RELATION BETWEEN MATERNAL ANTHROPOMETRY AND INFANT VISUAL RECOGNITION MEMORY IN SOUTHERN ETHIOPIA

By

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CHAPTER I

INTRODUCTION

Maternal anthropometric measures, namely height, weight, and body mass index (BMI), are indicators of maternal nutritional status. Nutrition during pregnancy and during lactation influences nutritional status of the infant. Low maternal nutritional status results in an insufficient amount of nutrients provided to the fetus and to the newborn/infant in breast milk and therefore insufficient infant nutrient intake. Many nutrients are important for cognitive development, thus infants with insufficient intake of these nutrients are at risk for cognitive delay.

Ethiopia is one of the poorest countries in the world, where 35% of the population is undernourished (UN World Food Programme, 2003). The situation is especially critical for children. Ethiopia ranks 6th in the world in number of child deaths with diarrhea, pneumonia, and neonatal disorders being the major causes of death. Underweight and nutritional deficiencies are the underlying causes of these deaths as they can lead to a compromised immune system (Black, Morris, & Bryce, 2003). Forty-seven percent of Ethiopian children under five are underweight, 11% suffer from wasting, and 52% are stunted (UNICEF, 2004). These children become parents of a new generation but still suffer from consequences of early malnutrition. A recent study conducted in Ethiopia reports the average height of Ethiopian women to be 7 cm less than the average height of

North American women (Abebe, Kennedy, & Gates, submitted). Low height indicates long-term malnutrition (WHO Working Group, 1986).

The purpose of this study is to investigate the influence of anthropometric measures of Ethiopian mothers, that represent maternal nutritional status, on the cognitive development of their infants. Maternal anthropometry can be easily assessed by measuring height and weight and calculating BMI (WHO Expert Committee, 1995). To assess infant cognitive development, the Institute of Medicine (2004) recommends using tests that assess specific cognitive dimensions as opposed to global cognitive assessments. One of the recommended methods is testing of visual recognition memory. Visual recognition memory emerges early in infancy and predicts cognitive abilities in later life, e.g. Intelligence Quotient (IQ), language, vocabulary, and memory. It also relates to processing speed and attention. Infant visual recognition memory exhibits modest reliability and good discriminant and predictive validity (Rose, Feldman, & Jankowski, 2004).

Research question:

Can maternal anthropometric measures, namely height, weight, and BMI, be used as predictors of infant visual recognition memory?

Objective:

To investigate relations between infant visual recognition memory and maternal anthropometric measures

Hypotheses:

- Infant anthropometry is correlated with maternal anthropometry.
- Infants' ability to complete the visual recognition memory procedure will differ by maternal anthropometry.
- Visual recognition memory variables are significantly correlated with maternal anthropometry.
- Infants whose mothers have BMI<19 and /or weight and height z-scores<-2 will have poorer performance in the visual recognition memory procedure than infants whose mothers have better anthropometry.
- Maternal anthropometry will predict infant performance in the visual recognition memory procedure.

Assumptions:

- Infants participating in the study are breastfed.
- Infants were born at term.
- Infants' birth dates are accurate.
- Mothers are healthy.

Limitations:

- This is a descriptive study, therefore relations but not cause and effect between maternal anthropometry and infant visual recognition memory variables can be observed.

- This study involves a convenience sample, therefore the results are not generalizable.
- Other factors that may influence maternal anthropometry, except nutritional status, were not taken into account.
- Maternal socioeconomic status, education, and interaction with infant, all of which are important contributors to infant development, were not investigated.

Definitions of terms:

Infant visual recognition memory:

A type of memory that emerges in early infancy and is related to processing speed and attention (Rose et al., 2004)

Maternal anthropometric measures:

Height, weight, body mass index

Infant visual recognition memory variables:

- *Variables established from coding of visual recognition memory testing*

  number of looks to each side, number of shifts, duration of each look, total looking time
- *Other variables calculated from the coded variables*

  mean familiarization time, duration of the longest look during familiarization, mean duration of each look during familiarization, shift rate during familiarization, mean duration of each look during test phases, shift rate during test phases, and novelty quotient

CHAPTER II

REVIEW OF LITERATURE

The first section of this literature review presents information about the fetal origins hypothesis in order to provide a rationale for exploring the relation between maternal anthropometry and infant cognitive development. The next section summarizes studies investigating relations between maternal anthropometry and infant psychological development. Infant visual recognition memory, which is a method of cognitive development testing that was employed in research presented in this thesis, is discussed in the third section of this review.

The fetal origins hypothesis

Overview

The fetal origins hypothesis, also known as the fetal programming hypothesis, was proposed by Barker (1994). This hypothesis states that there is relationship between the environment in utero a child is exposed to and disease in later life. Barker (1995) analyzed data of low birth weight babies born in England in early 1900s; he compared their anthropometric data from the time of birth and early infancy and health data from later life. The statistical analysis demonstrated correlation between the conditions observed at the time of birth and early infancy and chronic disease in later life:

For instance, weight at one year of age was correlated with coronary heart disease mortality and birthweight was correlated with the incidence of type 2 diabetes. When there is insufficient energy available to support growth and development of the fetus, the fetus adapts with permanent physiological changes that increase risk for chronic disease in later life [as Lucas (1991) puts it, the fetus is "programmed" for chronic disease in later life]. Associations similar to the study of Baker (1995) were found in other epidemiological studies investigating cardiovascular disease (Leon, Johansson, & Rasmussen, 2000; Rich-Edwards et al., 1997) and diabetes (Hales et al., 1991; Ravelli et al., 1998).

Developing countries

The fetal origins hypothesis is of importance in developing countries that have increased rates of malnutrition (Moore, 1998). More than 20 million babies are born with low birth weight worldwide, 95.6% of which are in developing countries (UNICEF and WHO, 2004). There are several factors that may influence the low birthweight, but maternal malnutrition seems to be the key factor (Moore, 1998). Several studies conducted in developing countries support the fetal origins hypothesis. Studies performed in Jamaica report childhood blood pressure inversely related to birth weight (Forrester et al., 1996), childhood glycemic control and serum cholesterol related to short birth length (Forrester et al., 1996), and lower maternal nutritional status during pregnancy related to childhood hypertension (Godfrey et al., 1994). Studies conducted in India indicate an inverse relation of birth weight and plasma glucose and insulin in childhood (Yajnik et al., 1995) and association of low weight, short length, and small head circumference at

birth with increased prevalence of coronary heart disease in adulthood (Stein, Fall, Kumaran, Osmond, Cox, & Barker, 1996). In a Gambian study (Margetts, Rowland, Foord, Cruddas, Cole, & Barker, 1991), maternal weight at 7.5 months of pregnancy was associated positively with child systolic blood pressure at 1-7 years.

Studies investigating the fetal origins hypothesis, conducted in both developed and developing countries, suggest that prenatal nutrition affects postnatal life and development. Given that maternal anthropometric measures are indicators of maternal and prenatal nutritional status, it is reasonable to explore the relation between maternal anthropometry and infant cognitive development. We were not able to identify any research investigating this relationship.

Maternal anthropometry & child psychological development

Maternal anthropometry has been investigated in association with factors such as pregnancy outcome (Fiala, Egan, & Lashgari, 2006), pregnancy complications (Wataba, Mizutani, Wasada, Morine, Sugiyama, & Surehara, 2006), breastfeeding duration (Oddy, Li, Landsborough, Kendall, Henderson, & Downie, 2006), and hemoglobin and serum ferritin concentration (Rasmussen, Bergsjo, Jacobsen, Haram, & Bakketeig, 2005), but there is a very limited amount of literature available on relation of maternal anthropometry and child psychological development.

A study conducted in Kenya (Bhargava, 2000) investigated factors that influence physical and psychological development of infants. In this study, maternal prepregnancy Body Mass Index (BMI) was positively associated with the infant scores on the Motor cluster of the Brazelton Neonatal Behavioral Assessment Scale. Although the maternal

prepregnancy BMI was positively related to infant weight, length, and head circumference, it did not show significant association with infant scores on the Bayley Motor Scale at six months. Neggers, Goldenberg, Ramey, and Cliver (2003) examined prepregnancy body mass index of low-income African-American mothers and psychomotor development of their children. Results of the study indicate that maternal prepregnancy BMI is significantly associated with and is a significant predictor of the child's general intellectual ability score and nonverbal differential ability score as measured on Differential Ability Scales (DAS). The children of mothers with BMI>29 (obese) had significantly worse performance on the test in comparison to children of normal weight mothers. No relations were found between maternal prepregnancy BMI and child differential ability verbal score and gross motor ability score as measured on DAS and Peabody Developmental Motor Scales respectively. Another study evaluated the effect of maternal body mass index at birth on development of six years old children in Iceland (Thorsdottir, Gunnarsdottir, Kvaran, & Gretarsson, 2005). Maternal BMI was negatively associated with child developmental scores, namely learning subtest, verbal component, and total developmental index of The Icelandic Developmental Inventory. Children of obese mothers had significantly lower scores as compared to children of normal weight mothers.

Although different tests were used in these three studies, an underlying trend of maternal BMI influence on child performance on developmental tests can be observed. In the study conducted in the developing country (Bhargava, 2000), where malnutrition is a problem, a higher BMI was associated with a better performance on the developmental test. On the other hand, the two studies conducted in developed countries (Neggers et al.,

2003; Thorsdottir et al., 2005), where overweight and obesity are problems, a higher BMI corresponded to a worse performance on the developmental tests. It can be concluded that both too low and too high maternal BMI negatively affect the child's psychological development.

Infant visual recognition memory

Definition

Visual recognition memory is a type of memory that emerges in early infancy and is related to processing speed and attention (Rose et al., 2004). Studies suggest that visual recognition memory in infancy predicts IQ (DiLalla et al., 1990), language (Rose, Feldman, Wallace, & Cohen, 1991), vocabulary (Fagan, 1984), and memory (Thompson, Fagan, & Fulker, 1991) in later life. Some of the factors that were identified to have influence on visual recognition memory are prematurity (Rose, Feldman, & Jankowski, 2001), long labor and low Apgar scores (Caron, Caron, & Glass, 1983), genetic abnormalities (e.g. Down's syndrome; Miranda & Fantz, 1974), prenatal exposure to teratogens [e.g. cocaine (Jacobson, Jacobson, Sokol, Martier, & Chiodo, 1996), PCBs (Jacobson, Fein, Jacobson, Schwartz, & Dowler, 1985), alcohol (Jacobson, Jacobson, Sokol, Martier, & Ager, 1993)], and nutritional deficiencies (Rose, 1994). Visual recognition memory is assessed by visual paired comparison testing (Fantz, 1956; Fagan, 1974). This method consists of two phases – a familiarization and a test. During a familiarization phase, the infant is presented two identical stimuli at the same time. During a test phase, the infant is exposed to a previously viewed (familiar) stimulus paired with a new (novel) stimulus (Rose et al., 2004). During the visual paired

comparison testing the infant exhibits habituation and/or dishabituation (Kavšek, 2004). Habituation is a decrease in attention to a stimulus that is presented repeatedly or continuously and is represented by variables that measure time of infant fixation to the stimulus, e.g. duration of longest look to the stimulus, number of looks to the stimulus. Dishabituation is remembering a previously viewed stimulus and its comparison to a new stimulus, e.g. novelty preference. After the infants assimilate the familiar stimulus, they direct their attention to a novel stimulus. Infants by the age of six months usually look more at new stimuli therefore have developed novelty preference (Rose et al., 2004). A recent meta-analysis suggests that dishabituation variables are better predictors of later intelligence for at risk infants (e.g. premature), whereas habituation variables can better predict later intelligence in infants that are not at risk (healthy) (Kavšek, 2004).

Use of visual recognition memory in nutritional studies

Nutritional researchers have used visual recognition memory to examine the effects of physical growth, nutrient intake (long-chain polyunsaturated fatty acids and iron), alcohol consumption, and fish/mercury intake on child development.

Physical growth

A study conducted by Rose (1994) investigated relation between visual recognition memory and physical growth measures of 5-12 months old infants in India. In infants of adequate weight, the novelty quotient increased and the familiarization time decreased with increasing age. On the other hand, underweight infants did not demonstrate novelty preference development in any of the age (5-6, 7-8, 9-10 months) or familiarization

length (10, 15, 20, 30 sec) groups. Results of this study also indicate correlation between visual recognition memory and infant birth-weight, head circumference, weight, and length.

A recent investigation conducted in Ethiopia (Kennedy et al., 2006) explored relations between anthropometric measures and visual recognition memory of 6-8 month old infants. Infants were growth retarded (mean weight z-score -1.12 ± 1.19 SD, mean length z-score -1.05 ± 1.31.SD) with a significant disturbance in the development of novelty preference; they exhibited preference for the familiar stimulus as opposed to the expected preference for the novel stimulus. The length of longest look to the stimulus (a marker of stimulus encoding) was associated with infant weight (an indicator of short-term malnutrition) and the mean look duration in test phases was related to head circumference (indicating long-term brain development). The malnourished infants (length-for-age z-scores < -2) demonstrated slower visual information processing; they had lower mean shift rates during familiarization and test phases.

Long-chain polyunsaturated fatty acids

The influence of supplementation with docosahexenoic acid (DHA) on novelty preference of preterm infants was examined by Werkman and Carlson (1996). In this randomized trial, both infant groups - control or DHA supplemented formula - demonstrated the same novelty preference but infants consuming the DHA supplemented diet had shorter duration of looks suggesting faster processing of information.

A randomized controlled trial performed by O'Connor et al. (2001) observed the effect of long-chain polyunsaturated fatty acids supplementation on growth and

development of preterm infants. Six months old infants who received formula supplemented with arachidonic acid (AA) and DHA from egg-derived triglycerides and fish oil had significantly higher novelty preference as compared to control group and the group supplemented with AA and DHA from fish/fungal oil. Composition analysis of the formulas revealed that the formula containing AA and DHA from fish/fungal oil contained small amount of eicosapentaenoic acid (EPA) whereas the formula with AA and DHA form egg-derived triglycerides and fish oil did not contain any EPA. This variation may have influenced the difference in infants' performance on the novelty preference test. However, authors did not explain why two experimental groups receiving AA and DHA supplementation from different sources were used.

A randomized study conducted in Norway investigated effect of n-3 and n-6 long chain polyunsaturated fatty acids on infant neurobiological development (Helland et al., 2001). Women received either cod liver oil (a good source of n-3 fatty acids) or corn oil (a good source of n-6 fatty acids) supplementation from 17-19th week of pregnancy until 3 months after delivery; their infants were tested on novelty preference at 6 and 9 months of age. No significant differences in novelty preference were found between the two supplemented groups.

Another study explored relation between levels of DHA and development of attention in infancy (Colombo et al., 2004). Infants of mothers with higher erythrocyte phospholipids DHA concentration at birth had shorter look duration at 4-6 months and therefore demonstrated faster development of attention. These infants also were less distracted at the age of 18 months.

Iron

Lozoff, De Andraca, Castillo, Smith, Walter, and Pino (2003) examined the effect of six month-long iron supplementation on infant development and behavior, including visual recognition memory. Infants fed unsupplemented formula exhibited longer looks at stimuli at 12 months as compared to infants who consumed formula supplemented with iron. There were no significant differences in novelty preference between the two groups.

Alcohol

An influence of alcohol intake at conception and during pregnancy on infant information processing was investigated by Jacobson et al. (1993). The information processing was measured using visual recognition memory and cross-modal transfer tests at 6.5 and 12 months. The maternal alcohol consumption during pregnancy was significantly associated with longer fixation of the infant on the stimulus in both tests, which indicates slower information processing, and this association was dose dependent. The alcohol intake at conception was not significantly associated with the duration of fixation on the stimulus, which indicates that alcohol affects information processing at later stages of pregnancy. Infant novelty preference variables were not related to maternal alcohol intake.

Fish/mercury intake

Studies of Myers et al. (1995) and Oken et al. (2005) both investigated maternal fish consumption during pregnancy and infant neurodevelopment. The earlier study (Myers et al., 1995) conducted in Seychelles reported no relation between maternal hair mercury

level during pregnancy and lower infant visual recognition memory (% looking time to the novel target) and attention scores (time to reach criterion looking at target) at the age of 6.5 years. The latter study (Oken et al., 2005) conducted in the U.S. on 6-8 months old infants found positive association between fish consumption during pregnancy and infant visual recognition memory score (% novelty preference) and negative association between maternal hair mercury level and infant visual recognition memory score. The reason for difference in results of these two studies may be another substance contained in the fish consumed at Seychelles, e.g. selenium that may alleviate the negative effect of exposure to mercury (Nishikido, Furuyashiki, Naganuma, Suzuki, & Imura, 1987).

Although some of the studies only measured novelty preference and not information processing speed (Rose, 1994; O'Connor, 2001; Helland, 2001; Myers, 1995; Oken, 2005), it can be concluded that visual recognition memory variables are sensitive to the level of nourishment, DHA concentration, iron intake, alcohol exposure, and fish/mercury intake. Infants' overall performance on the visual recognition memory tests increased with higher general nutrient availability, DHA concentration and iron intake, but decreased with exposure to toxins, i. e. alcohol and mercury.

CHAPTER III

METHODS

Participants

The participants were Ethiopian infants six to eight months old and their mothers. They were recruited in four villages in the Sidama zone of Southern Ethiopia – Alamura, Bushelo, Jara Damela, and Jara Gelaleheha. It was a convenience sample of one hundred infants and one hundred mothers that were recruited with the cooperation of local community health workers and the Bushelo Health Center. In order to participate in the study, the infants had to be six to eight months old, breastfed at the time of data collection, and perceived as healthy by their mother, i.e. without vomiting, diarrhea or coughing in the three days before testing. The age of the infants was verified with record cards from the local clinic. If an infant demonstrated developmental signs of being either younger than 6 months (e.g. unable to sit without mother's help) or older than 8 months (e.g. having teeth), he/she was not included in the study. Informed consent was obtained from the mothers. The study was approved by the Institutional Review Boards of Oklahoma State University at Stillwater, Debub University at Awassa, Ethiopia, and University of Colorado Health Sciences Center at Denver.

Anthropometric measurements

Mothers:

Mothers' height and weight measurements were collected. The height was measured to the nearest 0.1 cm using a locally designed stadiometer and the weight was assessed to the nearest 0.1 kg.

Infants:

The anthropometric measurements collected from infants were weight, length, and head circumference. The weight was measured to the nearest 2 g using a Seca 345 infant scale (Seca, Hamburg, Germany). All infants were weighed in a t-shirt of known weight that was also one of the incentives for participation in this project. The actual infant weight was obtained by subtracting the t-shirt weight from the weight value obtained by the scale. The recumbent length was assessed to the nearest 0.1 cm using a length-board (Shorr, Olney, MD). The head circumference was obtained to the nearest 0.1 cm using a non-stretchable measuring tape.

All anthropometric measurements were performed by trained research assistants under supervision of a research team member. Each of the height and length measurements was performed twice; if the measurements differed by more than 0.5 cm, a third measurement was taken. The mean of the measurements was used for data analysis. The scale used for weight measurements automatically averaged multiple measures; this average was used for data analysis.

Visual recognition memory testing

Apparatus:

The apparatus used for visual recognition memory testing was modeled after that described by Rose et al. (2001). It was a three-sided 110 cm high booth made locally of plywood (Figures 1 and 2). The middle section of the booth contained two square openings for the stimuli that were placed 59.5 cm from the ground and a small round opening for a camera lens between them in order to record infant visual fixation for further analysis. The stimuli were attached to two revolving windows placed into the square openings and their centers were 30 cm apart. Each mother was seated 50 cm in front of the testing booth with her infant on her lap.

Figure 1. Frontal view of the testing apparatus.

Figure 2. Back view of the testing apparatus.

Testing procedure:

The testing took place outdoors in a quiet village area to ensure adequate light for videotaping and to limit distraction. Each trial consisted of a one minute familiarization phase and two five-second test phases (the test phases immediately followed the familiarization phase). During the familiarization phase, two identical stimuli were presented at the same time. In the test phase, a previously viewed stimulus (a familiar stimulus) was paired with a new one (a novel stimulus). There were four trials for each infant that were administered during one visit.

Two researchers were involved in the testing procedure: placing the stimuli on the revolving windows from behind the testing booth, revolving the windows, timing the length of the phases, and videotaping the infant looking behavior. They were hidden behind the testing booth and therefore not seen by the infant. Each of the experimenters was responsible for placing and revolving one of the two stimuli. This was practiced in

advance to ensure both of the stimuli appeared at the exact same time. One of the experimenters was timing the length of the phases using a stop watch (1 minute for familiarization and 5 seconds for test phase) and the other experimenter was responsible for operating the camera.

Testing time:

The length of the phases was established based on a pretest conducted on an American six month old infant and a study conducted by Rose et al. (1994) with infants in India. The timing started when the stimuli were presented to the infant regardless of whether the infant was looking at the stimuli or not and ended when the stimuli were rotated out of infant's view after the interval elapsed regardless of the time the infant spent looking at the stimuli.

Stimuli:

The stimuli were abstract multicolored or black-and-white patterns adapted from Rose et al. (2001). There were four pairs of stimuli – one for each of the trials (Figure 3). The stimuli pairs were tested in fixed order for all of the infants as shown in Figure 3. The familiar stimuli are shown on the left and the novel stimuli are shown on the right in Figure 3. The stimuli were not used interchangeably within the stimuli pair, i.e. the same stimuli were used as familiar and novel for all of the infants. Rose et al. (2001) tested the stimuli and concluded that they are equally attractive to the infants; therefore the infants' bias due to their preferences should be minimal. The right-left placement of the familiar and novel stimuli were alternated across the four trials (right placement in two of the four

trials and left placement in the remaining two trials) to control for infants' side preferences.

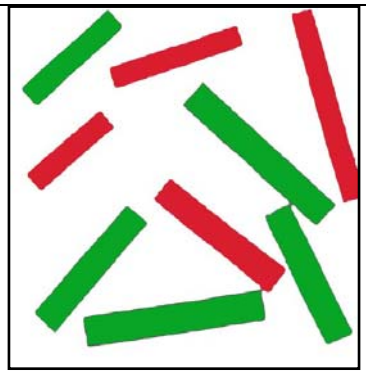
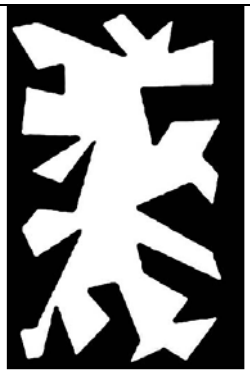
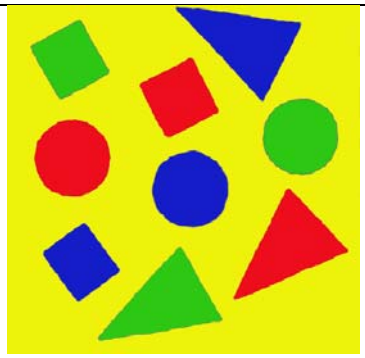
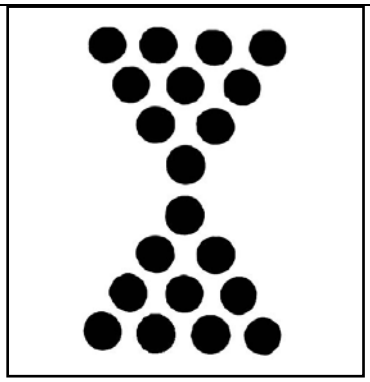
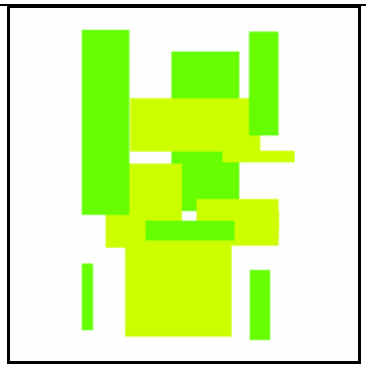
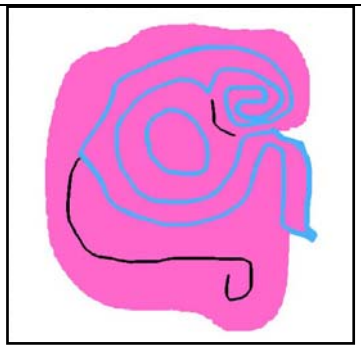
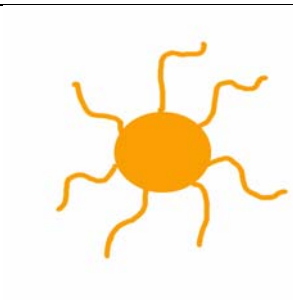
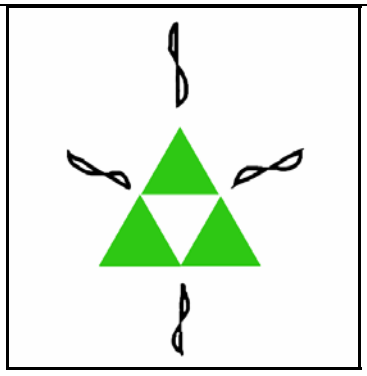
	Familiar stimulus	Novel stimulus
Pair 1		
Pair 2		
Pair 3		
Pair 4		

Figure 3. Stimuli used during visual recognition memory testing.

Visual recognition memory coding

Preparation:

The recorded infant looking behavior data were transferred from videotapes to DVDs in order to separate subjects into individual tracks and to be able to use media players (e.g. Windows Media Player, Real Player) on a PC during coding. This allowed for easier and more precise handling of the recording as compared to a VHS player or a camera. Sixty-nine infants of the 100 infants tested were included in the coding analysis. Infants with the following conditions were excluded:

- completed less than 3 trials (n = 12)
- crying during testing procedure (n = 7)
- mother held their head during testing procedure (n = 4)
- familiarization time less than 5 seconds on two or more trials (n = 4)
- feeding during testing procedure (n = 2)
- technical problems (n = 1)
- no looks to stimuli during test phase (n = 1)

Training:

Before scoring the experimental data, six student coders underwent training. The students did not participate in the data collection and were blind to the placement of stimuli. First, they were instructed about the coding criteria:

- A baby was judged to be looking at a stimulus if the reflection of the stimulus was seen in the pupil of one of the eyes or from the angle of the gaze based on the known angles of fixation from the training video

- A look was defined as an eye fixation on a stimulus of at least one second in duration
- A look away was defined as an eye fixation away from the stimulus of at least one second in duration
- A shift occurred when an infant's gaze moved from one stimulus to another with less than one second between fixations

Then the coders watched a training video demonstrating looks in specific directions involving subjects not participating in the experiment (adults and older children). Finally, all the coders watched a real visual recognition memory trial that was not included in the data analysis. In a group, observed by a research team member, they were asked to identify and measure looks to the right stimulus, looks to the left stimulus, and shift in looks between the two stimuli. Any disagreements were discussed among the coders and if an agreement was not reached, the situation was resolved by the research team member. The same procedure was repeated with the change that the coding took place in two independent teams of three students who then met together to resolve discrepancies. After training, one of the teams was chosen to code all of the 69 infants and the other to code independently 20 randomly selected infants to determine reliability.

Coding procedure:

In the team, one student coded looks to the right stimulus, a second student coded looks to the left stimulus, and the third student coded the shifts in looks between the stimuli and operated the media player. Right looks, left looks, and shifts in both phases were first identified and the time they occurred on the recording was noted. Then the

individual right and left looks and shifts were timed using a stop watch and their length recorded. All the measures, i.e. number of looks to each side, number of shifts, duration of each look, and total looking time for both phases of all trials were recorded on a coding sheet (see Appendix A). The team typically needed 45 minutes to complete scoring of looking behavior of one infant.

Reliability:

The inter-coder reliability was determined from scorings of twenty randomly selected infants coded independently by each team. The measures recorded by the two teams were correlated and reliability coefficients were identified. The mean correlation coefficients were generally high and significant ($p<0.05$):

Familiarization phase:

- number of looks $r = 0.86$
- duration of looks $r = 0.88$
- shifts between stimuli $r = 0.85$

Test phase:

- number of looks $r = 0.87$
- duration of looks $r = 0.86$
- shifts between stimuli $r = 0.57$

Statistical analysis

Anthropometric measures:

Maternal Body Mass Index (BMI) was calculated from height and weight measurements (kilograms / meters^2). Infant weight-for-age, length-for-age, and weight-for-length ratios were calculated. All anthropometric measurements (maternal height, weight, BMI; infant weight-for-age, length-for-age, weight-for-length ratios, head circumference) were converted to z-scores. All of these procedures were performed using Epi Info version 3.3.2 (CDC, Atlanta, GA) and norms recommended by the World Health Organization (World Health Organization Working Group, 1986). For mothers, the highest available age in the Epi-Info program (17 years and 11 months) was assumed for calculation (Gibson, 2005). Both actual measurements and z-scores were used in analysis in order to compare the mothers to healthy 18 year-olds in the U.S.

Visual recognition memory measures:

In addition to variables established from coding (number of looks to each side, number of shifts, duration of each look, and total looking time) other variables were calculated: mean familiarization time, the duration of the longest look during familiarization, the mean duration of each look during familiarization, the shift rate (shifts per second) during familiarization, the mean duration of each look during test phases, the shift rate during test phases, and the novelty quotient (the amount of time the infant looked at the novel stimulus in all test phases divided by the amount of time spent looking at both novel and familiar stimuli during all test phases).

Analysis:

The data were analyzed using Statistical Package for Social Sciences version 12 (SPSS, Inc., Chicago, IL). Descriptive statistics including frequencies, means, and standard deviations were compiled. The following statistical tests were performed:

- *Hypothesis 1 – Infant anthropometry is correlated with maternal anthropometry:*

  Correlations between maternal anthropometric measures and infant anthropometric measures

- *Hypothesis 2 – Infants' ability to complete the visual recognition memory procedure will differ by maternal anthropometry:*

  ANOVA for difference in number of novelty preference trials completed as a function of maternal anthropometric measures

- *Hypothesis 3 – Visual recognition memory variables are significantly correlated with maternal anthropometry:*

  Correlations between maternal anthropometric measures and visual recognition memory variables

- *Hypothesis 4 – Infants whose mothers have BMI < 19 and/or weight and height z-scores < -2 will have poorer performance in the visual recognition memory procedure than infants whose mothers have better anthropometry:*

  ANOVA for difference in visual recognition memory variables as a function of maternal anthropometric measures

- *Hypothesis 5 – Maternal anthropometry will predict infant performance in the visual recognition memory procedure:*

  Regression for influence of maternal anthropometric measures on visual

recognition memory variables

CHAPTER IV

RESULTS

Maternal anthropometric measures

Means and standard deviations of maternal anthropometric measures are reported in Table 1 (in aggregate) and Table 2 (separated by individual village). The mothers were short; mean maternal height z-score was about -1.50. Short stature suggests long-term malnutrition and malnutrition in the growth period. The maternal weights were also below the median of the reference population recommended by the WHO for international use (WHO Working Group, 1986). The maternal BMIs were in normal range, but BMI is not an indicator of malnutrition, it indicates how heights and weights are proportional to each other. Infant anthropometric measures are reported in Table 3.

Table 1: Maternal anthropometric measures

	All subjects (N = 100)		**Visual recognition memory subjects (N = 69)[1]**	
	Mean	**SD**	**Mean**	**SD**
Weight (kg)	50.8	5.9	51.1	6.0
Weight z-score	-.84	.73	-.80	.74
Height (m)	1.55	.06	1.54	.07
Height z score	-1.48	1.07	-1.58	1.11
BMI	21.2	2.3	21.5	2.4
BMI z-score	-.13	.71	-.04	.73

[1] completed 3 or 4 visual recognition memory trials

Table 2: Maternal anthropometric measures by village

Village		Weight (kg)	Weight z-score	Height (m)	Height z-score	BMI	BMI z-score
Alamura	N	32	32	32	32	32	32
	Mean	51.2	-.80	1.53	-1.84	22.0	.08
	SD	6.6	.81	.06	.93	2.7	.79
Bushelo	N	24	24	24	24	24	24
	Mean	51.6	-.74	1.56	-1.27	21.2	-.11
	SD	5.6	.66	.07	1.16	2.0	.67
Jara Damela	N	34	34	34	34	34	34
	Mean	49.9	-.95	1.56	-1.21	20.4	-.38
	SD	5.4	.69	.07	1.10	1.7	.63
Jara Gelaleheha	N	10	10	10	10	10	10
	Mean	51.0	-.82	1.53	-1.73	21.7	.04
	SD	6.7	.84	.05	.85	2.2	.66
Total	N	100	100	100	100	100	100
	Mean	50.8	-.84	1.55	-1.48	21.2	-.13
	SD	5.9	.73	.06	1.07	2.3	.71

Table 3: Infant anthropometric measures

	Mean	**SD**
Weight/age z-score	-1.12	1.19
Length/age z-score	-1.05	1.31
Weight/length z-score	-0.35	1.30
Head circumference z-score[2]	0.06	1.52

N = 69, [2] N = 68 (one child refused head circumference measurement)

Correlations between maternal anthropometry and infant anthropometry

Maternal anthropometric measures (weight, weight z-score, height, height z-score, BMI, BMI z-score) were correlated with infant anthropometric measures (weight-for-age z-score, length-for-age z-score, weight-for-length z-score, head circumference, head circumference z-score). The correlations are reported in Table 4. The results indicate that maternal height is positively correlated with infant weight-for-age z-score ($r = 0.207$, $p = 0.039$), infant length-for-age z-score ($r = 0.366$, $p = 0.000$), infant head circumference ($r = 0.199$, $p = 0.048$), and infant head circumference z-score ($r = 0.225$, $p = 0.025$). Several studies relate low maternal height to obstructed/prolonged labor and consequently to the birth outcome (Rush, 2000). Since the mean maternal height z-score is about -1.50, this may be an explanation of the positive correlation between maternal height and infant anthropometric measures.

Table 4: Correlations between maternal anthropometry and infant anthropometry

	Infant weight for age z-score	**Infant length for age z-score**	**Infant weight for length z-score**	**Infant head circumference[2] (cm)**	**Infant head circumference z-score[2]**
Maternal weight	r = 0.081 p = 0.422	r = 0.174 p = 0.084	r = -0.078 p = 0.440	r = -0.010 p = 0.922	r = 0.036 p = 0.723
Maternal weight z-score	r = 0.076 p = 0.450	r = 0.174 p = 0.083	r = -0.083 p = 0.410	r = -0.017 p = 0.869	r = 0.038 p = 0.708
Maternal height	r = 0.207 p = 0.039	r = 0.366 p = 0.000	r = -0.126 p = 0.211	r = 0.199 p = 0.048	r = 0.225 p = 0.025
Maternal height z-score	r = 0.207 p = 0.039	r = 0.366 p = 0.000	r = -0.126 p = 0.210	r = 0.199 p = 0.049	r = 0.225 p = 0.025
Maternal BMI	r = -0.080 p = 0.429	r = -0.096 p = 0.343	r = 0.005 p = 0.960	r = -0.181 p = 0.073	r = -0.152 p = 0.134
Maternal BMI z-score	r = -0.081 p = 0.426	r = -0.094 p = 0.354	r = 0.003 p = 0.980	r = -0.162 p = 0.109	r = -0.112 p = 0.271

N = 100, [2] N = 99

Difference in number of visual recognition memory trials completed as a function of maternal anthropometry (ANOVA)

The differences in number of visual recognition memory trials completed as a function of maternal anthropometry were investigated using analysis of variance. The mothers were grouped based on number of visual recognition memory trials their infants completed (0-2 trials completed, 3-4 trials completed). Maternal anthropometric measures by number of trials completed are described in Table 5 and the differences are reported in Table 6. There are no significant group differences in number of visual recognition memory trials completed.

Table 5: Maternal anthropometry measures by number of trials completed

Number of trials		Weight	Weight z-score	Height	Height z-score	BMI	BMI z-score
0 trials	N	2	2	2	2	2	2
	Mean	46.8	-1.36	1.56	-1.28	19.2	-0.77
	SD	1.8	0.25	0.06	0.95	0.7	0.30
1 trial	N	1	1	1	1	1	1
	Mean	43.5	-1.80	1.49	-2.45	19.6	-0.60
	SD	NA	NA	NA	NA	NA	NA
2 trials	N	3	3	3	3	3	3
	Mean	48.7	-1.10	1.50	-2.21	21.6	0.07
	SD	1.4	0.19	0.06	1.07	1.4	0.40
3 trials	N	9	9	9	9	9	9
	Mean	53.4	-0.56	1.57	-1.12	21.7	-0.03
	SD	7.4	0.84	0.05	0.77	3.0	0.86
4 trials	N	78	78	78	78	78	78
	Mean	50.8	-0.84	1.55	-1.51	21.3	-0.11
	SD	5.6	0.70	0.07	1.11	2.2	0.70
Total	N	93	93	93	93	93	93
	Mean	50.8	-0.84	1.55	-1.50	21.2	-0.12
	SD	5.8	0.71	0.06	1.08	2.2	0.70

N = 93 (7 subjects with technical problems during visual recognition memory procedure excluded from this analysis)

Table 6: Group differences in number of visual recognition memory trials completed as a function of maternal anthropometry (2 groups: 0-2 trials, 3-4 trials completed)

	F	Sig.
Weight	2.577	0.112
Weight z-score	2.699	0.104
Height	1.055	0.307
Height z-score	1.059	0.306
BMI	0.801	0.373
BMI z-score	0.553	0.459

Correlations between maternal anthropometry and visual recognition memory variables

Maternal anthropometric measures were correlated with visual recognition memory variables (familiarization mean, novelty preference quotient, longest right look during familiarization, longest left look during familiarization, longest look during familiarization, mean duration of each look during familiarization, shift rate during familiarization, mean duration of each look during test trials, shift rate during test trials). The correlations are reported in Table 7. Both maternal weight and BMI are positively correlated with longest right look during familiarization ($r = 0.293$, $p = 0.015$ and $r = 0.262$, $p = 0.030$ respectively). Higher weight and BMI are indicators of better maternal nutrition and therefore would be consistent with shorter looks during familiarization, as better nourished infants need less time to assimilate a stimulus during familiarization. However, the longest left look during familiarization and most importantly the longest look during familiarization are not correlated with any of the maternal anthropometric

measures, therefore a conclusion about relation of maternal weight and BMI to longest look during familiarization cannot be made.

Table 7: Correlations between maternal anthropometry and visual recognition memory variables

	Weight	Weight z-score	Height	Height z-score	BMI	BMI z-score
Familiarization mean	r = 0.128 p = 0.296	r = 0.113 p = 0.356	r = -0.040 p = 0.742	r = -0.040 p = 0.743	r = 0.161 p = 0.186	r = 0.150 p = 0.218
NP quotient	r = 0.147 p = 0.227	r = 0.155 p = 0.203	r = 0.024 p = 0.843	r = 0.024 p = 0.842	r = 0.152 p = 0.212	r = 0.143 p = 0.242
Longest right look during familiarization	r = 0.293 p = 0.015	r = 0.295 p = 0.014	r = 0.063 p = 0.604	r = 0.063 p = 0.604	r = 0.262 p = 0.030	r = 0.250 p = 0.038
Longest left look during familiarization	r = 0.139 p = 0.254	r = 0.146 p = 0.230	r = 0.086 p = 0.481	r = 0.087 p = 0.479	r = 0.088 p = 0.473	r = 0.081 p = 0.510
Longest look during familiarization	r = 0.161 p = 0.186	r =0.173 p = 0.155	r = 0.110 p = 0.370	r = 0.110 p = 0.369	r = 0.094 p = 0.444	r = 0.092 p = 0.455
Mean duration of each look during familiarization	r = 0.036 p = 0.766	r = 0.031 p = 0.802	r = -0.121 p = 0.321	r = -0.121 p = 0.321	r = 0.133 p = 0.275	r = 0.142 p = 0.246
Shift rate during familiarization	r = 0.015 p = 0.901	r = 0.018 p = 0.886	r = 0.052 p = 0.673	r = 0.052 p = 0.672	r = -0.033 p = 0.785	r = -0.027 p = 0.823
Mean duration of each look during test trials	r = -0.090 p = 0.461	r = -0.091 p = 0.457	r = -0.088 p = 0.472	r = -0.088 p = 0.474	r = -0.029 p = 0.812	r = -0.038 p = 0.757
Shift rate during test trials	r = 0.170 p = 0.163	r = 0.165 p = 0.176	r = 0.159 p = 0.193	r = 0.159 p = 0.193	r = 0.057 p = 0.642	r = 0.057 p = 0.639

N = 69

Difference in visual recognition memory variables as a function of maternal anthropometry (ANOVA)

The differences in visual recognition memory variables as a function of maternal anthropometry were investigated using analysis of variance. The mothers were grouped based on their weight z-score (lowest – -1, -1 – 0, 0 – highest), height z-score (lowest – -3, -3 – -2, -2 – -1, -1 – 0, 0 – highest), and BMI (< 18.5, 18.5 – 24.9, 25 – 29.9). Means for the groups can be found in Tables 8, 11, and 14. The differences are reported in Tables 9, 12, and 15. There is a significant difference ($p = 0.052$) in mean duration of each look during test trials as a function of maternal height z-score groups. The Least Significant Difference test revealed that there is a significant difference between the moderately to severely malnourished group (height z-score -3 to -2) and the group with height z-score -1 to 0 (within normal range). Given that height is an indicator of long-term nutritional status and duration of look during test trial indicates the speed of processing, the result suggests that the level of maternal nutrition may affect processing speed. However, the pattern of the means (see Table 13) suggests that they are not related. The difference in novelty preference quotient as a function of maternal weight z-score groups is very close to significant ($p = 0.072$). The differences among groups as a function of BMI are not significant.

Table 8: Weight z-score groups means

Group	N	Mean	SD
lowest – -1	42	-1.53	0.31
-1 – 0	43	-0.60	0.27
0 – highest	15	0.40	0.23
Total	100	-0.84	0.73

Table 9: Group differences in visual recognition memory variables as a function of maternal weight z-score groups (3 groups: lowest – -1, -1 – 0, 0 – highest)

	F	**Sig.**
Familiarization mean	0.840	0.436
NP quotient	2.734	0.072
Longest look during familiarization	1.791	0.175
Mean duration of each look during familiarization	0.068	0.934
Shift rate during familiarization	0.364	0.696
Mean duration of each look during test trials	0.598	0.553
Shift rate during test trials	0.978	0.381

Table 10: Means for NP quotient as a function of maternal weight z-score groups

Group	**Mean**
Lowest – -1	0.36
-1 – 0	0.43
0 – highest	0.36

Table 11: Height z-score groups means

Group	N	Mean	SD
Lowest – -3	5	-3.55	0.49
-3 – -2	29	-2.37	0.25
-2 – -1	38	-1.54	0.28
-1 – 0	17	-0.47	0.27
0 – highest	11	0.48	0.44
Total	100	-1.48	1.07

Table 12: Group differences in visual recognition memory variables as a function of maternal height z-score groups (5 groups: lowest – -3, -3 – -2, -2 – -1, -1 – 0, 0 – highest)

	F	Sig.
Familiarization mean	0.129	0.971
NP quotient	1.378	0.251
Longest look during familiarization	0.294	0.881
Mean duration of each look during familiarization	1.619	0.180
Shift rate during familiarization	1.454	0.226
Mean duration of each look during test trials	2.486	0.052
Shift rate during test trials	1.336	0.266

Table 13: Means for Mean duration of each look during test trials as a function of maternal height z-score groups

Group	Mean
Lowest – -3	2.30
-3 – -2	2.79
-2 – -1	2.52
-1 – 0	2.29
0 – highest	2.69

Table 14: BMI groups means

Group	N	Mean	SD
<18.5	9	17.8	0.4
18.5 – 24.9	83	21.1	1.6
25 – 29.9	8	26.1	0.6
Total	100	21.2	2.3

Table 15: Group differences in visual recognition memory variables as a function of maternal BMI groups (3 groups: < 18.5, 18.5 – 24.9, 25 – 29.9).

	F	Sig.
Familiarization mean	0.579	0.563
NP quotient	0.940	0.396
Longest look during familiarization	0.588	0.558
Mean duration of each look during familiarization	0.271	0.764
Shift rate during familiarization	0236	0.791
Mean duration of each look during test trials	0.245	0.783
Shift rate during test trials	0.467	0.629

Influence of maternal anthropometry on visual recognition memory variables (regression)

The regression analysis was only performed on the variables that showed significant difference in ANOVA (see p. 37), i.e. novelty preference quotient and mean duration of each look during test trials. The results of this analysis are reported in Table 16. There is no significant influence of maternal anthropometric measures on visual recognition memory variables.

Table 16: Influence of maternal anthropometry on visual recognition memory variables

Model #	Dependent variable	Predictors	F	Sig.
1	NP quotient	Maternal weight Maternal height	0.798	0.454
2	Mean duration of each look during test trials	Maternal weight Maternal height	0.370	0.692

CHAPTER V

CONCLUSION

The objective of this study was to investigate relations between infant visual recognition memory and maternal anthropometric measures. Maternal anthropometry was assessed by measuring height and weight and calculating BMI, all of which were converted in z-scores. Infant cognitive development was evaluated using visual recognition memory testing. Literature is available on relation of maternal anthropometry and child psychological development and use of visual recognition memory testing of infants in nutritional research but we were not able to identify any study exploring relation between maternal anthropometry and infant visual recognition memory.

Although the infant anthropometric measures and visual recognition memory variables of the same subjects that were used for this study were correlated (Kennedy et al.), statistical analysis did not show any consistent relations between maternal anthropometry and infant visual recognition memory variables:

- *Hypothesis 1: Infant anthropometry is correlated with maternal anthropometry.* Maternal height is positively correlated with infant weight-for-age z-score, length-for-age z-score, head circumference, and head circumference. This is consistent with studies investigating relation of maternal anthropometry to anthropometric measures of infants (Christian, Gujral, Abbi, & Gopaldas,

1989) and newborns (Neggers, Goldenberg, Cliver, Hoffman, & Cutter, 1995; Das & Khanam, 1997).

- *Hypothesis 2: Infants' ability to complete the visual recognition memory procedure will differ by maternal anthropometry.*

  No difference in number of visual recognition memory trials completed as a function of maternal anthropometry was found.

- *Hypothesis 3: Visual recognition memory variables are significantly correlated with maternal anthropometry.*

  Correlations between both maternal weight and BMI and longest right look during familiarization were found, but in the opposite direction than expected.

- *Hypothesis 4: Infants whose mothers have BMI<19 and /or weight and height z-scores<-2 will have poorer performance in the visual recognition memory procedure than infants whose mothers have better anthropometry.*

  A significant difference in mean duration of each look during test trials as a function of maternal height z-score groups was found. The difference in novelty preference quotient as a function of maternal weight z-score groups is very close to significant. However, the group means suggest that they are not related.

- *Hypothesis 5: Maternal anthropometry will predict infant performance in the visual recognition memory procedure.*

  No significant influence of maternal anthropometric measures on infant visual recognition memory variables was found.

These results suggest that maternal anthropometric measures cannot be used as a predictor of infant visual recognition memory.

Further research

Further research may need to concentrate on factors that directly influence neurobehavioral development as compared to indirect factors such as maternal anthropometric measures. One of the direct factors with potential for investigation in relation to visual recognition memory is maternal interaction with the infant. Studies conducted in Ethiopia indicate that maternal care time (Ketema, Abate, & Jabar, 2003) and responsiveness (Aboud & Alemu, 1995) are associated with infant performance on the Bayley Infant Development Scale and Bayley Scale of Mental Development respectively.

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APPENDICES

APPENDIX A

VISUAL RECOGNITION MEMORY CODING SHEETS

ETHIOPIAN NOVELTY PREFERENCE STUDY SUMMER/FALL 2004

data coding sheet for NUMBER OF SHIFTS (**looks from 1 target to the other**)

Trial 1 familiarization: start _____; stop _____	
Total # of SHIFTS	

Comments:

Trial 1A test	
start _____; stop _____	
Total # of SHIFTS	
Trial 1B test	
start _____; stop _____	
Total # of SHIFTS	

Trial 2 familiarization: start _____; stop _____	
Total # of SHIFTS	

Comments:

Trial 2A test	
start _____; stop _____	
Total # of SHIFTS	
Trial 2B test	
start _____; stop _____	
Total # of SHIFTS	

Trial 3 familiarization: start _____; stop _____	
Total # of SHIFTS	

Comments:

Trial 3A test	
start _____; stop _____	
Total # of SHIFTS	
Trial 3B test	
start _____; stop _____	
Total # of SHIFTS	

Trial 4 familiarization: start _____; stop _____	
Total # of SHIFTS	

Comments:

Trial 4A test	
start _____; stop _____	
Total # of SHIFTS	
Trial 4B test	
start _____; stop _____	
Total # of SHIFTS	

ETHIOPIAN NOVELTY PREFERENCE STUDY SUMMER/FALL 2004
data coding sheet for RIGHT LOOKS (looks to target area on scorer's right)

Trial 1 familiarization: start _____; stop _____	
Total # of RIGHT LOOKS	
Duration of right look 1	
Duration of right look 2	
Duration of right look 3	
Duration of right look 4	
Duration of right look 5	
Duration of right look 6	
Duration of right look 7	
Duration of right look 8	
Duration of right look 9	
Duration of right look 10	

Comments:

Trial 1A test	
start _____; stop _____	
Total # of RIGHT LOOKS	
Total **duration** of looks	
Trial 1B test	
start _____; stop _____	
Total # of RIGHT LOOKS	
Total **duration** of looks	

Trial 2 familiarization: start _____; stop _____	
Total # of RIGHT LOOKS	
Duration of right look 1	
Duration of right look 2	
Duration of right look 3	
Duration of right look 4	
Duration of right look 5	
Duration of right look 6	
Duration of right look 7	
Duration of right look 8	
Duration of right look 9	
Duration of right look 10	

Comments:

Trial 2A test	
start _____; stop _____	
Total # of RIGHT LOOKS	
Total **duration** of looks	
Trial 2B test	
start _____; stop _____	
Total # of RIGHT LOOKS	
Total **duration** of looks	

Trial 3 familiarization: start _____; stop _____	
Total # of RIGHT LOOKS	
Duration of right look 1	
Duration of right look 2	
Duration of right look 3	
Duration of right look 4	
Duration of right look 5	
Duration of right look 6	
Duration of right look 7	
Duration of right look 8	
Duration of right look 9	
Duration of right look 10	

Comments:

Trial 3A test	
start _____; stop _____	
Total # of RIGHT LOOKS	
Total **duration** of looks	
Trial 3B test	
start _____; stop _____	
Total # of RIGHT LOOKS	
Total **duration** of looks	

Trial 4 familiarization: start _____; stop _____	
Total # of RIGHT LOOKS	
Duration of right look 1	
Duration of right look 2	
Duration of right look 3	
Duration of right look 4	
Duration of right look 5	
Duration of right look 6	
Duration of right look 7	
Duration of right look 8	
Duration of right look 9	
Duration of right look 10	

Comments:

Trial 4A test	
start _____; stop _____	
Total # of RIGHT LOOKS	
Total **duration** of looks	
Trial 4B test	
start _____; stop _____	
Total # of RIGHT LOOKS	
Total **duration** of looks	

ETHIOPIAN NOVELTY PREFERENCE STUDY SUMMER/FALL 2004
data coding sheet for LEFT LOOKS (looks to target area on scorer's left)

Trial 1 familiarization: start _____; stop _____	
Total # of LEFT LOOKS	
Duration of left look 1	
Duration of left look 2	
Duration of left look 3	
Duration of left look 4	
Duration of left look 5	
Duration of left look 6	
Duration of left look 7	
Duration of left look 8	
Duration of left look 9	
Duration of left look 10	

Comments:

Trial 1A test	
start _____; stop _____	
Total # of LEFT LOOKS	
Total **duration** of looks	
Trial 1B test	
start _____; stop _____	
Total # of LEFT LOOKS	
Total **duration** of looks	

Trial 2 familiarization: start _____; stop _____	
Total # of LEFT LOOKS	
Duration of left look 1	
Duration of left look 2	
Duration of left look 3	
Duration of left look 4	
Duration of left look 5	
Duration of left look 6	
Duration of left look 7	
Duration of left look 8	
Duration of left look 9	
Duration of left look 10	

Comments:

Trial 2A test	
start _____; stop _____	
Total # of LEFT LOOKS	
Total **duration** of looks	
Trial 2B test	
start _____; stop _____	
Total # of LEFT LOOKS	
Total **duration** of looks	

Trial 3 familiarization: start _____; stop _____	
Total # of LEFT LOOKS	
Duration of left look 1	
Duration of left look 2	
Duration of left look 3	
Duration of left look 4	
Duration of left look 5	
Duration of left look 6	
Duration of left look 7	
Duration of left look 8	
Duration of left look 9	
Duration of left look 10	

Comments:

Trial 3A test	
start _____; stop _____	
Total # of LEFT LOOKS	
Total **duration** of looks	
Trial 3B test	
start _____; stop _____	
Total # of LEFT LOOKS	
Total **duration** of looks	

Trial 4 familiarization: start _____; stop _____	
Total # of LEFT LOOKS	
Duration of left look 1	
Duration of left look 2	
Duration of left look 3	
Duration of left look 4	
Duration of left look 5	
Duration of left look 6	
Duration of left look 7	
Duration of left look 8	
Duration of left look 9	
Duration of left look 10	

Comments:

Trial 4A test	
start _____; stop _____	
Total # of LEFT LOOKS	
Total **duration** of looks	
Trial 4B test	
start _____; stop _____	
Total # of LEFT LOOKS	
Total **duration** of looks	

APPENDIX B

OKLAHOMA STATE UNIVERITY INSTITUTIONAL REVIEW BOARD

APPROVAL FORM FOR HUMAN SUBJECTS

Oklahoma State University Institutional Review Board

Date:	Monday, June 13, 2005
IRB Application No	HE0570
Proposal Title:	Relationship Between Maternal Anthropometric Measures and Infant Novelty Preference in Southern Ethiopia
Reviewed and Processed as:	Exempt

Status Recommended by Reviewer(s): Approved Protocol Expires: 6/12/2006

Principal Investigator(s

Vladimira Sykova
312 HES
Stillwater, OK 74078

Tay Seacord Kennedy
312 HES
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 415 Whitehurst (phone: 405-744-5700, emct@okstate.edu).

Sincerely,

Sue C. Jacobs, Chair
Institutional Review Board

VITA

Vladimira Sykova

Candidate for the Degree of

Master of Science

Thesis: RELATIONSHIP BETWEEN MATERNAL ANTHROPOMETRY AND INFANT VISUAL RECOGNITION MEMORY

Major Field: Nutritional Sciences

Biographical:

Personal Data: Born in Klatovy, Czech Republic, May 7, 1974, the daughter of Vladimir Syka and Jarmila Sykova.

Education: Graduated from Gymnazium Jaroslava Vrchlickeho, Klatovy, Czech Republic in May 1992; received an Associate of Business degree from Obchodni Akademie, Klatovy, Czech Republic in February 1994; received a Bachelor of Science in Nutritional Sciences degree (Summa Cum Laude) from Oklahoma State University, Stillwater, Oklahoma in December 2004; completed requirements for Master of Science in Nutritional Sciences from Oklahoma State University, Stillwater, Oklahoma in December 2006.

Experience:

- *Graduate Teaching Assistant*, Nutritional Sciences Department, Oklahoma State University, August 2006 – December 2006
- *Graduate Assistant*, Families and Schools for Health Project, College of Human Environmental Sciences, Oklahoma State University, May 2006 – December 2006
- *Graduate Research Assistant*, Nutritional Sciences Department, Oklahoma State University, January 2005 – December 2006

Professional Memberships: American Society for Nutrition, Graduate and Professional Student Government Organization, Graduate Students in Nutritional Sciences

Name: Vladimira Sykova Date of Degree: December, 2006

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: RELATION BETWEEN MATERNAL ANTHROPOMETRY AND INFANT VISUAL RECOGNITION MEMORY

Pages in Study: 61 Candidate for the Degree of Master of Science

Major Field: Nutritional Science

Scope and Method of Study:
Infant visual recognition memory, a measure of attention, memory and information processing speed, predicts IQ, language and vocabulary. This study examined relationship between infant visual recognition memory and maternal anthropometry. Visual memory was assessed using a videotaped novelty preference paradigm. One-hundred infants 6-8 months of age in Ethiopia were presented with graphic stimuli. Duration of looks and shifts in looks between stimuli were coded from the tape by two independent teams and novelty preference was determined. Sixty-nine infants completed at least three novelty preference trials. Weights and heights of infants' mothers were collected, and their BMI was calculated. Relationship between maternal anthropometry and infant novelty preference measures were analyzed using correlations, ANOVA, and regression.

Findings and Conclusions:
Maternal height is positively correlated with infant weight-for-age z-score ($r=0.207$, $p=0.039$), infant length-for-age z-score ($r=0.366$, $p=0.000$), infant head circumference ($r=0.199$, $p=0.048$), and infant head circumference z-score ($r=0.225$, $p=0.025$). Statistical analysis did not show any consistent relationship between maternal anthropometry and infant novelty preference variables. Although maternal height and infant anthropometric measures were correlated, maternal anthropometry cannot be used as a predictor of infant novelty preference. This study is a part of a project funded by NIH grant #NIH 5 R21 TW006729.

ADVISER'S APPROVAL: Dr. Tay Kennedy