Hurley et al., 2005). In a review of the literature regarding nutrition and depression in women of childbearing age, Bodnar and Wisner (2005) made several empirically-supported claims including: (1) Omega-3 fatty acid deficiency is a risk-factor for depression, (2) fish oil and folic acid have successfully alleviated depressive symptomology, (3) folate deficiency interrupts the efficacy of antidepressant medication, (4) folate, vitamin B-12, iron, zinc, and selenium deficiencies are more common among depressed individuals compared to their non-depressed counterparts, and (5) antioxidant consumption reduces depressive symptomology in clinical and non-clinical samples. A more recent review by Soh, Walter, Baur, and Collins (2009) presented preliminary support that supplementation with docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) may improve mood in pregnant women, but that the doses of each may impact the efficacy of this treatment.

A review of studies utilizing samples within the postpartum period (Leung & Kaplan, 2009) found similar relations between postpartum depression and the following vitamins and minerals: folate, vitamin B-12, calcium, iron, selenium, zinc, and n-3 fatty acids. Regarding iron in particular, several studies have found relations between iron deficiency and depression in the postpartum period (Beard et al., 2005; Corwin, Murray-Kolb, & Beard, 2003) using different indicators of iron status (i.e., hemoglobin, mean corpuscular volume, and transferrin saturation). Given studies supporting relations between iron and depression, several iron measures were used within the current study (i.e., ferritin, transferrin receptors, hemoglobin, and estimated daily

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dietary iron intake).

Several biochemical mechanisms have been used to explain the development of mood disorders based on nutritional deficiencies. In particular, studies (Doornbos et al., 2009; Doornbos, Fekkes, Tanke, de Jonge, and Korf, 2008; Wachs, 2009) have supported relations between nutritional deficiencies (e.g., tryptophan and vitamin B-6) and the interrupted synthesis of neurotransmitters known to directly affect depression (i.e., monoamines). Wachs (2009) further emphasized that the risk of developing depression may be exacerbated by a number of additional bioecological and psychosocial factors. A poorly nourished woman would have less energy to cope with such factors, thus accentuating her risk for developing depression or worsening existing depressive symptomology. Another recent review (Kaplan, Crawford, & Simpson, 2007) examined the biochemical mechanisms underlying relations between vitamin (vitamins B, C, D, and E) and mineral (calcium, chromium, iron, magnesium, zinc, and selenium) deficiencies and mood difficulties. The authors noted that vitamins and minerals may alter brain function and resulting mood due to their influence on enzyme/coenzyme reactions and methylation (particularly vitamin B-12 and folate) responsible for the regulation of protein synthesis, enzyme activation, and gene expression.

Collectively, studies support the influence that iron has on depressive symptomology and the use of multiple measures of iron to examine these relations. Therefore, the current study utilized both biochemical (i.e., hemoglobin, transferrin receptor, and ferritin concentrations) and estimated iron intake (Diet History Questionnaire [DHQ]) measures. The DHQ is a food frequency questionnaire developed by the National Cancer Institute (NCI; Diet History Questionnaire, Version 1.0., 2007) that is thought to be appropriate for this purpose, given that it has been used in several investigations within samples of pregnant women from Japan (Miyake, Sasaki, Tanaka, et al., 2006; Miyake, Sasaki, Yokoyama et al., 2006; Murakami et al., 2008) to examine the nutritional correlates of postpartum depression (PPD).

In addition, an empirically-supported measure of depressive symptomology, the

Symptom-Checklist-90-Revised (SCL-90-R; Groth-Marnat, 2003), was used within the current study. The differentiation of postpartum and other forms of clinical depression was not a primary purpose of the study and the only diagnostic difference between Postpartum Depression and Major Depressive Disorder, according to the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; American Psychiatric Association, 2000), is a course specifier. In other words, the differentiation between diagnoses is based on the timing of the emergence of depressive symptoms. Therefore, depression is measured broadly in the study without a differentiation of its forms. In addition to conceptual reasons for inclusion, this measure has also been used extensively in research and has demonstrated relations with depression and several nutritional variables, including: vitamin B-12, folic acid, and cholesterol, (Bovbjerg, McCann, Retzlaff, Walden, & Knopp, 1999; Mitchell, 2007).

Maternal Affect and Parenting

Parenting

The construct of parenting has been conceptualized in numerous ways throughout the research literature. For instance, some have measured parenting attitudes based on preferences for child raising practices (Adult-Adolescent Parenting Inventory–2 [AAPI-2]; Conners, Whiteside-Mansell, Deere, Ledet, & Edwards, 2006), whereas others have tried to capture parenting behavior via frequency of particular parenting practices (i.e., structured, coded self-report interview; Thompson, Raynor, Cornah, Stevenson, & Sonuga-Barke, 2002). Even highly correlated constructs have been conceptualized at different levels of breadth. For example, parenting style has been conceptualized broadly as an analysis of overarching, cross-situational tendencies related to the parent-child interaction (Parenting Styles and Dimensions Questionnaire [PSDQ]; Hart, Nelson, Robinson, Olson, & NcNeilly-Choque, 2000) or more specifically as transient, contextually-based parenting practices (Parenting Practices Questionnaire [PPQ]; Robinson, Mandleco, Olsen, & Hart, 1995). For the current study, the PSDQ was used to measure parenting style broadly based on Baumrind's (1971) trichotomy of authoritative, authoritarian,

and permissive parenting styles.

Relations between Maternal Affect and Parenting

A plethora of studies have documented relations between maternal affect and parenting (Albertsson-Karlgren et al., 2001; Anderson, Fleming, & Steiner, 1994; Berkule, 2007; Degroat, 2003; Hubbs-Tait et al., 2006; Leiferman, Ollendick, Kunkel, & Christie, 2005; Lovejoy et al., 2000; McElwain, & Volling, 1999; Self, 1998, among others). Generally, negative affect has been shown to be significantly related to more negative parenting styles like authoritarian (Rudy & Grusec, 2006) or permissive parenting styles (Drescher, 2008) and problematic care-giving behavior (Wearden, Peters, Berry, Barrowclough, & Liversidge, 2008). The PSDQ, in particular, has been used in several studies to investigate interaction effects utilizing parenting style and maternal depression variables. Topham and colleagues (2010) found that maternal depression and socioeconomic status (SES) moderated the relations between permissive parenting style and their child's obesity. In particular, for mothers with relatively more depressive symptomology, more permissive parenting was related to obesity, whereas this was not the case for mothers with relatively less depressive symptoms. Relations between permissive parenting style and child obesity were also shown to be significant for higher SES mothers, but not lower SES mothers.

Edwards (2004) also found that for mothers who believed that their children had more control than them over the parent-child interactions, lower depression scores were associated with more authoritarian parenting. However, this pattern was opposite for mothers that believed that they had more control over parent-child interactions than their children. In this case, those with greater depression scores had more authoritarian parenting styles. Edwards (2004) found that this exact same interaction existed for permissive parenting styles, while a different pattern of results was found for authoritative parenting. In this case, regardless of whom mothers thought had more control over the parent-child interactions, higher depression scores were associated with less authoritative parenting.

In addition to the use of the PSDQ, several studies have utilized subscales on the SCL-

90-R and found relations with parenting variables. One investigation (Decaluwe, Braet, Moens, & Van Vlierberghe, 2006) found that inconsistent discipline in parenting partially mediated the relation between maternal psychopathology/distress (Global Severity Index) and the child's internalizing behavior, within a sample of mothers of 10 to 16 year-old obese children. Another study by Millies (2005) found that parental care scores on the Parental Bonding Instrument (PBI) were significantly associated with somatic symptoms measured via the SCL-90-R in a sample of Asian Indian college student parents. The most consistent/robust relations have been found between depression on the SCL-90-R and parenting, including attitudes toward parenting (Anderson et al., 1994), parent-infant interactions (Albertsson-Karlgren et al., 2001), inadequate early parenting (Ashman, Dawson, Goodman, & Gotlib, 2002), negative maternal behavior in early childhood (Lovejoy et al., 2000), and dysfunctional interactions during feeding in the first three years of the child's life (Ammaniti, Cimino, D'Olimpio, Ambruzzi, & Lucarelli, 2004). Berkule (2007) also found that for mothers enrolled in a relationship-based Early Head Start program, those with greater depression at the time of enrollment demonstrated greater improvements in positive parenting **a**nd intrusiveness after the intervention.

Therefore, the PSDQ and SCL-90-R are thought to be adequate measures of the relations between affect and parenting. Given the robust associations between negative affect/depression and problematic parenting styles like authoritarian and permissive styles, this was the focus of the current study, as opposed to other maternal psychopathological variables like anxiety and positive parenting practices/styles. These studies also provide support that depression may interact with other variables in predicting parenting style.

Maternal Nutrition and Parenting

There are few studies investigating the direct link between maternal nutrition and parenting. In fact, an investigation of the literature on this topic only revealed two studies, to date. The first, conducted by Azizi-Egrari, Neumann, Bourque, Harrison, and Sigman (2004) utilized a Kenyan population of anemic mothers ($M_{Age} = 31$ years) and evaluated multiple nutritional

indicators including: (1) energy; (2) body mass index; (3) hemoglobin status; (4) and postpartum weight change. These nutritional indicators were then correlated with caregiver-child interaction variables evaluated from coded 2-hour observations investigating the following: (1) physical care (e.g. feeding, washing, putting to sleep), (2) holding/carrying, (3) touching (other than holding), (4) face-to-face contact, and (5) talking directly to the infant.

Several noteworthy patterns emerged from analyses of variance (ANOVA) including significant differences in the amount of time holding the infant based on anemia status (non-anemic mothers held babies longer) and significant differences in the amount of time looking at the infant based on weight change (mothers who gained or did not lose weight looked longer). An additional regression analysis was conducted in which the amount of time that mothers held infants was significantly predicted using the following predictors: maternal anemia status, infant birth weight, household socioeconomic status, and the amount of time that the infant's oldest sister spent holding the infant. Specifically, Azizi-Egrari and colleagues (2004) found that 36% (p < 0.01) of this parenting behavior (holding the infant) was explained by these variables and that all variables except for infant birth weight had statistically significant beta weights. In particular, the amount of time that mothers held infants was positively related to hemoglobin levels and negatively related to socioeconomic status and the amount of time that sisters spend holding the infant.

The second study directly investigating nutrition and parenting was conducted by Perez and colleagues (2005) and employed a sample of young South African mothers with full-term, normal birth weight infants. The study was a prospective, randomized, controlled trial of the effects of iron supplementation on mother-infant interactions from the time the infants were 10 weeks to 9 months of age. The three groups used included a non-anemic control, an anemic placebo control group, and an anemic iron-supplemented group. Iron supplementation took the form of 125mg $FeSO_4$ in addition to ascorbate and folate, daily. Mother-infant interactions were

assessed using the Parent/Caregiver Involvement Scale (PCIS; Perez et al., 2005) to code 20-minute videotaped sessions.

Results demonstrated differences in baseline mother-infant interactions such that both groups of anemic mothers (control and supplementation) were less responsive and more controlling of infants than non-anemic controls. Moreover, at the 9-month measurement, mothers in the anemic placebo group displayed significantly more negative interactions with their infants, fewer goal-setting behaviors, and less responsiveness than the non-anemic and anemic supplementation groups. At 9 months, the non-anemic controls and anemic supplementation groups were more similar to one another than the anemic placebo control group on all 11 scales of the PCIS (goal, negative, positive, relation, directiveness, control, teaching, play, responsive, verbal, and physical aspects of the mother-infant interaction; Perez et al., 2005). Overall, both studies provide preliminary evidence of a direct relation between iron and parenting, though neither controlled for nor examined maternal affect. Perez et al. (2005) found that mothers with worse (lower) iron status had less structured parenting style (i.e., less directive with less goal-setting), indicating that poorer iron status may be related to more permissive parenting style. The two studies combined found that poorer iron status was associated with less emotional responsiveness (i.e., less holding and engaging with infants positively) and more maternal controlling behavior of infants, suggesting that poorer iron status may also be related to more authoritarian parenting style. No studies were found investigating maternal nutrition and parenting in US samples or sample with less severe iron deficiency (i.e., non-anemic).

Integrated Model

Investigation of the extant literature revealed no studies that have directly assessed an integrated model of maternal nutrition, affect, and parenting as they have been described above. As noted previously, Wachs (2009) presented a multivariate theoretical model including these three variables to explain how nutritional deficiencies are related to the mental health of mothers and children. Within this model, he explained that insufficient nutrition may lead to depression

because of an inadequacy of biochemical precursors for monoamine neurotransmitters. Additionally, inadequate nutrition may lead mothers to have less energy to cope with other bioecological and psychosocial risk factors for depression and for women who are malnourished, maternal depression may lead to worse parenting. Wachs (2009) then noted that maternal depression may impact parenting because of the greater risk for the development of an insecure attachment between mother and child seen in depressed mothers. Beard et al. (2005) found that iron status, in particular, was related not only to affect and stress, but also to poorer cognitive functioning in mothers. They further noted that collectively these factors may negatively impact the parent-child interaction and child outcome.

Taken together, previous studies support the bivariate relations between each set of variables (i.e., maternal nutrition, affect, and parenting) and support the use of the measures within the current study. In addition, these studies suggest that nutrition and affect may interact to predict parenting style although no known studies have conducted such analyses. In particular, there may be a link between depressive symptomology and negative parenting style that is exacerbated (moderated) by poor iron status. For example, those who have poorer iron status should have positive relations between depressive symptoms and negative parenting styles, whereas these relations will not be present in those who have adequate iron status. This positive relation means that for those who have lower iron status, greater depression will be related to greater authoritarian and permissive parenting styles. This may be because these mothers will have decreased energy and strength to inhibit their negative thoughts and emotions, which contribute to more negative parenting styles, which are manifested as insufficient emotional support/nurturing (authoritarian) or discipline/structure (permissive) in the parent-child relationship.

Given the greater nutritional requirements for women during pregnancy and lactation and increased risk for the development of mood disorders during the postpartum period, the current study utilized women at 3 months postpartum to clarify the unique and important relations among

these variables. In addition to preliminary studies supporting the integrated model, the significant

theoretical and practical implications of the results justify the importance of the current study for

two reasons. Support of the hypothesized moderator model (i.e., iron status moderates the

positive link between depressive symptomology and negative parenting style) would indicate that

future research investigating relations between maternal nutrition and parenting should consider

the effects of maternal affect. This may result in clearer or more robust findings among these

variables, which will inform the assessment and treatment of clinical disorders such as

postpartum depression (PPD) and the negative and long-lasting effects that poor parenting

practices related to these conditions may have. This is especially important given that PPD is

commonly underdiagnosed and has far-reaching and long-lasting effects, as described previously.

Overall, this is a historically understudied but extremely important area of study with

considerable theoretical, clinical, practical, and social implications. Therefore, the current study

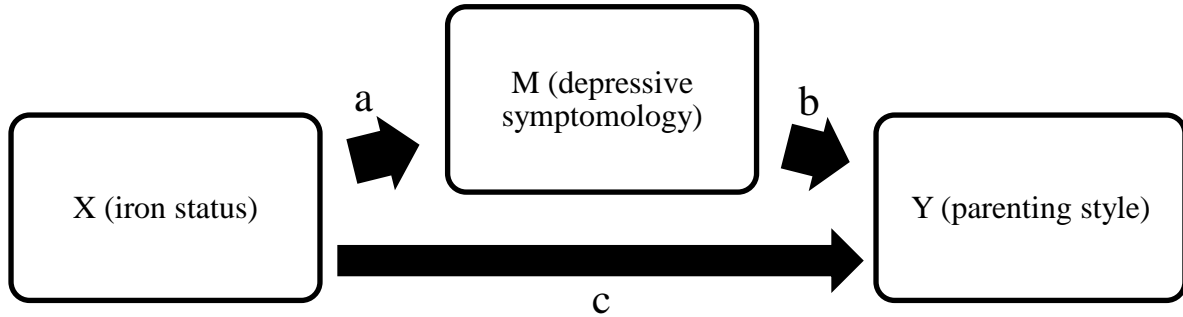includes the following hypotheses:

Hypotheses

1. Maternal depressive symptomology will be related to authoritarian parenting style, as
   suggested by Rudy and Grusec (2006) and others. However, maternal iron variables
   (hemoglobin, transferrin receptors, ferritin, and iron intake) will moderate this relation, given
   that the effects of depression on parenting style should be more pronounced in those with
   poorer iron status (Wachs, 2009). Specifically, only mothers who have poorer iron status will
   show positive relations between depressive symptomology and authoritarian parenting style.

2. For the same reasons presented in hypothesis #1, maternal iron variables will moderate the
   relation between depressive symptomology and permissive parenting style (Drescher, 2008).
   Only mothers who have poorer iron status will have positive relations between depressive
   symptomology and permissive parenting style.

Mediator analyses

Baron and Kenney (1986) developed a 4-step procedure to test for mediation using the

following model (with current study variables of interest):

This includes the following steps: (1) test path c by regressing Y on X, (2) test path a by

regressing M on X, (3) test path b by regressing Y on X and M, and (4) for complete

mediation, the effect of X on Y, after controlling for M (path c') should be zero.

Baron and Kenny's 4-step procedure			
X	M	Y	Step 1
Hemoglobin	Depressive Symptomology	Authoritarian Parenting	$F(1,98) = .005, p = .942$
Transferrin Receptors	Depressive Symptomology	Authoritarian Parenting	$F(1,90) = .022, p = .881$
Ferritin	Depressive Symptomology	Authoritarian Parenting	$F(1,75) = .066, p = .798$
Hemoglobin	Depressive Symptomology	Permissive Parenting	$F(1,98) = .044, p = .834$
Transferrin Receptors	Depressive Symptomology	Permissive Parenting	$F(1,90) = .280, p = .598$
Ferritin	Depressive Symptomology	Permissive Parenting	$F(1,75) = .018, p = .893$

Consent form

CONSENT FORM & PARENT PERMISSION

Project Title: Maternal Dietary Nutrients and Neurotoxins in Infant Cognitive Development

What is the purpose of this project and why am I being asked to participate?

To study how iron, zinc, lead, and cadmium in the diets of breast-fed babies affect how they develop mentally (intellectually) in the first months of life. The project is funded by the United States Department of Agriculture. You are being asked to participate because you indicated (a) that you primarily breast-feed your baby, and (b) that you are interested in learning more about the study. ("Primarily breast-fed infants" are infants who are fed no more than 28 oz. of formula/week.)

Who is responsible for it?

This project is conducted by David G. Thomas, Ph.D., Professor in the Department of Psychology and Tay S. Kennedy, Ph.D., Associate Professor in the Department of Nutritional Sciences at OSU. There are also graduate and undergraduate students from both departments working on this project whom you will be meeting along the way. This project is approved by the Institutional Review Board at OSU.

What type of information is being collected and what will I be asked to do?

We will collect three types of information from you and your baby:

1. Questionnaire information about your family, including demographic information; parenting stress, attitudes, and style; your prenatal care; your affect or mood; and you and your baby's diets.
2. A sample of milk and a sample of blood from you (not from your baby) when your baby is 3 months of age.
3. Measures of your baby's physical growth and mental development taken when he/she is 3, 6, and 9 months old.

All of these will be described in later sections.

How long will each visit take?

We will ask you to bring your baby to the lab at OSU at a time when she/he has had a recent nap and will be alert. We will first do the mental development testing with your baby. After that is finished, we will do the weighing and measuring and have you complete forms related to your nutrition and feelings. In addition, at the 3-month visit we will then weigh you, ask for a breast milk sample, take the blood sample at the University Health Center and have you fill out several additional questionnaires regarding parenting, nutrition, and your feelings. See the table at the end of this document for estimated times for each procedure.

What about my privacy and confidentiality?

The records of this study will be kept private. Any written results will discuss group findings and will not include information that will identify you or your child. Research records will be stored securely and only researchers and individuals responsible for research oversight will have access to the records. It is possible that the consent process and data collection will be observed by research oversight staff responsible for safeguarding the rights and wellbeing of people who participate in research.

Computerized data will be maintained on a computer accessible only to researchers and this computer, along with all others records and videotapes, will be kept in a locked room in Dr. Thomas' laboratory at OSU. In addition, your names will only appear on this consent form and on a master list which will also be kept locked in Dr. Thomas' laboratory. All other records, including videotapes of your baby, will be identified only with a code number, and information that connects code numbers with names will be kept only on the master list. We are required to keep our records for 5 years after we publish our findings, but after that they will be destroyed (including videotapes).

What are the benefits of participating?

You will be paid $90 for your participation to help defer the costs of traveling to OSU. You will receive $40 for the 3-month visit, and $25 each for the 6- and 9-month visits. You will only be paid for those visits that you actually make. If you are taking a class at OSU that offers research credit, you will receive 1 credit for each hour of participation (½ credits for each ½ hour or less). In addition, Dr. Kennedy is a registered dietitian and will provide feedback to you regarding your diet based on the Diet History Questionnaire as well as any other concerns that you might have.

Your participation will also help us to better understand the role of iron, zinc, lead, and cadmium in infant development. Iron deficiency is associated with developmental delays in a number of psychological domains, particularly cognitive development. Unfortunately, despite our wealth, many children in the United States suffer from iron deficiency. Less is known about zinc deficiency and virtually nothing is known about how these two trace metals interact with each other and with the lead and cadmium.

What are the alternatives to participating?

The alternative is to not participate. Your participation is entirely voluntary. There is no penalty for choosing to not participate and you will not lose any rights, privileges, medical care, etc. if you choose not to participate. If you are eligible for research credit in a course due to your participation, the instructor of that course will make optional comparable activities available. You may choose to not participate now, or at any time during your participation, and you are free to withdraw your consent at any time during the study.

What if I have other questions or concerns about my participation?

If you have any questions or need to report an effect from the research procedures, you may contact David G. Thomas, Ph.D. at (405) 744-7078 (david.thomas@okstate.edu), or Tay S. Kennedy, Ph.D. at (405) 744-5965

(tay.kennedy@okstate.edu). If you have questions about your rights as a research volunteer, you may contact Dr. Shelia Kennison, IRB Chair, 219 Cordell North, Stillwater, OK 74078, 405-744-3377 or irb@okstate.edu.

SUMMARY OF TESTS AND MEASUREMENTS AND ESTIMATED TIMES

Mother's tests and measurements: All when baby is 3 months of age	
Test	Estimated time
Weight	5 min
Blood sample	20-40 min
Milk sample	5-10 min
Demographic Information Questionnaire	5 min
Parenting Stress Index	5 min
Adult-Adolescent Parenting Inventory	5 min
Pregnancy Risk Assessment Questionnaire	5 min
Diet History Questionnaire	50 min (can be done at home)
Parenting Styles and Dimensions Questionnaire	10 min
Symptom Checklist-90-Revised	12-15 min
Positive and Negative Affect Scale	5 min
Additional mood onset and nutrition questions	10 min
24-hour food record (of infant's diet)	15 min over a 24 hour period; done at home
	TOTAL TIME = approx. 2.5-3 hours
Infant's tests and measurements: Done at 3, 6, and 9 months	
Brain wave recording	30-60 min
Visual Information Processing & Attention	30-60 min
Positive and Negative Affect Scale	5 min
Additional nutrition questions	5 min
Weight, length, etc.	5 min
	TOTAL TIME = approx. 1.25-2.25 hours

MOTHERS' PROCEDURES & CONSENT

What tests and measurements will I participate in?

a. Weight at initial visit when the baby is 3 months old.
b. Blood sample at 3-month visit (taken at the OSU Student Health Center after an overnight fast) will be assessed for iron, zinc, lead and cadmium and two measures of immune response.
c. Milk sample at 3-month visit.

d. Demographic Information Questionnaire at 3-month visit. This questionnaire contains questions about household income, family education, etc.
e. Parenting Stress Index at 3-month visit. This questionnaire measures stress associated with your role as a parent.
f. Adult-Adolescent Parenting Inventory at 3-month visit. This questionnaire measures your attitudes and beliefs about being a parent.
g. Pregnancy Risk Assessment Questionnaire at 3-month visit. We will use parts of this questionnaire developed by the Centers for Disease Control to help assess some of the risk factors that may have occurred during your pregnancy.
h. Parenting Styles and Dimensions Questionnaire at 3 month visit. This measure will be used to assess parenting style.
i. Symptom Checklist-90-Revised at the 3 month visit. This measure will be used to assess aspects of your affective style. In other words, it will be measuring your characteristic mood.
j. Positive and Negative Affect Scale at the 3, 6, and 9 month visits. This measure will assess your recent mood/emotions.
k. Additional affective and nutrition questions at 3 month visit. The 3 affective questions will ask about the onset of mood disturbances. More specifically, you will be asked whether your mood symptoms emerged before, during, or after pregnancy. The 9 nutrition questions will ask about foods that your baby has eaten since they were 6 and 9 months of age, if not exclusively breastfed.
l. Diet History Questionnaire at 3 months of age (done at home or on the internet). This will allow us to better understand your nutritional health over the last year.
m. 24-hour food record at 3 months of age (done at home). To determine how much your baby is eating, we will ask you to weigh your baby before and after each feeding for 24 hours. We will give you a form to record the weights and any other food the baby eats. We will give you a scale to weigh the baby and show you how to use it and come to your house to pick it up when the 24 hours is over.

What are the risks to me of participating in this project?

The risks associated with our procedures are similar to those risks associated with routine physical exams or psychological tests.

- Some mothers may experience some discomfort when responding to sensitive questions about family income or aspects of prenatal care and behavior.
- The sampling of blood from you will cause momentary discomfort and possibly some bruising. However, the procedure will be done by a certified phlebotomist, someone who is trained to draw blood, from the University Student Health Center.

STATEMENT OF VOLUNTARY PARTICIPATION

I understand that participation is voluntary and that I will not be penalized if I choose not to participate. I also understand that I am free to withdraw my consent at any time and end my participation in this project without penalty.

SIGNATURES
I have read and fully understand the consent form. I have had a chance to ask questions about the study and my questions have been answered to my satisfaction. I sign this form freely and voluntarily. A copy of this form has been given to me.

Date: _____/_____/_____   Time: _____:_____ am/pm

_____   _____

       Name (please print)   Signature

"I certify that I have personally explained all elements of this form to the participant before requesting the participant to sign it."

Signed: _____

       Project director or authorized representative

<div align="center">INFANTS' PROCEDURES AND MOTHERS' PERMISSION</div>

What tests and measurements will my baby participate in?
- Brain wave recording. We will measure how your baby is developing by looking at how his/her brainwave patterns respond to simple sounds. We will present 100 tones over headphones (specially designed for babies) that your baby will be wearing while she/he is resting in your arms and nursing. The brain waves will be recorded through tin leads sewn into a soft elastic cap. Other recording leads will be attached to the baby's ear lobes and placed above and to the side of one eye. Before attaching the leads we will clean the area with alcohol on a cotton swab. The recording leads by the eyes are applied with a small amount of gel and held down with a piece of paper tape. The recording leads only to measure the tiny electrical signals produced by the infant's brain; NO electricity passes through them. *Sometimes babies can get fussy when we put on the elastic cap. We will treat your baby with care and sensitivity, but if you feel that he/she is getting upset, you may stop the procedures at any time.*
- Visual Information Processing. The second measure of your infant's development is to show him/her a picture of a face on a computer screen and then to show that face along with a new one. Infants will view these faces while sitting in a darkened room in a car seat (with you sitting directly behind). During this test, we will record the baby on videotape to see where the baby is looking.

- Attention. The third way to measure your infant's development is to by recording his/her heart rate while he/she is doing the Visual Information Processing test. To measure heart rate, we will use 3 recording leads placed in a triangle on the infant's chest and stomach. Like with the brain wave test, we will first clean each area with an alcohol swab and apply the lead with gel and a small piece of paper tape.
- Weight, length, head circumference and upper arm circumference. We will measure your baby's weight and length while he/she is wearing a dry diaper and tee-shirt. We will also measure the circumference of your baby's head and upper arm with a measuring tape

What are the risks to my baby of participating in this project?

The risks associated with our procedures are similar to those risks associated with routine physical exams or psychological tests.
- As described above, some infants might be upset because they dislike the placement of the elastic cap used for the brain wave test.
- Although the gel used to place the EEG and HR recording leads is hypoallergenic, there is a remote possibility that your baby could experience a mild allergic reaction to the gel.

STATEMENT OF VOLUNTARY PERMISSION

I have read and fully understand the consent form. As parent or guardian I authorize
_____ (print name) to participate in the described research. I also understand that I am free to withdraw my permission at any time and end my child's participation in this project without penalty.

_____
Parent/Guardian Name (printed)

_____   _____
Signature of Parent/Guardian   Date

"I certify that I have personally explained all elements of this form to the participant before requesting the participant to sign it."
Signed: _____

    Project director or authorized representative

Institutional Review Board approval

Oklahoma State University Institutional Review Board

Date: Tuesday, December 11, 2007

IRB Application No AS0783

Proposal Title: Maternal Dietary Nutrients and Neurotoxins in Infant Cognitive Development

Reviewed and Processed as: Expedited (Spec Pop)

Status Recommended by Reviewer(s): Approved   Protocol Expires: 12/10/2008

Principal Investigator(s

David Thomas   Tay Seacord Kennedy
215 N. Murray   312 HES
Stillwater, OK 74078   Stillwater, OK 74078

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in section 45 CFR 46.

☒ The final versions of any printed recruitment, consent and assent documents bearing the IRB approval stamp are attached to this letter. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be submitted with the appropriate signatures for IRB approval.
2. Submit a request for continuation if the study extends beyond the approval period of one calendar year. This continuation must receive IRB review and approval before the research can continue.
3. Report any adverse events to the IRB Chair promptly. Adverse events are those which are unanticipated and impact the subjects during the course of this research; and
4. Notify the IRB office in writing when your research project is complete.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact Beth McTernan in 219 Cordell North (phone: 405-744-5700, beth.mcternan@okstate.edu).

Sincerely,

Sue C. Jacobs, Chair
Institutional Review Board

Parenting Styles and Dimensions Questionnaire (PSDQ)

REMEMBER: Rate how often you exhibit this behavior with your child.

I EXHIBIT THIS BEHAVIOR:
1 = Never
2 = Once In Awhile
3 = About Half of the Time
4 = Very Often
5 = Always

__ 1.   I am responsive to my child's feelings and needs.
__ 2.   I use physical punishment as a way of disciplining my child.
__ 3.   I take my child's desires into account before asking the child to do something.
__ 4.   When my child asks why he/she has to conform, I state: because I said so, or I am your parent and I want you to.
__ 5.   I explain to my child how I feel about the child's good and bad behavior.
__ 6.   I spank when my child is disobedient.
__ 7.   I encourage my child to talk about his/her troubles.
__ 8.   I find it difficult to discipline my child.
__ 9.   I encourage my child to freely express himself/herself even when disagreeing with parents.
__ 10.   I punish by taking privileges away from my child with little if any explanations.
__ 11.   I emphasize the reasons for rules.
__ 12.   I give comfort and understanding when my child is upset.
__ 13.   I yell or shout when my child misbehaves.
__ 14.   I give praise when my child is good.
__ 15.   I give into my child when the child causes a commotion about something.
__ 16.   I explode in anger towards my child.
__ 17.   I threaten my child with punishment more often than actually giving it.
__ 18.   I take into account my child's preferences in making plans for the family.
__ 19.   I grab my child when being disobedient.
__ 20.   I state punishments to my child and do not actually do them.
__ 21.   I show respect for my child's opinions by encouraging my child to express them.
__ 22.   I allow my child to give input into family rules.
__ 23.   I scold and criticize to make my child improve.
__ 24.   I spoil my child.
__ 25.   I give my child reasons why rules should be obeyed.
__ 26.   I use threats as punishment with little or no justification.
__ 27.   I have warm and intimate times together with my child.
__ 28.   I punish by putting my child off somewhere alone with little if any explanations.
__ 29.   I help my child to understand the impact of behavior by encouraging my child to talk about the consequences of his/her own actions.
__ 30.   I scold or criticize when my child's behavior doesn't meet my expectations.
__ 31.   I explain the consequences of the child's behavior.
__ 32.   I slap my child when the child misbehaves.

Symptom Checklist-90-Revised (SCL-90-R)

INSTRUCTIONS:

The SCL-90-R test consists of a list of problems people sometimes have. Read each one carefully and write the number of the response that best describes HOW MUCH THAT PROBLEM HAS DISTRESSED OR BOTHERED YOU DURING THE PAST 7 DAYS INCLUDING TODAY. Write only one number for each problem (0 1 2 3 4). Do not skip any items. If you change your mind, draw an X through your original answer and then circle your new answer (0 1 2 3 4).Read the example before you begin. If you have any questions, please ask them now.

0 = Not at all
1 = A little bit
2 = Moderately
3 = Quite a bit
4 = Extremely

How much were you distressed by:

1. Headaches
2. Nervousness or shakiness inside
3. Repeated unpleasant thoughts that won't leave your mind
4. Faintness or dizziness
5. Loss of sexual interest or pleasure
6. Feeling critical of others
7. The idea that someone else can control your thoughts
8. Feeling others are to blame for most of your troubles
9. Trouble remembering things
10. Worried about sloppiness or carelessness
11. Feeling easily annoyed or irritated
12. Pains in heart or chest
13. Feeling afraid in open spaces or on the streets
14. Feeling low in energy or slowed down
15. Thoughts of ending your life
16. Hearing voices that other people do not hear
17. Trembling
18. Feeling that most people cannot be trusted
19. Poor appetite
20. Crying easily
21. Feeling shy or uneasy with the opposite sex
22. Feelings of being trapped or caught
23. Suddenly scared for no reason
24. Temper outbursts that you could not control
25. Feeling afraid to go out of your house alone

26. Blaming yourself for things
27. Pains in lower back
28. Feeling blocked in getting things done
29. Feeling lonely
30. Feeling blue
31. Worrying too much about things
32. Feeling no interest in things
33. Feeling fearful
34. Your feelings being easily hurt
35. Other people being aware of your private thoughts
36. Feeling others do not understand you or are unsympathetic
37. Feeling that people are unfriendly or dislike you
38. Having to do things very slowly to insure correctness
39. Heart pounding or racing
40. Nausea or upset stomach
41. Feeling inferior to others
42. Soreness of your muscles
43. Feeling that you are watched or talked about by others
44. Trouble falling asleep
45. Having to check and double-check what you do
46. Difficulty making decisions
47. Feeling afraid to travel on buses, subways, or trains
48. Trouble getting your breath
49. Hot or cold spells
50. Having to avoid certain things, places, or activities because they frighten you
51. Your mind going blank
52. Numbness or tingling in parts of your body
53. A lump in your throat
54. Feeling hopeless about the future
55. Trouble concentrating
56. Feeling weak in parts of your body
57. Feeling tense or keyed up
58. Heavy feelings in your arms or legs
59. Thoughts of death or dying
60. Overeating
61. Feeling uneasy when people are watching or talking about you
62. Having thoughts that are not your own
63. Having urges to beat, injure, or harm someone
64. Awakening in the early morning
65. Having to repeat the same actions such as touching, counting, or washing
66. Sleep that is restless or disturbed
67. Having urges to break or smash things
68. Having ideas or beliefs that others do not share
69. Feeling very self-conscious with others
70. Feeling uneasy in crowds, such as shopping or at a movie
71. Feeling everything is an effort

72. Spells of terror or panic
73. Feeling uncomfortable about eating or drinking in public
74. Getting into frequent arguments
75. Feeling nervous when you are left alone
76. Others not giving you proper credit for your achievements
77. Feeling lonely even when you are with people
78. Feeling so restless you couldn't sit still
79. Feelings of worthlessness
80. The feeling that something bad is going to happen to you
81. Shouting or throwing things
82. Feeling afraid you will faint in public
83. Feeling that people will take advantage of you if you let them
84. Having thoughts about sex that bother you a lot
85. The idea that you should be punished for your sins
86. Thoughts and images of a frightening nature
87. The idea that something serious is wrong with your body
88. Never feeling close to another person
89. Feelings of guilt
90. The idea that something is wrong with your mind

VITA

Nicki Lynn Aubuchon-Endsley

Candidate for the Degree of

Doctor of Philosophy/Education

Thesis: INTERACTIVE EFFECTS OF MATERNAL AFFECT AND NUTRITION ON PARENTING

Major Field: Psychology

Biographical:

Education:

Completed the requirements for the Doctor of Philosophy in Psychology at Oklahoma State University, Stillwater, Oklahoma in July, 2012.

Completed the requirements for the Master of Science in Psychology at Oklahoma State University, Stillwater, Oklahoma in July 2007.

Completed the requirements for the Bachelor of Science in Psychology and Biology at the University of Denver, Denver, Colorado in 2006.

Experience:

Research Associate, Nutrition and Development Project
Principal Investigator, Robert Clark Behavioral Health Center
Research Associate, Developmental Psychophysiology Research Laboratory
Research Assistant, Center for Applied Clinical Research
Research Assistant, Neuropharmacology Lab
Research Assistant, Cognitive Neuroscience Lab
Research Partner, Plant Evolution and Biodiversity Lab

Professional Memberships:

Society for Psychophysiological Research
Experimental Biology
Oklahoma Network for the Teaching of Psychology
Society for Research in Child Development
American Psychological Association, Division 12-Clinical Psychology
Oklahoma Psychological Association Student Society
Southwestern Psychological Association

Name: Nicki Lynn Aubuchon-Endsley   Date of Degree: July, 2012

Institution: Oklahoma State University   Location: Stillwater, Oklahoma

Title of Study: INTERACTIVE EFFECTS OF MATERNAL AFFECT AND
                NUTRITION ON PARENTING

Pages in Study: 78   Candidate for the Degree of Doctor of Philosophy

Major Field: Psychology

Scope and Method of Study:
    Studies have supported relations between maternal nutrition and affect and
    relations between maternal affect and parenting, but few have investigated direct
    relations between nutrition and parenting. Models linking all three variables are
    also underdeveloped. Existing literature suggests that iron status/intake and
    depressive symptomology may interact to predict negative parenting styles like
    authoritarian and permissive parenting though no known studies have tested this
    hypothesis. Therefore, the current study investigated these interaction effects in
    addition to alternative mediating models. A sample of mothers ($n = 105$) at 3
    months postpartum were utilized given that they have increased micronutrient
    requirements and are at greater risk for the development of mood disorders.
    Participants completed questionnaires regarding their dietary iron intake,
    parenting styles/attitudes, and affect. Biochemical measures of maternal iron
    status (i.e., hemoglobin, soluble transferrin receptor, and serum ferritin
    concentrations) were assessed from intravenous blood samples.

Findings and Conclusions:
    There were significant interactions between both iron status and intake and
    depressive symptomology in predicting authoritarian parenting style. For those
    with hemoglobin below 14.0g/dL, depressive symptomology was positively
    related to authoritarian parenting style. For those with estimated daily dietary iron
    intake above 20.90mg, those with more depressive symptomology had more
    authoritarian parenting style. The latter finding is thought to be due to the mothers
    taking large doses of supplementation perhaps to treat poor iron status (i.e., low
    hemoglobin and ferritin). Because relations were found within well-nourished
    women, standards for iron deficiency may need to be re-conceptualized in
    lactating women. Screening for poor iron status and depressive symptomology in
    postpartum women may help to identify those at risk for problematic parenting.
    Dietary interventions may help to eliminate relations between depression and
    parenting. Differences in relations between iron status and intake should also be
    considered in future studies. Additional studies are needed to replicate current
    study findings and explore underlying mechanisms that account for interactions.

ADVISER'S APPROVAL: Dr. David G. Thomas