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Shifts in Colour Discrimination and Food Imagery Preferences during the First Trimester

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Abstract

The present study aims to test the adaptive theory of pregnancy sickness to limit fetal exposure to teratogens, by investigating possible shifts in colour discrimination and food imagery preferences in women during their first trimester of pregnancy. We hypothesized that colour discrimination and food imagery preference shifts are part of the changes that occur to the first trimester pregnant woman's perceptual shifts. The reason for this shift is to protect the embryo during its most vulnerable phase of development. We recruited 6 pregnant women in their first trimesters and 9 nonpregnant women to participate in the study. Subjects completed the Farnsworth-Munsell 100 hue test in which they were asked to order 85 coloured caps in their order of hue. Next, subjects viewed a slideshow of 10 common food exemplars. Each slide displayed a food at 6 different stages of its ripeness or freshness and subjects were asked to rate how appetizing they found each food. Preliminary results confirm our first prediction that first trimester subjects have better chromatic discrimination when compared with non-pregnant subjects.

Shifts in Colour Discrimination and Food Imagery Preferences during the First Trimester of Pregnancy

An estimated 10,000 infants were born with birth malformations and up to twice as many self-induced abortions occurred over the period of 4 years from 1957 to 1961, due to a drug, prescribed for treatment of morning sickness (Rajkumar, 2004). The drug that swept in over 40 countries (mostly in Europe) was Thalidomide and today this incident is known as the Thalidomide tragedy (Rajkumar; CAFMR, 1996; Lenz, 1988). Studies conducted after the tragedy confirmed that thalidomide is a powerful teratogen, which if taken by pregnant women between days 35 and 49 after their last menstrual period could have detrimental effects on the embryo, even with the ingestion of a single pill (Rajkumar; Lenz). Approximately 40% of exposed infants die within the first year of their life.

Morning sickness, from an evolutionary perspective, is not pathological; it is hypothesized to be a useful adaptation that increases the individual's chances of survival. As such, a physician informed by evolutionary principles would be unlikely to prescribe pharmacological therapy for the treatment of morning sickness (excluding hyperemesis gravidarum (HG) and emesis due to non-pregnancy related causes).

General Introduction

Several distinct changes characterize pregnancy, including changes in a woman's physiology, perception, hormonal profile, psychological state, and dietary preferences (Flaxman & Sherman, 2000). This study explores whether changes in visual perception, specifically shifts in visual discrimination and preferences also accompany pregnancy. Earlier studies have documented shifts in olfactory perception (e.g., increased generalized sensitivity) and taste perception (e.g., increased 1st trimester sensitivity to bitter taste) during pregnancy (Dastur, 2000; Duffy, Bartoshuk, Striegel-Moore & Rodin, 1998). To date, no studies have examined changes in visual perception.

The pregnancy sickness as embryo protection hypothesis proposes that the mother experiences a variety of symptoms (e.g., nausea and vomiting, increased disgust sensitivity and lethargy) in order to avoid ingestion of toxicogenic foods, which could cause abnormalities, birth defects, or fatal malformations in the embryo (Fessler, Eng, & Navarrete, 2005; Nesse & Williams, 1995; Profet, 1992). The collection of these adaptive symptoms, which we view as defenses, occurs in the mother's body as a result of shifts in the physiological and psychological functioning of systems that facilitate the selection of innocuous foods. The current study extends on the pregnancy sickness as an adaptation hypothesis, also known as the embryo protection hypothesis, by testing colour related visual changes in the mother during their first trimester of pregnancy. Our research questions are: (1) Is a shift in preference away from unripe and overripe foods associated with women in their first trimester of pregnancy when compared with nonpregnant women and (2) is an

increase in colour discrimination ability associated with women in their first trimester of pregnancy when compared with nonpregnant women.

It is important to distinguish pregnancy sickness from hyperemesis gravidarum. Hyperemesis gravidarum (HG) is an extreme form of pregnancy sickness that affects 0.3% to 2% of all pregnant women (Philip, 2003). HG is characterized by excessive vomiting that leads to dehydration, electrolyte and metabolic disturbances and nutritional deficiencies during the first trimester of pregnancy (Broussard & Richter, 1998). This condition is most likely pathological and needs to be treated.

A thorough literature review on the current state of knowledge about pregnancy sickness will be followed by an evaluation of alternative theories and hypotheses that attempt to explain pregnancy sickness.

Lines of Evidence

Historical

Modified diet and symptoms of nausea and vomiting during pregnancy have been observed in cultures as long as 4000 years before present (BP) in the Pleistocene period (Andrews & Whitehead, 1990; Profet, 1992). Profet proposed that there was considerable selection pressure for the development of pregnancy sickness in the Pleistocene era due to the high teratogenic content of wild plants compared to modern domesticated plants. Additionally, dry seasons and drought years forced hunter-gatherer societies to move from one region to another, exposing the population, including women, to new kinds of toxins. For example, a study of seasonal diet changes in hunter-gatherers in Eastern Paraguay has shown a great variability in the species of plants consumed (Hill, Hawkes, Hurtado & Kaplan, 1984). Curiously, total calories of ingested food did not vary greatly. This variation of exposure to toxins further amplified the selection pressure.

A more recently developed explanation for the high selective pressure on pregnant females to develop pregnancy sickness is attributed to the ingestion of pathogens found in meat (Fessler, 2002; Flaxman & Sherman, 2000). Two common parasitic protozoas found in meat, Plasmodium and Toxoplasma gondii are associated with congenital neurological birth defects (Fessler; Smith, 1999). Meat was an important source of food for hunter-gatherer societies, but methods for eliminating pathogens from meat were poor. Fessler suggested that the need to avoid meat-borne pathogens provided sufficient selection pressure for the evolution of pregnancy sickness.

Cross-Cultural

Cross-cultural prevalence of pregnancy sickness is also well established (Flaxman & Sherman, 2000; Profet, 1992; Schmitt & Pilcher, 2000). Flaxman & Sherman reviewed 56 studies related to pregnancy sickness and found that 62% of women across 16 countries experienced the common symptoms of pregnancy sickness (i.e.,

nausea and vomiting). Frequencies varied greatly among countries from 84% prevalence rate of symptoms in Japan to 34% in India.

Minturn & Weiher (1984) observed pregnancy sickness in 31 societies. In 23 (74%) of these societies, pregnancy sickness was clearly a pregnancy related phenomenon. However, this study did not specify whether pregnancy sickness symptoms concentrated around the first trimester, or the symptoms spread out over the full period of pregnancy.

Profet (1992) noted that there is archaeological evidence showing that !Kung women of the Kalahari Desert, and Australian Aboriginal women had vomiting and food aversions during pregnancy. Further, pregnant women had clay-eating rituals (kaolinic and montmorillonitic clays are most common) in the South American Ottomac tribe along the Orinoco Valley and in tribes in East Africa and along the Equator (Abrahams & Parsons, 1996; Profet, 1992; Wiley & Katz, 1998). Clay may protect the embryo by preventing the absorption of toxins (e.g., potato alkaloids) contained in plants (Abrahams & Parsons).

Heredity

Evidence of hereditary influence on pregnancy sickness is ambiguous. Research does show that women were significantly more likely to experience pregnancy sickness if their mother or sisters had also experienced the symptoms (Corey, Berg & Nance, 1992; Gadsby, Barnie-Adshead & Jagger, 1997; Vellacott, Cooke & James, 1988; Whitehead, Andrews & Chamberlain, 1992). Corey et al., examined the pregnancy history of 830 monozygotic and 902 dizygotic female twin pairs and performed tetrachoric correlations to measure the contribution of genetic factors to miscarriage, twinning, hypertension-toxemia and nausea and vomiting. They found that monozygotic twin pairs were significantly more concordant in experiencing pregnancy sickness than dizygotic twin pairs. A methodological drawback to this and these kinds of studies is that daughters are being assessed currently whereas mothers are being assessed by retrospective questionnaires. While currently there are no studies that reported formal heritability estimates, the current state of literature does suggest a genetic component to pregnancy sickness.

Psychological

Food aversions, one of the central symptoms of pregnancy sickness, are generally defined as a strong desire to avoid certain kinds of foods or beverages (Pope, Skinner & Carruth, 1992). In pregnancy, food aversions, measured by subjects' attitude towards foods, are aimed at foods that were consumed by the female before the pregnancy. Food aversions have shown to be so strong during pregnancy that they can induce nausea and vomiting in the person.

A study showed that women in their first trimester mentioned food aversions to coffee, tea, cocoa, vegetables, and meat and eggs the most (Dickens & Trethowan, 1971). Cooksey (1995) has a more extended list of examples including cooked vegetables, Italian foods and sauces, tea, cola drinks, milk, seafood, fried

foods, cola drinks, nonchocolate sweets, and juice. Dastur (2000) reports that the top five pregnancy related food aversions were meats (16.8%), Italian food sauces (9.6%), vegetables (9.2%), poultry (8.4%) and fried foods (7.2%).

Physiological

Fifty to ninety percent of all women experienced symptoms of pregnancy sickness during the first trimester of pregnancy (Dastur, 2000; Gadsby, Barnie-Adshead & Jagger, 1992; Klebanoff, Koslowe, Kaslow, & Rhoads, 1985; Lindseth, Buchner & Gustafson, 1998). Further, the symptoms occurred with equal probability between 7 a.m. and 11 p.m. during the first trimester of pregnancy, which is in contrast to the common belief that the symptoms occur mostly in the morning (see Figure 3).

Dastur (2000) investigated changes in olfactory sensitivity and perception in pregnant women in their first trimester. Pregnant subjects were measured longitudinally in each trimester of their pregnancy. A control group of non-pregnant women were also measured at the same time intervals. None of the women in the control group were taking oral contraceptives during the period of the study. The results showed that subjects had (a) increased olfactory sensitivity during the first trimester (i.e., threshold at which they were able to detect a smell was lower than for non-pregnant women) and (b) the findings are consistent with Profet's theory of morning sickness.

Navarrete, Fessler, & Eng (2006) found that aversions during the first trimester of pregnancy may not be exclusive to food. The study predicted that pregnant women should be more withdrawn from outgroup members during the first trimester of pregnancy because the embryo is most vulnerable to pathogens that may be contracted through contact with outgroup members. Additionally, they predicted that this withdrawal should lessen in second and third trimesters of pregnancy. Two hundred and six pregnant subjects were asked to provide their opinions on two essays; a critical essay of a foreigner about the U.S. and a positive essay about U.S. values, written by an American author. Subjects' ratings of disgust were measured on a Likert scale using a variety of statements. The results of the study showed that pregnant women in their first trimester were significantly more likely to rate the foreigner more negatively and the resident more positively in comparison to non-pregnant women. Further, this effect disappeared by the second and third trimesters. These results are consistent with the idea that pregnant women in their first trimester avoid outgroup members to protect themselves and the embryo from diseases and pathogens, which may likely be carried by outgroup members. A heavy criticism of this study is that there was no control group therefore the results could indicate a decrease in ethnocentrism in the second and third trimesters, as opposed to an increase in ethnocentrism in the first trimester. The researchers counterargued using data from their pilot study, which was based on nonpregnant women to affirm the validity of their hypothesis. Another criticism of the study was the confound in the manipulation of the independent variables. The researchers were actually manipulating two variables across conditions; the quality

of the statement and the ethnicity of the speaker. This weakness was not addressed in the article.

Theories Explaining Pregnancy Sickness

Nonfuctional Theories

There is a line of research investigating various ways to eliminate the symptoms of pregnancy sickness using herbal remedies such as ginger, peppermint and cannabis (Westfall, Janssen, Lucas & Capler, 2006; Westfall, 2003). This research, however, does not investigate the possible causes of pregnancy sickness; rather it assumes that pregnancy sickness is a pathological condition. Westfall et al., found that cannabis is an effective and supposedly safe way to control nausea and vomiting in early pregnancy. The data showed that 92% of respondents reported cannabis as "extremely effective" or "effective" in treating pregnancy sickness related symptoms. While Westfall appears to argue that women with hyperemesis gravidarum are the ones who need cannabis the most, her research sample consists of women who have normal levels of nausea and vomiting. There are two assumptions in Westfall's research that would be important to clarify before concluding that cannabis is useful for treating pregnancy sickness. First, it is unclear whether cannabis is healthy for the embryo. Some studies provided suggest evidence that women who smoked cannabis gave birth to infants who were, on an average, 150 g lighter, 1.2 cm shorter, and had 0.2 cm smaller head circumference than their nonsmoking counterparts (Balle, Olofsson & Hilden, 1999). However, these studies are confounded with smoking and low social economic status, which is why it is difficult to find conclusive evidence. Second, it is important to run the study with a representative sample. Westfall appears to focus her interest on women with hyperemesis gravidarum. However, the research sample must be representative of the target population if she is to draw conclusions about women with extreme cases of pregnancy sickness.

Some researchers have suggested that morning sickness, especially hyperemesis gravidarum, is a result of a psychological dysfunction (Quinlan & Hill, 2003, Fairweather, 1968). Fairweather administered the Cornell Medical Index (CMI) and Minnesota Multiphasic Personality Inventory (MMPI) to pregnant and nonpregnant women and found that those subjects with hyperemesis gravidarum are significantly more likely to experience hysteria, excessive dependence on their mothers, and infantile personalities. This theory is largely discredited today due the lack of evidence to support the conclusions.

Finally, some researchers suggested that pregnancy sickness could be the result of a gastrointestinal tract dysfunction (Broussard & Richter, 1998; Walsh, Hasler, Nugent & Owyang, 1996). Walsh et al, postulated that higher progesterone levels during early pregnancy may evoke abnormalities in the basal electrical rhythm of gastric contractions causing slow-wave gastric dysrhythmias. However, progesterone is not likely to be the culprit of pregnancy sickness because levels of progesterone steadily increase after the first trimester (see Figure 4). According to

Profet, other hormones such as the human chorionic gonadotropin hormone (hCG) and estradiol are much more likely candidates for triggering pregnancy sickness because hCG peaks during the first trimester of pregnancy and estradiol is known to cause nausea in nonpregnant women who have taken birth control pills (Jarnfelt-Samsioe, 1987; Morris, 1973; Profet, 1992).

Functional Theories

Forbes (2002) argues that spontaneous abortions during the first trimester and the symptoms of pregnancy sickness are not the result of embryo protection mechanisms, but are the result of a genetic conflict between the mother and the embryo. The source of the conflict is that the mother attempts to expunge embryos with intrinsic chromosomal defects by reducing the production of luteinizing hormone (LH).

Embryos with chromosomal defects are associated with the production of suboptimal levels of the hCG hormone, which is involved in maintenance of pregnancy and the probable trigger of pregnancy sickness (Forbes, 2002; Homan, Brown, Moran, Homan & Kerin, 2000). As such, pregnancy sickness has an indirect adaptive value, not a direct one, as suggested by the embryo protection hypothesis. Forbes presents 5 lines of evidence for the genetic conflict hypothesis. First, pathogens and mutagens occur naturally in the diet and some foods have harmful effects (Flaxman & Sherman, 2001, 2000; Schardein, 1996; Profet, 1995; Minturn & Weiher, 1984). Second, pregnancy sickness is associated with food aversions, and strong and pungent odors are often correlated with the presence of pathogens or mutagens (Flaxman & Sherman, 2000; Profet, 1995). Third, pregnancy sickness occurs during organogenesis, when the developing embryo is at greatest susceptibility to mutagens (Profet, 1995). Fourth, the incidence of pregnancy sickness correlates with diet; pregnancy sickness is absent from societies that consume less harmful foods (Flaxman & Sherman, 2001, 2000). Finally, the 5th line of evidence that is consistent with both embryo protection hypothesis and inferior chromosome quality hypothesis is the correlation of pregnancy sickness with pregnancy outcome; women without pregnancy sickness are more likely to experience stillbirths, miscarriages, and spontaneous abortions (Weigel & Weigel, 1989). The evidence that Forbes presents to support the chromosomal defects hypothesis is also consistent with the embryo protection hypothesis. Forbes' argument for the inferior chromosome hypothesis is that the correlation between diet across cultures and prevalence of pregnancy sickness is spurious. Low prevalence of pregnancy sickness in some societies could be due to the poor nutritional content of foods available to women; not the other way around as suggested in the embryo protection hypothesis that women in some cultures choose (non-consciously) to under-nourish themselves. Forbes also neglects to mention shifts in olfactory and taste perception that also occurs in the first trimester, both of which support the embryo protection hypothesis.

Profet (1992) was the first to articulate the embryo protection hypothesis using multidisciplinary empirical evidence. The hypothesis built on Hook, Little and

Walker's observations about food aversions to specific foods such as alcohol, tobacco, meat, fish, coffee and fatty foods (Hook, 1978; Little & Hook, 1979; Walker, 1985). Profet proposed that pregnancy sickness is an evolved adaptation to limit fetal exposure to toxins in the maternal diet. The core pieces of evidence that support this hypothesis are that (a) the timing of pregnancy sickness coincides with organogenesis, a period when the embryo is most vulnerable to developmental defects; (b) women with pregnancy sickness experience food aversions especially towards foods that are high in teratogenic content; (c) and olfactory sensitivity becomes hyperacute during the period of pregnancy sickness, enabling better detection of toxins in foods. Profet suggested that the mechanism of pregnancy sickness is the result of the recalibration of the chemoreceptors of the chemoreceptor trigger zone (CTZ), gastrointestinal region, and olfactory epithelium.

More recently, Flaxman and Sherman (2000) offered further support for the embryo protection hypothesis by showing that pregnancy sickness is associated with the avoidance of spoiled foods, burned meats, fish and eggs.

Visual Perception

According to Profet's theory, we should see physiological and perceptual changes during the first trimester in sensory systems that enable the pregnant woman to select the least harmful foods. Changes in olfactory, visual and taste perception are likely the sensory mechanisms by which these cues of toxicity are detected, typically at thresholds lower than before the pregnancy. Evidence of lowered olfactory thresholds during the first trimester has been documented along with shifts in taste perception (Nordin, Broman, Olofsson & Wulff, 2004; Dastur, 2000; Duffy, Bartoshuk, Striegel-Moore & Rodin, 1998; Gilbert & Wysocki, 1991). Beyond olfactory and taste changes, we hypothesize that visual changes may also support this defensive view of pregnancy sickness.

Pregnant women who can better discriminate between good and bad foods will expose their developing embryos at lower risk than those who can not. However, we have a great gap in our knowledge about the kinds of visual perceptual changes that take place, if any, during the first trimester.

Present Study

The goal of this present study is to learn about what kinds of visual changes, if any, may be happening to women during their first trimester of pregnancy. More specifically, we are interested in examining whether there are any shifts in the woman's ability to discriminate between colours and whether there are any shifts in preferences for foods at varying levels of ripeness or freshness.

Hypotheses & Predictions

The hypothesis of the objective component is that women in their first trimester of pregnancy will exhibit increased colour discrimination ability compared with nonpregnant women. Our prediction is that there will be a significant decrease of

error scores on the Farnsworth Munsell 100 hue test for all 4 hues. The hypothesis of the subjective component is that women in their first trimester of pregnancy will find unripe and overripe foods less appetizing compared with nonpregnant women. Our prediction is that there will be a significant decrease in ratings of appetizingness for unripe and overripe foods.

Methods

Subjects

Fifteen women served as subjects in the study. Six of these subjects were pregnant women in their first trimester and another 9 subjects were non-pregnant women, who served as a comparison group.

We recruited subjects from the Greater Vancouver Regional District (GVRD), British Columbia, over a 3-month period. Recruitment methods included Google Adwords Internet advertising, poster advertisements at Kwantlen University College, medical clinic boards, midwifery offices, blood clinics (employees only), and through word-of-mouth. The Google Adwords ads appeared in search results to over 150 search words related to pregnancy (for a list of keywords, see Appendix I) and on content-network pages. Content-network pages are websites that display Google advertising on their pages (for a list of content-network pages, see Appendix J). Google Adwords was configured so that only visitors in the GVRD region were able to see the advertisements. However, due to some inaccuracies, 5 participants from Ontario, California and Vancouver island also signed up to participate. These women were informed that the study is conducted on-site, and unless they can come to the campus, we won't be able to run the study with them.

Ethical Approval

The protocol, informed consent, and posters were submitted to the Kwantlen Research Ethics Board (REB) for ethical approval. Informed, written consent was obtained from every subject (see Appendix A) before participation in the study. Main points of the informed consent were also reiterated to the subject including the following elements: voluntary participation, confidentiality of collected data, and withdrawal from study without penalty. Subjects were informed about the purpose of the study, but not about specific hypotheses as they could serve as demand characteristics and could bias the results of the study.

Risks & Benefits

Each subject received $15 cash for participating in the study and was entered into a prize draw for a fruit juicer ($150 value). Participants were informed that they had a 1 in 60 chance to win. Additionally, subjects were educated about the purpose of this study and were offered resources if they were interested in learning about the phenomenon in more detail. There were no direct health benefits to completing this study.

Subjects were not exposed to significant harm during the study. There was a chance that the images of foods (e.g., spoiled broccoli) evoke nausea and possibly even vomiting in a minority of pregnant subjects. This potential risk was explained to women and they were reassured that such a response, while unlikely, is a normal reaction to such images. Also, the testing room was situated close to a washroom to be prepared for such an experience. The subjects, as always, were free to discontinue the study at this or any point if they so choose.

Inclusionary Criteria

Confirmed First Trimester Pregnancy

Women were considered pregnant after a self-reported confirmation of a urinary or blood test. The date of conception was also collected through self-report of the women. Acceptable means for the determination of the date of conception date were obtained from an ultrasound test in combination with the results of an ovulation period test, or two weeks after the women's last menstrual period (LMP), which approximates the time of ovulation. The two methods produce results that do not significantly deviate from each other (Olesen, Westergaard, Thomsen & Olsen, 2004). Women who were between 6-12 weeks post-conception and experienced at least one symptom of pregnancy sickness were included in the study. Two subjects were over the 12-week threshold (15 & 17 weeks), but were allowed to participate due to the difficulty in recruiting first trimester participants.

Corrected to Normal Vision

Women who had normal or corrected to normal vision, such as women who wore glasses, contact lenses, or have gone through laser corrective surgery were permitted to participate in the study. One pregnant subject had a corneal transplant recently that made her eyes sensitive to light. She was included in the analyses because corneal transplants are not associated with chromatic discrimination changes.

Age Restriction

Women who were between the ages of 20 and 39 were permitted to participate in the study. The reason for the age restriction is twofold. First, colour-discrimination ability is best between the ages of 20 to 39 (Kinnear & Sahraie, 2002; Mantyjarvi, 2001). Second, the optimal age of child bearing is between the ages of 18 and 40 (CDC, 2004; Dickinson, 2005). Additionally, an age restriction was essential for this study because women above the age of 40 years have a significantly higher proportion of miscarriages and genetic malformations.

Non-pregnant Women

Women with normal menstrual cycles (23 to 35 day long cycles) could participate in the study. A menstrual cycle is defined as the period from the first day of menstrual bleeding to the last day before the next menstrual period. Normal length of

menstrual cycle varies between 23 and 35 days with 28 days as the median length of a menstrual period (Solomon, et. al., 2001; Wilcox, Baird, Dunson, McChesney, & Weinberg, 2001). Further requirements for participation were that women had to be in a non-lactating, non-menopausal phase of their lives. They could be in any phase of their menstrual cycle, but they must not been taking hormonal contraceptives for at least 6 months.

Exclusion Criteria

All criteria applied to both the pregnant and non-pregnant groups unless otherwise specified under the subheading.

Nausea & Vomiting Interventions

Women taking pharmacological or non-pharmacological treatment for nausea and vomiting were excluded. Artificial reduction in nausea and vomiting would confound with the two conditions in the study.

Contraceptive Use

Women who use contraceptives that alter hormonal levels were not permitted to participate in the study (condoms o.k.). Hormonal contraceptives such as ethinyl estradiol, norgestrel, diethylstilbestrol, and norethindrone were excluded. Hormonal contraceptives are associated with fluctuations in olfactory sensitivity, which may affect food aversions and cravings, and symptoms of nausea and vomiting (Doty, Snyder, Huggings, & Lowry, 1981).

Use of Drugs

There are drugs that are known to affect patients' visual-perception (Eisner & Incognito, 2006; Eisner, Burke & Toomey, 2004). Subjects that took such drugs were excluded from the study.

Tamoxifen is a drug that is prescribed as adjuvant therapy for women who have breast cancer. Subjects who took Tamoxifen for a period longer than 2 years have been shown to have poorer colour-discrimination abilities. Subjects who have taken drugs that are known to produce such effects will be excluded.

Medical Conditions

There are medical conditions that affect vision. Subjects that are diagnosed with any of the following medical conditions were excluded from the study (see Appendix G).

Inexperience with Foods

Women with limited experience with a range of foods (e.g., vegans or wide-spread food allergies) were excluded from the study. Women who do not eat foods that are used in the study would be unable to accurately assess the food's ripeness or freshness, therefore making inaccurate assessments of appetizingness.

Procedure

Subjects completed the study in the psychology lab's testing rooms at Kwantlen University College, or in the offices of the Obstetricians and Gynecologists. Test administration was scheduled between 10:00 A.M. and 6:00 P.M. to minimize the interference of circadian rhythms on the subject's wakefulness. However, some subjects requested to be tested outside of this time interval. The testing rooms' windows and doors were covered with a solid material to ensure that the only source of light is from the full light spectrum viewer. The SpectraLight-3 (D50 bulbs) full-spectrum natural light booth produced the illumination in the testing rooms.

The test was administered individually to ensure each subject understood the instructions. Individual attention to subjects allowed for clarifying any misunderstandings and confusions about the study or the instructions. This configuration also allowed us to informally collect qualitative data about how subjects behaved and responded to the stimuli and our methodology.

Test Administration

Subjects arrived in the testing rooms at a scheduled time. The research assistant discussed the nature of the research, went over the informed consent documents with the subject and asked the subject to sign the consent form if she agrees to participate (see Appendix D). Confidentiality, voluntariness and privacy of their participation were emphasized at this stage. After signing the informed consent, subjects were given the $15 cash in an envelope. Subjects then completed the demographic questionnaire. This was followed by the administration of the Farnsworth-Munsell 100 (FM100) Hue test (the objective component) and the Food Appetizingness Test (FAT) (the subjective component). At the end, subjects were debriefed by informing them about the goals of the study (see Appendix E). They were then given time to read the debriefing form and given a chance to ask questions and make comments. Subjects were provided with our contact information in case they wish to follow up with us at a later time. Subjects were not told the hypothesis of the study because we wanted to ensure they do not inadvertently tell another potential subject about it.

Instrument

Viewing Booth

We used the Judge IIS viewing booth with (D50) bulbs (produces full-spectrum light) to administer both the objective component of the study.

Farnsworth-Munsell 100 Hue Test (FM100)

The FM100 test was used to measure subject's colour discrimination ability. The test consists of four trays containing 85 removable colour reference caps (incremental hue variation) spanning the visible spectrum. Colour vision

abnormalities and aptitude are detected by the ability of the test subject to place the colour caps in order of hue. Scoring of the colour caps is completed through a Windows based scoring program. The test was administered in daylight conditions that were established using the Judge IIS viewing booth.

Food Stimuli

We purchased a diverse variety of foods from a local grocery store (see Appendix H). The foods were stored in the research lab at room temperature in low humidity. The warm temperature stimulated the decaying process. Due to low humidity, most foods shrank dramatically as their water content evaporated. We decided to put the foods in a bag with a slice of apple to slow down the shrinking process and increase the decaying process.

Meat Stimulus

An Australian studio produced time-lapse video of a piece of raw beef. The period of the time-lapse was 1 week. The studio provided a steep discount for us in exchange for displaying their logo in poster presentations.

Camera & Lighting

To take pictures of the stimuli, we used a FujiPix S20 Pro prosumer (i.e., high-end consumer) camera on a tripod stand. We ensured that the camera was fixed in the same position and location for the period we took photos of the fruits and vegetables. The camera was configured in macro mode with shutter speed of 6/1000 second and aperture set to maximum (F11) in order to maximize depth of field. As a result, more of the stimulus was in focus, which increased contrast around the edges of the fruits and vegetables and minimized blurry areas. Further, manual focus allowed us to focus the image more accurately in the low light environment. The resolution of the image was set to highest (2832 x 2128 pixels, 6 Megapixel). We placed the stimuli in the Judge IIS viewing booth to ensure standard full-spectrum lighting. The room had two sources of external light; (a) one window, and (b) glass portion of the door. Blinds on the window and aluminum foil on the glass portion of the door minimized external light from entering the research room.

Time-Lapse Photography

We photographed the foods every 2 days for 20 days, at which point all foods had decayed. We took photos of the broccoli and lettuce every day for 11 days because of their faster decaying rate. The photographs were not manipulated or touched-up in any way once transferred onto the computer. The only change we made to the photos was to crop them in order to fit the photos on a slideshow.

Demographic Questionnaire

The demographic questionnaire collected general information about the subject including the subject's age, ethnic background as defined by the subject, medical

condition that might interfere with their vision, and use of glasses or contact lenses. The data was collected through an electronic form at a computer workstation and stored in a MySQL database.

Food Appetizingness Test (FAT)

The test was administered at a computer workstation in the testing room. The food images were presented in a randomized manner. Each slide consisted of one food at 6 stages of its ripeness or freshness. The slide consisted of images that ranged (a) from a completely unripe fruit to a completely ripe fruit and, or (b) from a completely ripe fruit to completely overripe fruit (the unripe and overripe fruit series were analyzed separately). In order to avoid order effects, the presentation of the slides was also randomized. Each food was rated over 3 trials, which meant that each slide was presented 3 times; randomization of the images ensured that the order of the images on the slide were different across the 3 trials.

The subjects were asked to rate each photo on a Likert-like scale of 1 – 7 (anchors: 1-very unappetizing, 4-I would eat it, 7-very appetizing). The rating scale was positioned below each image. Subjects were allowed to rate the fruits on the screen in any order they wish because this mimicked a real-life situation more closely. In a real-life situation, people are presented with a number of choices (e.g., fruits on a tree, vegetables in the market) from which they make a decision about the most appetizing and least appetizing foods.

The Food Appetizing Test was built with PHP Hypertext Preprocessor (PHP) and MySQL (SQL: Structured Query Language) database technology. The testing computer was configured to run PHP and MySQL locally, avoiding the need to connect to the Internet. This enabled us to collect the data securely using a flexible and powerful platform.

Funding

Two $5,000 Kwantlen Minor Research Grants (MRG) were provided to Dr. Farhad Dastur to fund this study.

Results

A total of fifteen subjects participated in the study (6 pregnant, 10 nonpregnant). The mean age of the pregnant group was $\bar{x}_{pregnant} = 34$ and the mean age of the nonpregnant group was $\bar{x}_{nonpregnant} = 26.4$. The pregnant group included 4 Caucasian, 1 Indo-Canadian and 1 Fijian-Canadian subject. The nonpregnant group included 6 Caucasian, 2 Chinese-Canadian, 1 Indo-Canadian and 1 Filipino-Canadian subjects. In the pregnant group, 5 subjects worked full time and 1 subject worked part-time. In the nonpregnant group, 3 subjects worked full time, 3 worked part time, 2 were full time students and another 2 were in the “other” category (e.g., unemployed). Finally, the pregnant group had 3 subjects that had 1 to 4 years of post secondary education and 3 subjects that had more than 5 years of post-secondary education.

The non-pregnant group had 7 subjects who had 1 to 4 years of post-secondary education, 1 subject that had 5 or more years of post-secondary education and 2 subjects who had none.

(Insert Table 1 around here)

Objective Component

The FM 100 test score and time to complete was recorded for this part of the study. The test score is reported in terms of total error scores (TES). In addition to the raw TES score, we also reported the logarithmic TES values as described in FM 100 standardization studies (Kinnear & Sharaie, 2002; Mantyjarvi, 2001; Roy, Podgor, Collier & Gunkel, 1990). We ran a one-factor ANOVA to test the difference in the means of the Log TES scores in the pregnant and non-pregnant groups. The Log TES means turned out to be significant ($F_{(1,4.1)} = 4.756$, p<.05) (see Table 2).

(Insert Table 2 around here)

The assumptions of the ANOVA have been met. The Log TES charted on a histogram displays a normal curve, and Levene's test for equality of error variances was not significant ($F_{(1,4.1)} = .234$ $p = .636$).

Subjective Component

For each food, we performed a one-way ANOVA's resulting in 10 analyses. Appetizing rating for each food image was the dependent variable in the mode, and the status of the participant (pregnant or non-pregnant) was the independent variable. The means for 10 food groups are displayed in Table 3.

(Insert Table 3 around here)

Ten one-way multivariate analyses of variance (MANOVA) were performed to determine the effect of pregnancy on the 6 dependent variables, the 6 stages of food images. No significant differences were found among the 6 stages on any of the food images, Wilks's $\Lambda = .52$, $F(6,9) = 1.37, p = .32$ for the apple, Wilks's $\Lambda = .42$, $F(5,9) = 2.51, p = .11$ for the banana, Wilks's $\Lambda = .86$, $F(6,9) = .24, p = .95$ for the broccoli, Wilks's $\Lambda = .91$, $F(5,10) = .20, p = .95$ for the lettuce, Wilks's $\Lambda = .64$, $F(6,9) = .85, p = .56$ for the mushroom, Wilks's $\Lambda = .63$, $F(5,10) = 1.17, p = .38$ for the papaya, Wilks's $\Lambda = .48$, $F(6,9) = 1.62, p = .25$ for the pear, Wilks's $\Lambda = .73$, $F(6,9) = .56, p = .75$ for the raspberry, Wilks's $\Lambda = .58$, $F(5,7) = 1.02, p = .47$ for the steak, and Wilks's $\Lambda = .48$, $F(6,9) = 1.58 p = .26$ for the tomato. ANOVA's were not necessary as follow up tests to the MANOVA.

Discussion

The objective component of the study supports our prediction that pregnant women have a significantly increased ability of chromatic discrimination as shown by the

FM 100 hue test. The statistical analysis shows that women in their first trimester have much better ability to discriminate between fine differences in colours. If we were able to get participants who perfectly fit our criteria (within the first trimester, no visual problem), it is likely that the significance of our findings would be further amplified.

The subjective component of the study does not support our prediction that pregnant women find foods significantly less appetizing when compared with nonpregnant women. The findings show that pregnant and non-pregnant women find the 10 categories of food images similar in terms of level of appetizingness. The appetizing rating means show a very small tendency for pregnant women to rate foods lower in appetizingness. The mean difference was largest on the fresh steak image where most pregnant women rated the meat to be very unappetizing, while non-pregnant women found the steak quite appetizing. Many pregnant subjects made a note to tell me that the steak was so disgusting that they had to skip rating it. None of the non-pregnant subjects had such an issue. This is consistent with the evolutionary embryo protection hypothesis as meats are the most dangerous to the embryo as meat carries the most dangerous pathogens (Flaxman & Sherman, 2001, 2000).

One reason for not finding significant differences among the two groups (pregnant and nonpregnant) might be due to the increased variability introduced through individual differences. The cross-sectional study design increased the noise in the data greatly, reducing our chances of finding a significant difference. It may be possible to overcome this obstacle by dramatically increasing the sample size, or by designing a repeated measures study where subjects are tested while they are pregnant and then tested again after they gave birth.

Overall, the result of the objective component serves as another test of the hypothesis that pregnancy sickness has evolved to protect the embryo during the first trimester of pregnancy. Previous research has shown that olfactory and taste sensitivity goes through a physiological and perceptual change during the first trimester of pregnancy, but this is the first study to provide preliminary evidence that similar physiological and perceptual changes may be occurring on the visual domain too (Nordin et. al, 2004; Dastur, 2000; Duffy et. al, 1998; Gilbert & Wysocki, 1991). We think that these physiological and perceptual changes occur together because they are all involved in the selection of edible foods.

Selection of edible foods involves the integration of information about the food coming from all of our senses. Depending on the stage of the food selection (e.g., attention, exploration, decision to eat), we rely on different senses to give us information about the food in question. For example, imagine a situation our ancestors may have likely faced. As they walked in a forest and spotted a berry in a bush, they first relied on almost exclusively visual information. If there were many berries around, they may have been able to smell the berries in which case they would have received some olfactory information about the berries in the area. As they walked up to the berry and picked a berry from the bush, they received tactile

information as they touched the food. Additionally, they had much more refined visual information because they can position the berry close-up in the middle of their visual field where their visual acuity is highest. If the berry passes this test, they would put the berry in their mouth, where they would receive further information about the berry; namely, taste and more refined olfactory information.

Future studies could explore further changes in the visual domain by setting up the study with a longitudinal design. This allows increased experimental control and would enable picking more subtle changes in pregnancy. Another area that could be explored is whether or not there are any specific hues to which pregnant women become more sensitive during the first trimester. It could be, perhaps that first trimester women are more sensitive to yellows and reds, colours of ripeness. Or conversely, it could be that first trimester women become more sensitive to bluish colours that signify fungi and rotten food. We have also not analyzed the data to see if there is differential discrimination for a specific hue in pregnant women, but it would be a curious idea to explore this possibility in a future project.

The present study provides sufficient support to the idea that first trimester pregnant women's visual discrimination ability may become more sensitive at least during the first trimester, but possibly even in the second and third trimesters. This in turn provides further support that pregnancy sickness serves to protect the embryo during its most vulnerable time of development.

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Appendix A

Kwantlen
UNIVERSITY COLLEGE

Consent Form

Colour-related perceptual shifts in first trimester pregnant women

Dr. Farhad Dastur, Chair, Pschology Dept. Kwantlen University College

Levente Orban, Honours Student, Psychology Dept. Kwantlen University College

Application #: [xxx xxx xxx]

The University College and those conducting this study subscribe to the ethical conduct of research and to the protection at all times of the interests, comfort, and safety of subjects. This form and the information it contains are given to you for your own protection and full understanding of the procedures. Your signature on this form will signify that you have received a document (please see attached form) which describes the procedures and benefits of this research project, that you have received an adequate opportunity to consider the information in the document, and that you voluntarily agree to participate in the project.

Voluntary Participation

Your participation in this research project is completely voluntary. You have the right to withdraw from the research study at any time without any penalties.

Confidentiality

The collected data will be held confidentially in a locked drawer at Kwantlen University College. [more]

About This Study

The purpose of this fun, safe and stimulating research study is to learn about what kind of perceptual changes occur, if any, during the first trimester of pregnancy. The length of your participation would take approximately 1 hour. You will not be followed up once you complete this study, however, you will have a chance to follow

up with us if you so choose. The study will be administered in a psychology lab or a doctor's office in full. You will not be asked to move to another location.

The study has two parts. The first part of the study consists of you viewing a series of coloured caps and placing them in their proper order of hue. This portion of the study takes approximately 25 minutes. The second part of the study consists of you viewing a series of food images and rating each food on their level of appetizingness. You will view about 300 images in total, which will take approximately 25 minutes to complete.

The study will proceed at a pace that is comfortable for you. There are no time limits and you can take a break at any point during the study.

Risk of harm, discomfort or inconvenience

Some of the images may evoke nausea in you. Be assured that this response, while unlikely, is completely normal. Pease feel free to stop the study at any point you feel you need to go to the washroom.

Benefits

Benefit to subject: You will receive $15 cash to help cover transportation costs to participate in this study. Further, you will be entered for a chance to win a fruit juicer ($100 value). You will have a 1 in 60 chance to win.

Benefit to society: Today, we know very little about what kind of perceptual changes occur during pregnancy. This study will fill the vacuum that in this area of research. Further, the results of this study may support the pregnancy sicknes as adaptation hypothesis, which is an evolutionary theory that suggests that pregnancy sickness developed as a defense mechanism to protect the embryo and avoid toxic substances during the first trimester of pregnancy.

Funding

This study was funded by two Kwantlen Minor Research Grants.

Persons to Contact

If you want to talk to anyone about this research study because you think you have not been treated fairly or think you have been hurt by joining the study, or you have any other questions about the study, you should call the principal investigator, Dr.

Farhad Dastur at (604) 599-2170, or call the Kwantlen Office of Research and Scholarship at (604) 599-2373.

Once you have read this document, or the document has been read and explained to you, and you have been given the chance to ask any questions, please sign or make your mark below if you agree to take part in the study.

Print Name of Subject: _____

_____ _____

Signature of Subject Date Signature of Witness Date

_____

Witness to Consent if Subject Unable to Read or Write Date

(Must be different than the person obtaining consent)

To receive a summary of the results, pease complete this section:

_ _

Email Address

Signed copies of this consent form must be 1) retained on file by the principal investigator, 2) given to the subject and 3) placed on file in the Office of Research and Scholarship at Kwantlen University College.

Appendix B

RESEARCH ETHICS BOARD

APPLICATION FOR ETHICS REVIEW

Cover Page

Application #

(For REB use only)

(Please submit your application via e-mail to research@kwantlen.ca)

Title of project

Shifts in Food-Related Colour Preferences in First Trimester Women

Principal Investigator

Dr. Farhad Dastur

Position

Chair

Department

Psychology

Contact telephone numbers

Office: (604) 599-2170, Cell: (778) 772-9428

Email

farhad.dastur@kwantlen.ca

Other contact methods (optional)

Fax Pager

Preferred address to receive correspondence and/or approval if other than email

Co-investigator(s) (Name, Position, Department)

Levente Orban, honours student & research assistant, Psychology

Additional assistants and their roles

4 key words

pregnancy sickness, evolution, visual perception

Proposed Start Date: JAN 2008 Proposed End Date:MAY 2008

(Expect a minimum of 6 – 8 weeks for a response from the Research Ethics Board.)

Signature:

Principal Investigator: FARHAD DASTUR

Date: NOV 15, 2007

Full title of research

Shifts in Food-Related Colour Preferences in First Trimester Women

Describe the purpose of the research.

The purpose of this study is to investigate pregnancy-related changes in visual perception.

Context

Pregnancy is characterized by several distinct changes including changes in a woman's physiology, perception, hormonal profile, psychological state, and dietary preferences. This study explores whether changes in visual perception, specifically shifts in visual discrimination and preferences also accompany pregnancy. Earlier studies have documented shifts in olfactory perception (e.g., increased generalized sensitivity) and taste perception (e.g., increased 1st trimester sensitivity to bitter taste) during pregnancy (Dastur, 2000; Duffy, Bartoshuk, Striegel-Moore & Rodin, 1998; Gilbert & Wysocki, 1991). To date, no studies have examined changes in visual perception.

Pregnancy Sickness as a Beneficial Adaptation

The first trimester (up to approx. 12 weeks post conception) is a time of significant embryonic organogenesis: the development and differentiation of the embryo's major organ systems (Moore, 1982; Seeley, Stephens, & Tate, 1992). It is also the time associated with the greatest number of miscarriages (Wilcox, Baird, & Weinberg, 1999). Exposure to toxins during the first trimester is a risk factor for the development of birth defects or miscarriages because the embryo and its developing organs have few defenses against such toxins (Hodgson & Levi, 1987). Toxins are found naturally in many foods, either as defenses against pests or as a result of bacteria, fungi, or molds. The cues for these toxins are typically strong and bad odours and bitter or sour tastes. Profet (1988; 1992) theorized that the symptoms of pregnancy sickness—nausea, vomiting, and food aversions—are actually defenses that the mother's body uses to avoid food-related toxins. It is no coincidence then, that first trimester is also the period most associated with both sensory changes and symptoms of pregnancy sickness. Changes in olfactory and taste perception are likely the sensory mechanisms by which these cues of toxicity become detected, typically at thresholds lower than before the pregnancy. Evidence of lowered olfactory thresholds during first trimester have been documented (Dastur, 2000). Beyond olfactory and taste changes, we hypothesize that visual changes may also support this defensive view of pregnancy sickness. Pregnant women who can better discriminate between good and bad foods will put their developing embryos at lower risk than those who can't.

Relevance

The relevance of this line of research is twofold. First, if the predictions are supported, it will provide empirical support for a theory that re-conceptualizes pregnancy sickness in non-pathological terms and embeds the experience of symptoms (e.g., food aversions) in an adaptive analysis of health and illness. Second, the information from this research fills in the almost complete void in our knowledge of whether changes in visual perception accompany early pregnancy and what those changes are.

Describe the research question or hypothesis to be tested if known.

The theory that pregnancy sickness is an evolved adaptation to limit fetal exposure to toxins in the maternal diet was used to generate two hypotheses: 1) that 1st trimester women will have increased colour discrimination ability relative to nonpregnant controls; and 2) that 1st trimester women will rate images of unripe, overripe, or spoiled foods lower in preference than nonpregnant controls. For example, we expect increased preferences for hues associated with ripeness in fruits

and vegetables (yellows, oranges, and reds) and decreased preferences for hues associated with foods that are unripe, overripe, or spoiled (greens, blues, and browns).

We hypothesize that these shifts in colour preference are one of the perceptual cues that pregnant women use to make decisions that discriminate between foods of varying levels of quality (e.g., ripeness, spoilage, etc). In this formulation, a shift in visual perception is akin to a line of defense in a larger and integrated set of defenses that serve to protect the developing embryo.

Describe the methodology of the research study/project.

Our first hypothesis will be tested with an objective test and our second hypothesis will be tested with a subjective test.

I. Objective Discrimination Test

We use a quasi-experimental design with two levels of the quasi-independent variable (1st trimester vs. nonpregnant). In our objective test of colour discrimination we use the Farnsworth Munsell 100-Hue test (FM-100). This test is an easy-to-administer, portable, and highly effective method for measuring an individual's colour vision. It has been used by ophthalmologists, optometrists, vision researchers, government and industry for over 40 years to identify colour vision ability and colour vision deficiencies.

The dependent measure is the number of errors on the FM-100 Hue test. We predict that first trimester women will display fewer discrimination errors indicating better discrimination ability.

II. Subjective Preference Test

We use a quasi-experimental, between-within groups design with 2 levels of a quasi-independent variable (1st trimester vs. nonpregnant) and 6 levels of an independent variable (age of food). A series of high-resolution food images will be displayed to the subjects using a data projector in a darkened room. Measures will be taken to ensure consistency of stimuli presentation. Subjects will rate each food image for "appetizingness" on a 1 -7 Likert-like scale: 1 = very unappetizing, 4 = I would eat it, 7 = very appetizing. Several kinds of foods (fruits, meats, and vegetables) will be presented at varying levels of the foods' ripeness, freshness, or spoilage. Examples of the foods include tomato, banana, steak, bread, broccoli, pear and papaya. Six images of each food, corresponding to six ages, will be presented simultaneously and in random sequence. The presentation of each different set of food images will also be randomized. The subjects will rate each photo over three

trials. Subjects will have as much time as they need to complete the ratings and they will be free to take breaks at any point during the study.

The dependent measures are the preference ratings for each food. We predict that first trimester women will have lowered preferences across all ages of the foods, especially those ages far from ripeness (unripe to overripe) or freshness (fresh to spoiled).

Procedure

Subjects will be tested in a quiet and private testing room either at Kwantlen University or in the office of an Obstetrician/Gynecologist. Testing will occur any day of the week between 10 a.m. and 7 p.m. to avoid potential circadian rhythm effects. Upon completion of the informed consent procedure, and the demographic questionnaire (e.g., age, education level), subjects will complete the two tests of the study, first the objective discrimination test followed by the subjective preference test, and lastly the debriefing. We anticipate that this entire procedure will require 1 hour.

Describe the method(s) of recruiting participants.

We intend to test 60 participants in this study. We plan to use several methods to recruit participants including newspaper ads, posters placed at universities, hospitals, and community spaces, word-of-mouth, and ads on relevant internet sites (e.g., the Psychology lab website). Obstetricians and gynecologists will be approached for permission to advertise to their client/patients and, if conditions permit, to test those subjects within their offices.

Describe the participant groups in this study.

Inclusionary Criteria:

All subjects will be healthy women between the ages of 20 and 40.

Pregnant women will be included for participation if they have confirmed pregnancies and they have experienced any of the following symptoms within the past month: nausea, vomiting, dry heaves, food aversions, noticeably increased smell sensitivity.

First Trimester Group: First trimester will be defined as 6-12 weeks post conception (from last menstrual cycle or ultrasound determination). Pregnancies will be confirmed by a pregnancy test or ultrasound (as reported by the subject).

Nonpregnant Control Group: Women at any phase of their menstrual cycle, not in menopause, and not taking hormone-based contraceptives (as these might influence visual perception).

Exclusionary Criteria

Any subjects taking medications (e.g., the anti-epileptic drug phenytoin) or with a medical condition (e.g., macular degeneration) known to alter visual perception will be excluded.

Subjects with visual system problems such as severe astigmatism or uncorrected myopia will also be excluded.

Subjects with greatly limited experience to a range of foods (e.g., vegans or wide spread food allergies) will be excluded.

Pregnant women who conceived through interventions at a fertility clinic will be excluded.

Will the study involve any potential risks to the participants? If so, please describe the risks.

The images of some of the foods (e.g., spoiled broccoli) may evoke nausea and possibly even vomiting in some of the pregnant subjects.

This potential risk will be explained to the women and they will be reassured that such a response, while unlikely, is a normal reaction to such images. The testing room will be situated close to a washroom in the event of such an experience. The subjects, as always, will be free to discontinue the study at this or any point if they so choose.

Describe your informed consent procedures where applicable. Where it is not applicable, explain why it is not, e.g. where one is studying the public activities of politicians who have agreed to publicity, consent is already given. (Be sure to consider all of the elements of the Requirement for Free and Informed Consent in the guidelines.)

Subjects will receive an informed consent form before participating in the study which they will be free to take home in order to have information about the study, the investigator's name, and contact info. Subjects will be encouraged to read the consent form thoroughly before deciding to participate. Additionally, the research assistant will verbally explain the study and the procedures taken to protect the rights and confidentiality of the subject and their data. Any questions the subjects may have will be answered. Subjects will be told verbally and in the consent form that they are free to withdraw from the study at any time without penalty. They will also be told that their continued participation should be as informed as their initial consent and they should feel free to ask for clarification or new information throughout their participation.

The honour's student / research assistant (Mr. Levente Orban) will be trained in good ethical procedures surrounding confidentiality and respectful treatment of human participants. He has also completed the TCPS Research Ethics Tutorial in 2007 and has completed a course in Professional and Ethical Issues (Psyc 4800).

Where deception is used, please include your rationale and debriefing procedures.

This study does not use deception. The specific and detailed hypotheses and predictions of the study will not be shared with the subjects at the beginning of the study in order to avoid response bias. Full disclosure of the hypotheses will occur at the debriefing.

What provisions are made for informing participants, for follow-up with participants?

Subjects will be given a chance to request a summary of the results of the study.

How do you plan to handle the requirement of confidentiality and/or anonymity where applicable?

Subjects' responses will be treated confidentially. Data for each subject will be collected on a laptop computer in a database program (MySQL) that is password protected. A backup of the data will be placed on a memory stick which will then be placed in a locked filing cabinet in the Principal Investigator's locked office at Kwantlen.

Describe any potential conflict of interest of anyone involved in the research.

The principal investigator is the current chair of the research ethics board. To address this conflict of interest, the principal investigator will not participate in the ethical evaluation of this project. The results of that determination will be communicated by another member of the research ethics board.

Describe any provisions for compensation of participants if applicable.

All subjects will be offered compensation for travel expenses of $15 cash. In addition, all subjects will be eligible to win a juice maker (approximate value $100). The odds of winning, which will be communicated to the subjects, are 1 in 60. We believe that the value of this prize and the odds of winning represent a small incentive and not an undue inducement to participate.

To what purposes will this research be put? Will it be published or presented to an audience outside Kwantlen?

1. This project serves as a partial fulfillment of the requirements for the Honours portion of the Bachelor of Applied Arts program degree in Psychology.

2. We intend to present the results of this research at the following research conferences:

June 1 - 4, 2008: Human Behavior and Evolution Conference (HBES), Kyoto, Japan

July 17 - 20, 2008: International Society for Human Ecology (ISHE), Bologna, Italy

3. We intend to publish the results in a peer-reviewed academic journal (e.g.,

Evolution & Human Behavior Journal.

14. Please notify the REB when your research is complete. Please submit an

annual succinct status report to let us know if there are any changes from what was described in this application.

This form must be resubmitted after approval if there are major changes to your study. See part C of the Kwantlen University College policy on post approval monitoring. Major changes include changes in protocol, consent, risks, participant groups, recruitment, compensation, deception, confidentiality, anonymity, researchers involved, or other ethically sensitive matters. Please highlight changes on the resubmitted form.

Date: Nov. 15, 2007 Signature:_____

Appendix C

Recruitment Protocol

There are three ways a subject may find out about the study:

Sign up sheets

The subject may read the sign up sheets located in the psychology lab for this study. The sign up sheet is a standard form provided by the psychology lab. The only customized area on the form will be the title of this pilot study.

Psychology Lab Assistant:

Psychology lab assistants will be on the lookout for potential subjects. They will offer them to sign up to participate in various studies including this one. The protocol for this process is defined by the psychology lab.

Research Assistant:

Potential subjects will be approached by the research assistant in the psychology lab. The research assistant will say the following script:

Hello,

I would like to invite you to participate in a research study on women's food preferences. You may receive bonus marks from your psychology instructor if you decide to participate. Would you like to participate?

If Yes: Excellent, come on in to the testing room and I will tell you more about the study.

If Not right now: You may sign up at a time that is convenient for you on the sign up sheet. Here is the sign up sheet, please write down your name and phone number in the slot that you prefer.

If No: Thanks anyway, Good-bye.

Appendix D

Protocol

Step 1: Subject will arrive in the Cognition & Perception Lab as a result of either an appointment made in advance, or a drop in.

Step 2: I will greet the subject: “Hello X, Thank you for coming here to participate in the study. Have a seat and I’ll go over with you on what you will do in this study.”

Step 3: “Here’s the informed consent,” [hand informed consent form to subject], “I will go over it with you emphasizing the important parts of this document. After that, I will give you a few minutes to read the informed consent thoroughly. Once you read it, please sign your name at the end of the document. Please sign both copies of the document – one is for you, one is for me. ”

Step 4: Wait until the subject finishes reading and signing the consent form.

Step 5: “Here is the first questionnaire that I would like you to fill out. It is a demographic questionnaire asking about a few basic details about you. Please let me know when you’re finished.”

Step 6: Subject hands back questionnaire. At this point I will ask the participant to move under the viewing booth and explain that this device produces daylight conditions in order to ensure that the colour caps are under a standardized lighting condition. I will then administer the FM 100 test.

Step 7. Once the FM 100 is complete, I will ask the participant to move to the iMac computer where I start up the food rating application. I ask the participant to read the questionnaire and offer to clarify anything that might be confusing. If the participant is ready to start, I will tell them to use the left click mouse button to proceed to the next page.

Step 8. Once the participant has completed the food appetizing test, I ask them what they thought of the study and whether they can guess what we are investigating. As the conversation progresses I try to hit all the points mentioned in the debriefing form. I hand them the debriefing form during the conversation.

Appendix E

DEBRIEFING FORM

Colour Discrimination and Preferences for Food Imagery during

the First Trimester

Thank you for participating in this project.

Purpose of the Project:

This study explored changes in visual perception during the first-trimester of pregnancy.

Context

Pregnancy is a time of change, including changes in a woman's physiology, perception, hormonal profile, psychological state, and dietary preferences. Our study explored whether changes in visual perception, specifically shifts in visual discrimination and preferences also accompany pregnancy. Earlier studies have noted shifts in smell perception (e.g., increased generalized sensitivity) and taste perception (e.g., increased 1st trimester sensitivity to bitter taste) during pregnancy (Dastur, 2000; Duffy, Bartoshuk, Striegel-Moore & Rodin, 1998; Gilbert & Wysocki, 1991). To date, no studies have examined visual perception.

Pregnancy Sickness as a Beneficial Adaptation

The first trimester is a time of organ development in the embryo (Moore, 1982; Seeley, Stephens, & Tate, 1992). It is also the time associated with the greatest number of miscarriages (Wilcox, Baird, & Weinberg, 1999). Exposure to toxins during the first trimester is a risk factor for birth defects or miscarriages because the embryo and its developing organs have few defenses against such toxins (Hodgson & Levi, 1987). Toxins are found naturally in many foods, either as defenses against pests or as a result of bacteria, fungi, or molds. The cues for these toxins are typically strong and bad odours and bitter or sour tastes. Profet (1988; 1992) theorized that the symptoms of pregnancy sickness—nausea, vomiting, and food aversions—are actually defenses that the mother's body uses to avoid food-related toxins. Interestingly, the first trimester is also the period most associated with both sensory changes and symptoms of pregnancy sickness.

Changes in smell and taste perception are likely the sensory mechanisms by which these cues of toxicity become detected, typically at levels lower than before the pregnancy. Evidence of lowered smell thresholds during first trimester has been documented (Dastur, 2000). Beyond smell and taste changes, we believe that visual

changes may also support this defensive view of pregnancy sickness. Pregnant women who can better discriminate between good and bad foods will put their developing embryos at lower risk than those who can't.

Our Hypotheses and Predictions

The theory that pregnancy sickness may be an evolved adaptation to limit fetal exposure to toxins in the maternal diet was used to generate two hypotheses: 1) that 1st trimester women will have increased colour discrimination ability relative to nonpregnant controls; and 2) that 1st trimester women will rate images of unripe, overripe, or spoiled foods lower in preference than nonpregnant controls. For example, we expect increased preferences for hues and other cues associated with ripeness in fruits and vegetables (yellows, oranges, and reds) and decreased preferences for hues associated with foods that are unripe, overripe, or spoiled (greens, blues, and browns).

We hypothesize that these shifts in visual preference are one of the perceptual cues that pregnant women use to make decisions that discriminate between foods of varying levels of quality (e.g., ripeness, spoilage, etc). In this formulation, a shift in visual perception is like a line of defense in a larger and integrated set of defenses that serve to protect the developing embryo.

Visual Discrimination Test

In this test, known as the Farnsworth Munsell 100 hue test, you placed coloured caps in sequence according to their hue. This is a widely used test of colour vision.

Rating Images of Foods Test

In this test, you rated how appetizing images of foods were that varied according to ripeness or freshness.

Relevance

This research is relevant for two reasons. First, if the predictions are supported, it will provide support for a theory that re-examines pregnancy sickness not as a disorder but as a normal, healthy, and useful part of the experience of pregnancy. Second, the information from this research fills in the almost complete absence in our knowledge of whether changes in visual perception accompany early pregnancy.

If you have any further questions or if you would like a summary of our results please contact the Principal Investigator:

Dr. Farhad Dastur

Dept. of Psychology,

Kwantlen University, Surrey, BC V3W 2M8

604.599.2170

farhad.dastur@kwantlen.ca

We thank you again for your participation.

Resources

Some Websites that provide information on Pregnancy and on Pregnancy Sickness:

General Information on Preconception, Pregnancy, Birth, and Post-Partum

http://www.pregnancy.org/

Ask the Experts, Get the Answers

http://www.pregnancy.org/experts.php

Pregnancy and Childbirth

http://pregnancy.about.com/

Ten Top Morning Sickness Tips

http://pregnancy.about.com/od/morningsickness/tp/tpmorningsick.htm

Pregnancy Info from the U.S. National Institutes of Health

http://www.nlm.nih.gov/medlineplus/pregnancy.html

Appendix F

Demographic Questionnaire

What is your age ____

What is your ethnicity ____

How many years of education have you received after completing high school?

____ none ____ 1-4 years ___ 5+ years

Are you working: ___ part time ____ full time ____ student ____ other

What week of your pregnancy are you currently in? _____

How was the date of your pregnancy determined? _____

Please rate the intensity of the following symptoms (if experienced)

	Very Weak						Very Strong
Food aversion	1	2	3	4	5	6	7
Smell Sensitivity	1	2	3	4	5	6	7
Nausea	1	2	3	4	5	6	7
Dry Heaves	1	2	3	4	5	6	7
Vomiting	1	2	3	4	5	6	7
Taste Sensitivity	1	2	3	4	5	6	7

Did you receive fertility drugs to help conception? ___ yes ___ no

Are you taking anti-nausea drugs? ___ yes ___ no

Appendix G

(a) Cataracts Conjunctivitis (i.e., pinkeye)

(b) Fuchs' Dystrophy

(c) Retinitis Pigmentosa

(d) Colour Blindness

Appendix H

List of Purchased Foods

Fruits	Status
Banana	used in pilot
Pear	used in pilot
Papaya	used in pilot
Apple	new
Strawberry	new
Vegetables	
Broccoli	used in pilot
Tomato	used in pilot
Lettuce	new
Pepper	new
Mushrooms	new
Grains/Starches	
White Bread	new
Potatoes	new
Meats	
Steak	new
Chicken	new
Salmon	new

Appendix I

List of Google Adwords Keywords

1st trimester
1st trimester of pregnancy
5 weeks pregnant
6 weeks pregnant
7 weeks pregnant
8 weeks pregnant
abdominal pain during pregnancy
allergies pregnancy ** 1.20
become pregnant
being pregnant
belly during pregnancy
calendar of pregnancy
conceive
conceiving
conception
dizziness during pregnancy
during pregnancy
during pregnancy health
during pregnancy vomiting ** 1.20
early pregnancy
early pregnancy nausea
early pregnancy symptoms
early pregnancy test
early signs of pregnancy
exercising during pregnancy
stage pregnancy
staying fit during pregnancy
studies on pregnancy
track pregnancy
first trimester
fitness during pregnancy
food avoid pregnancy
food cravings during pregnancy
food during pregnancy
food for pregnancy
food for pregnant
food for pregnant woman
food for pregnant women
food in pregnancy
food not to eat when pregnant
food poisoning and pregnancy
food poisoning during pregnancy ** 1.20
food poisoning in pregnancy
food poisoning pregnancy ** 1.20
food poisoning pregnant
food poisoning while pregnant
food to avoid during pregnancy ** 1.20
food to avoid in pregnancy
food to avoid when pregnant
food to avoid while pregnant
food to eat during pregnancy
spicy food during pregnancy
food to eat when pregnant
food to eat while pregnant
food when pregnant
food while pregnant
foods and pregnancy
foods during pregnancy
foods for pregnancy
foods for pregnant women
foods in pregnancy
foods not to eat during pregnancy
foods not to eat when pregnant
foods not to eat while pregnant
foods to avoid during pregnancy
foods to avoid in pregnancy
foods to avoid when pregnant
foods to avoid while pregnant
foods to eat during pregnancy
foods to eat when pregnant
foods to eat while pregnant
get pregnant
having a baby
healthy eating during pregnancy
pregnant trimester
pregnant women
healthy pregnancy
hives during pregnancy
insomnia during pregnancy ** 1.20
maternity clothes
maternity fashion
maternity leave
migraines during pregnancy
miscarriage
mommy to be
morning sickness
nausea during pregnancy
ovulation calendar
pregnancy advice
pregnancy morning sickness ** 1.20
pregnancy nausea ** 1.20
pregnancy nutrition
pregnancy questions
pregnancy sickness
pregnancy sign
pregnancy signs
pregnancy stages
pregnancy studies
pregnancy study
pregnancy support
pregnancy symptom ** 1.20
pregnancy symptoms
pregnancy symptoms trimester
pregnancy symptoms week by week
pregnancy test
pregnancy tests
pregnancy trimester
pregnancy website

trying to conceive	spicy food	food
pregnancy websites	pregnancy	spicy food and
pregnant	pregnant clothes	pregnancy
	pregnant food	
	pregnant foods	

Appendix J

List of Content-network Pages

411directoryassistance.ca
amazingpregnancy.com
baby-gaga.com
babycenter.com
babyzone.com
biology-online.org
diaperswappers.com
exclusivelearning.com
ezinearticles.com
families.com
fqnotebook.com
freeovulationcalendar.info
healthline.com
helium.com
i-am-pregnant.com
imvu.com
justmommies.com
kidsinvictoria.com
manoramaonline.com
medhelp.org
mymonthlycycles.com
nationalledger.com
obgyn.net
ovulation-calendar.net
pregnancy-guidelines.com
womenshealthcaretopics.com
wrongdiagnosis.com
about.com
answers.com
are-you-pregnant.com
askdramy.com
babyandbump.com
babyhopes.com
babyzone.com
blinklist.com
cnn.com
dailymail.co.uk
ehealthforum.com
epigee.org
hd.org
health-info.org
imdb.com
justmommies.com
laineygossip.com
mymonthlycycles.com
myspace.com
ovulation-calendar.net
petplace.com
pregnancy-info.net
pregnancy-period.com

pregnancy-info.net
pregnancy-period.com
pregnancy.org
pregnancyanalysis.org
pregnancycheck.com
ratemds.com
revolutionhealth.com
skypedia.org
soaps.com
soulcysters.net
sparkpeople.com
thelaboroflove.com
tickerfactory.com
tvshark.com
urbanlegendsonline.com

- suite101.com
- surebaby.com
- thecmr.com
- viseembryo.com
- webmd.com

Figure Caption

Figure 1. Summary of One-Way ANOVA Analysis

Figure 2. F-tests and their significance for each food.

Figure 3. Number of Women experiencing pregnancy sickness throughout a day

Figure 4. Levels of Progesterone and Estrogen during Pregnancy

Figure 1. Summary of One-Way ANOVA Analysis

	F	$Power$	η^2
Banana	3.40**	.884	.20
Broccoli	29.41***	1.00	.68
Pear	2.77*	.796	.18
Papaya	11.48***	1.00	.47
Tomato	9.38***	1.00	.40

Note. *p<.05 **p<.01 ***p<.001

Figure 2. F-tests and their significance for each food.

	F-value
Banana1	6.26*
Broccoli	106.63***
Pear1	31.90***
Papaya	17.28*
Tomato1	6.32*

Note. *p<.05 ***p<.001 1The comparison was made between the second and sixth image

Figure 3. Proportion of women experiencing pregnancy sickness throughout the day

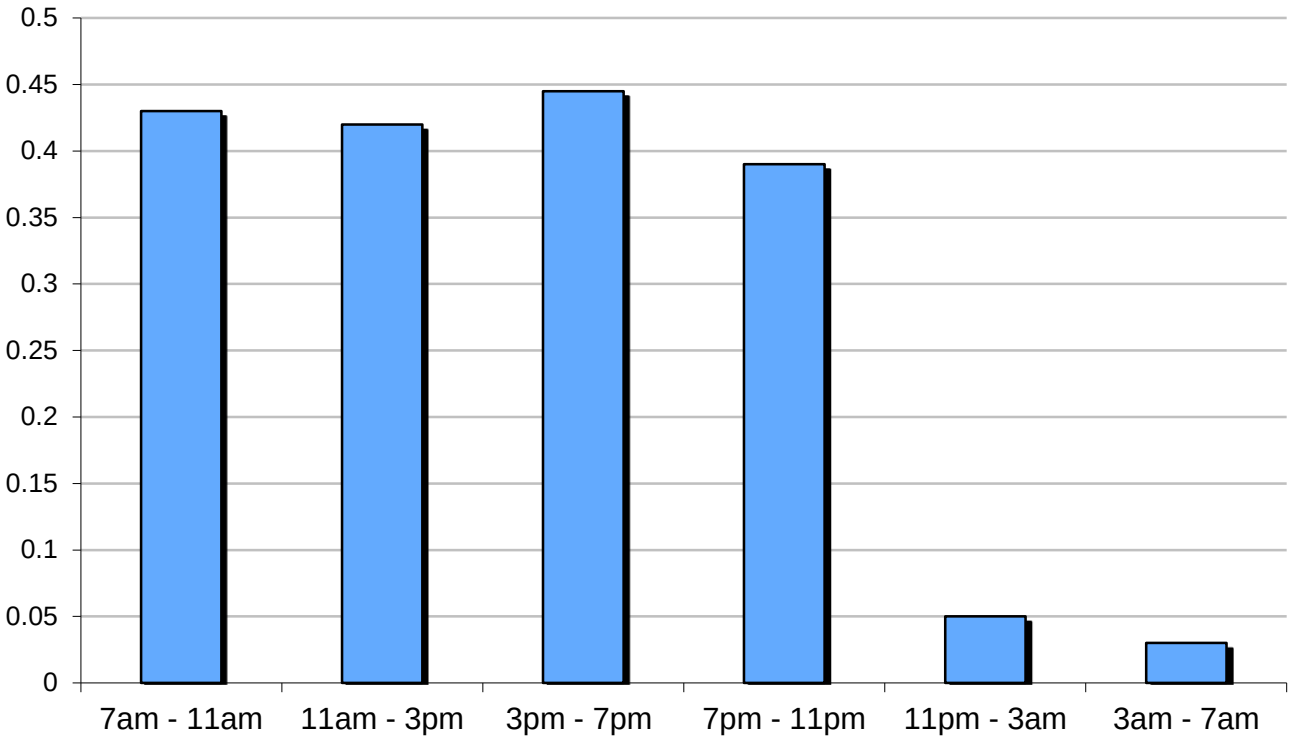

Figure 4. Levels of Progesterone and Estrogen during Pregnancy

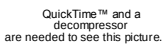

Table 1

Descriptive Statistics for demographic variables

		Subject Variable	
		Pregnant	Nonpregnant
Age		34	26.4
Ethnicity	Caucasian	4	6
	East Asian		2
	South Asian	1	1
	Filipino		1
	Fijian	1	
Work	Full Time	5	3
	Part Time	1	3
	Students		2
	Other		2
	None		2
Post-Secondary Education	1-4 years	3	7
	5+ years	3	1

Table 2

Significance test of FM 100 test

	F value	Sig.	Effect Size	Power
Pregnant	4.756	0.047	.254	52.8%

Table 3

Appetizing rating means for the 10 food groups

	Stage of Food					
Apple	Mildly Unripe				Mildly Overripe	
Pregnant	5.56	5.44	4.83	4.39	4.17	3.89
Non-pregnant	5.03	5.10	4.97	4.88	4.60	2.77
Banana	Mildly Unripe				Completely Overripe	
Pregnant	2.89	4.28	4.28	2.72	1.28	1.00
Non-pregnant	2.77	4.17	5.00	3.93	1.67	1.00
Broccoli	Completely Ripe				Completely Overripe	
Pregnant	5.9	5.4	4.6	3.7	1.8	1.0
Non-pregnant	6.0	5.5	4.8	4.0	2.4	1.1
Lettuce	Completely Ripe				Completely Overripe	
Pregnant	6.4	3.9	2.0	1.5	1.2	1.0
Non-pregnant	6.5	4.2	2.7	2.0	1.4	1.0
Mushroom	Completely Ripe				Completely Overripe	
Pregnant	3.17	1.56	1.28	1.17	1.0	1.06
Non-pregnant	4.83	2.0	1.6	1.27	1.23	1.20
Papaya	Mildly Unripe				Completely Overripe	
Pregnant	5.0	3.50	2.33	1.39	1.06	1.0
Non-pregnant	4.6	4.3	2.87	1.93	1.33	1.0
Pear	Mildly Unripe				Mildly Overripe	
Pregnant	5.9	5.4	4.8	3.8	2.4	1.1
Non-pregnant	5.2	5.3	4.8	4.4	3.5	1.1
Raspberry	Completely Ripe				Completely Overripe	
Pregnant	6.1	5.9	3.9	1.6	1.6	1.3
Non-pregnant	6.70	5.30	3.30	1.40	1.40	1.00
Steak	Completely Fresh				Completely Decayed	
Pregnant	2.80	2.80	2.50	1.70	1.88	1.00
Non-pregnant	4.80	4.40	3.90	2.10	1.80	1.00
Tomato	Completely Unripe				Mildly Overripe	
Pregnant	1.94	2.28	3.89	4.00	3.50	4.17

Non-pregnant	2.33	2.93	4.87	5.22	4.97	4.97