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Influences of Contexts on Consumers' Visual Attention towards Food Images: Eye-tracking Studies

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ABSTRACT

Food perception is influenced not only by sensory properties of the food itself, but also by individuals- or environment-related contexts. Visual cue appears to be the most dominant factor in modulating food perception. This research aimed to determine whether individuals' visual attention towards food images can vary as a function of contextual variables such as hunger/fullness (Chapter 3), chronic stress (Chapter 4), and culture (Chapter 5). In Chapter 3 and Chapter 4, participants were asked to freely view visual slides, including four different images per slide, shown on the monitor. Using eye-tracking techniques, participants' visual attention towards food images (e.g., high- and low-calorie food images) was compared either between fasted and fed states (Chapter 3) or between high and lows level of chronic stress (Chapter 4). Chapter 3 and Chapter 4 showed that participants' visual attention towards the food images were increased when they were hungry or highly stressed compared to when they were satiated or mildly stressed. In Chapter 5, North American and Chinese participants were asked to view pictures of food menu with varying saliency level of background contexts. Chinese participants, in comparison to American participants, were more attentive to the background contexts. By contrast, American participants focused more on the food image than Chinese counterparts. However, the culture-induced visual attention to the food image disappeared when the pictures of foods which were surrounded by medium and high levels of background saliency were presented. Our findings provide empirical evidence that visual attention towards food images can be changed by contextual factors including hunger/fullness, chronic stress, and culture. Furthermore, this thesis suggests that the eye-tracking technique can be applied to measure the reducing effect of food products on individuals' hunger.

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CHAPTER 1

GENERAL INTRODUCTION

Consumers' food perception is influenced not only by sensory properties of the food itself, but also by contextual factors such as individuals and environments. The expectations about contextual factors are increasingly important. People from different backgrounds have different perceptions of food. For example, individuals who have different Body Mass Indexes (BMI) appear to have different eating styles. In addition, people show different levels of appetite between fasted and fed states. Also, individuals' food perception may be different depending on a level of mental or physical stress.

With the development of society, it has allowed people to freely purchase food items everywhere by using their mobile devices browsing photos or video clips online. Therefore, food and hospitality industries pay more attention to enhance visual attraction of not only the real food, but also the food images to meet the need of people from different backgrounds. Thus, it is getting more and more important to find out how contextual factors affect consumer's food perception so that food and hospitality industry can provide higher-quality food service.

This thesis is composed of three studies investigating the effects of contextual variables on consumers' visual attention towards food- or non-food-related images. More specifically, this thesis aimed to examine whether visual attention towards the images of food items can vary as a function of hunger/fullness (Chapter 3), chronic stress (Chapter 4), and culture (Chapter 5).

Study 1 (Chapter 3) was designed to test whether individuals' fasted/fed status and eating behavior could modulate their visual attention towards food and non-food images. In addition, the hunger/fullness-induced visual attention to food-related images was compared depending on the level of BMI: i.e., normal-weight vs. overweight/obese.

Study 2 (Chapter 4) was designed to examine whether chronic stress could affect individuals' visual attention towards food and non-food images. High stress participants and low

stress participants were recruited in the study. It was hypothesized that participants with high chronic stress would pay more attention towards food-related images, in particular high-calorie food images, compared to those under low chronic stress. Also, negative emotions may mediate the chronic stress-induced implicit visual attention towards the images of foods.

Lastly, Study 3 aimed to investigate whether individuals' visual attention towards food images could be modulated by cultural background: Western *vs.* East Asian culture. Specifically, North American and Chinese participants' visual attention towards food images can be different as a function of the saliency level of background contexts, such as cutlery and table decoration, in the photos of food menu. It was expected that Americans would pay more attention towards the image of food items compared to Chinese participants based on the previous cross-cultural studies that Western people focus more on the focal objects, while East Asians give more stress on the surrounding background contexts.

These studies will provide a better understanding of how individuals' visual attention towards food images can be dependent by hunger/fullness, chronic stress, and culture. Furthermore, these findings will provide foodservice and marketing professionals with valuable explanations as to how consumers focus on food images in given contexts, which may potentially increase their sales and foodservice quality.

CHAPTER 2

LITERATURE REVIEW

1. Vision

1.1. Anatomy and physiology

Vision is caused by the joint efforts of rods, cones, retina, optic nerves, occipital lobe and so forth. The light is received by rods and cones, activating the pigments in the rods and cones and then it is converted into nerve impulses in the membranes of vesicles (Zeki, 1993). These nerve impulses were transmitted through the rod or cone cell to the synaptic knobs then to bipolar nerve cells, then to the ganglions and then to the optic nerves (Zeki, 1993). Therefore, optic neurons carry nerve impulses from retina to the brain. Retina can be divided into four sections- nasal, temporal, upper, and lower (Zeki, 1993). Because the eye is curving, the nasal retina of the left eye and the temporal retina of the right eye are used to responsible for the left half of the view, whereas the nasal retina of the right eye and the temporal retina of the left eye are responsible for the right half of view (Zeki, 1993).

Brain is the central part of human being's body, which controls people's daily activities and movements. In the brain, there are specific regions responsible for analyzing visual perception so that people can show different responses according to different visual stimuli. The occipital lobe at the back of the brain is mainly intended to control the vision. Visual cortex occupies the occipital lobe of the brain, indicating that the occipital lobe is predominantly visual function area in brain. V1 area is an important part in occipital lobe which is commonly referred as the striate cortex (Zeki, 1993). Previous studies showed that different visual abilities (e.g., color, face, motion) were separately presented in the other brain areas (Bodamer, 1947; Zihl et al., 1983; Zeki & Marini, 1998; Koch, 2005). As for color perception, for example, Koch (2005) illustrated that an area of the fusiform gyrus (V4) is essential for perceiving color. People will

not be able to perceive color without this area. The corporations of frontal cortex and other brain regions are also needed for the color perception.

Milosavljevic and Cerf (2008) demonstrated that there are two cortical routes associated with visual perception in human being's brain. A dorsal pathway spatially deploys attention ("where"), and this process is from the primary visual cortex (V1) in the occipital lobe, through the posterior parietal cortex, and then to the dorsolateral prefrontal cortex. Another route is a ventral pathway associated with object recognition ("what"), involving in the inferotemporal cortex and the ventrolateral prefrontal cortex.

Eyes are the windows of human being. People's eye movements reacted differently to different visual stimuli. Thus, eye movement is an important indicator to detect people's sense of vision. There are 5 types of eye movements: (1) optokinetic responses (OKR); (2) vestibulo-ocular reflexes (VOR); (3) saccades; (4) smooth pursuit; and (5) convergence. Among these kinds of eye movement, smooth pursuit was triggered by small targets, indicating that visual cortex was essential for it (Buttner et al., 1986). Previous studies showed that in the paramedian pontine reticular formation (PPRF), the specific cell groups (e.g., Long-lead bursters, short-lead bursters and omnipause neurons) were necessary to generate horizontal saccades (Raphan & Cohen, 1978; Fuchs et al., 1985).

Perceiving foods is a multisensory process which involves smell, taste, hearing, touch and vision. Visual cue plays an important role in food perception. That means, what you "see" will affect the liking of what you "eat". According to previous studies (Rolls & Baylis, 1994; Thesen et al., 2004), it is known that orbitofrontal cortex (OFC) and amygdala are two important brain areas which are responsible for the visual-olfactory multisensory interaction. Rolls and Baylis (1994) demonstrated that there are related orbitofrontal neurons which respond to the

gustatory, olfactory, and visual inputs in monkeys' brains. Thesen et al. (2004) reported that the OFC is the place where conscious perception of aroma and other higher-order olfactory information are processed.

1.2. Factors influencing visual perception

1.2.1. Gender

Females tend to be more emotional because they do more care-taking jobs in families, while males tend to be more rational. Gur et al. (2002) conducted a test on temporo-limbic and prefrontal structures by quantitative magnetic resonance imaging (MRI), indicating that females have larger orbital frontal cortices than males, which made the ratio of orbital gray to amygdala volume different. Therefore, according to their social responsibility and brain characteristics, it is obvious to see that males and females are different in some ways. Previous research demonstrated that males and females differently respond to visual stimulus (Darley & Smith, 1995; Lee et al., 2002; Karama et al., 2002; Wrase et al., 2003; Montagne et al., 2005). For example, Wrase et al. (2003) presented negative, positive, and neutral pictures to males and females participants. Brain areas activated by pleasant and unpleasant pictures were different between females and males participants. For pleasant pictures, frontal lobe (especially, inferior and medial frontal gyrus) was activated in males more than in females. However, female participants showed stronger brain activation in the anterior and medial cingulate gyrus toward unpleasant pictures. Accordingly, proportion of male and female participants is very important to studies, which would potentially alter the results of studies. Also, gender effect is a significant factor for experiment designs or data analysis in research, especially the research about

psychology or sensory science, since males and females perceive the world in different ways as mentioned above.

Previous research showed that males and females were also different in color perception and preference (McGuinness & Lewis, 1976; Paoletti, 1987; Bimler et al., 2004; Jian et al., 2010). For example, Paoletti (1987) demonstrated that males tended to prefer soft color, while females tended to prefer brighter color because of their hormonal and environmental differences. Another example is that Jian et al. (2010) conducted a color task between 30 females and 30 males by using 22 test color strips and 2 shade charts having various shades of different colors. The participants were asked to match the color strips to the shade colors. The results showed that females had more correct responses than did males, especially for red and green color. In addition, females were likely to see more shade colors than did males.

1.2.2. Age

It is known that human being's body changes with the growth of age, such as ageing of organs. As for people's vision, people's vision becomes worse when they get older because of the ageing of eyes and brain. One common problem for elder people is presbyopia, indicating age affects people's vision. Previous studies (Eriksen et al., 1970; Klein et al., 1996; Allison et al., 1984; Ball et al., 2002; Owsley et al., 2002; Cliff et.al. 2013) showed that age is an important factor to affect human visual perception. For instance, to identify objects, old adults need to be exposed to the objects longer time than young adults (Eriksen et al., 1970). In Klein et al. (1996)'s study, a large population-based study was conducted to find the change in visual acuity over a 5-year period. People aged 75 years and older were more likely to have impaired vision and had double of the visual angle which leaded to worse visual perception ability than younger

people. Using 286 normal participants ranging in age from 4 to 95 years, Allison et al. (1984) reported that the visual evoke-related potentials (e.g., P60, N75), which were responsible to reflect the activation of visual cortex by visual stimuli, changed with age. Visual evoke related potential amplitudes decreased with the increase of age. Compared to young adults, old adults appear to need more time to process visual inputs in daily tasks (e.g., finding a cellphone number, finding and reading the ingredients on a can of food) (Owsley et al., 2002). In addition, with the increase of age, people tend to have lower photopic or scotopic sensitivity, which results in lower sensitivity to the light (Sturr et al., 1997; Jackson et al., 1998; Jackson & Owsley, 2000).

1.2.3. Emotion

Emotional state may modulate visual perception. The way we feel the world would change the way we see the world. Positive, neutral, and negative emotions alter attention preferences (Fredrickson, 1998; Hermans et al., 1999; Bradley et al., 2000; Mogg et al., 2000; Mogg et al., 2002; Fredrickson, 2003; Wadlinger & Isaacowitz, 2006). In other words, people tend to have different visual perception under different emotional state. When positive emotion was induced, people tend to have broader visual attention. For example, Wadlinger and Isaacowitz (2006) showed that positive mood caused wider attention breadth, indicating that participants tended to pay more attention to backgrounds (peripheral images) and also make more frequent saccades. In addition, Hermans et al. (1999) indicated that anxious people tended to look at threatening stimuli (e.g., spiders) more than neutral stimuli (“flowers”).

Individuals’ mood will be altered by the environment around them. Earlier studies showed that music altered people’s mood, which modulated people’s visual perception on visual

stimuli (Bouhuys et al., 1995; Van den Stock et al., 2009; Jeong et al., 2011; Jolij & Meurs, 2011). Jeong et al. (2011) found that happy facial expression were rated as more happy when happy music was presented, while happy face were rated as less happy when sad music was presented. Also, Jolij and Meurs (2011) showed that participants more accurately detected happy faces when happy music was presented. When neither the happy face nor sad face (ambiguous face expression) was shown, people tended to report higher proportion of happy faces when happy music was played.

1.2.4. Personality

Personality is crucial to determine how people see and feel the world. In fact, earlier research showed that personality influences the visual perception (Mathews et al., 2003; Bar-Haim et al., 2007; Rauthmann et al., 2012). Mathews et al. (2003) used the trait scale of the State-Trait Anxiety Inventory (STAI) to select and divide participants into non-anxious group and anxious group to determine the effect of fearful expression on both groups. Fearful expression did not show a difference from the neutral one in non-anxious group, while the fearful expression had a big influence on participants' visual attention in anxious group, indicating that higher anxiety people had slower disengagement of visual attention from fearful stimuli than lower anxiety people.

Previous studies showed that extraversion/introversion, neuroticism and psychoticism modulate people's visual perception (Zuber & Ekehammar, 1988; Newton et al., 1992; Grelotti, et al., 2002; McPartland et al., 2004; Perlman et al., 2009; Cheung et al., 2010; Frühholz et al., 2010). For example, Zuber and Ekehammar (1988) demonstrated that higher psychoticism people tended to be more affected by color and less affected by meaningfulness in their

preference pictures than lower psychoticism people. Also, Newton et al. (1992) demonstrated that higher extraversion participants tended to have quicker visual search abilities, whereas higher neuroticism people performed more slowly in the visual task. And higher psychoticism people performed lower accuracy in the test. Another example was that Cheung et al. (2010) conducted a study by showing upright and inverted face stimuli (images) to the participants in both extraversion (higher extraversion score) and introversion groups (higher introversion score). The results showed that inversion effect was very significant for the extraversion participants but not for the introversion participants. In addition, Frühholz et al. (2010) demonstrated that people with higher neuroticism, anxiety, depression and lower extraversion were more sensitive to emotional facial expressions (negative/positive expressions).

1.2.5. Culture

Western culture emphasizes independence, while East Asian culture highlights interdependence (Chiu, 1972). Previous cultural and social psychological studies showed differences in visual perception between cultures (Chua et al., 2005; Kitayama et al., 2003; Masuda & Nisbett, 2001; Nisbett et al., 2001). Western people tend to look at visual stimuli more analytically, focusing on focal objects and their attributes, whereas East Asian people pay more attention to contextual information such as background and context (Masuda & Nisbett, 2001; Nisbett et al., 2001; Nisbett & Masuda, 2003; Nisbett, 2003; Nisbett & Miyamoto, 2005; Miyamoto et al., 2006). In Masuda and Nisbett (2001)’s study, Japanese and Americans participants were asked to look at underwater animations where certain fish was regarded as a focal object. The animations also included other fishes and objects (e.g., plants) as background objects. After looking at the animations two times, participants were asked to describe the

animations. Japanese participants reported background objects 65% more than did American participants. Furthermore, using an eye tracker, Chua et al. (2005) demonstrated that cross-cultural differences between European Americans and Chinese. European Americans looked at the focal object (e.g., a tiger in a jungle) significantly more quickly and longer than Chinese participants. Similarly, Goh et al.(2009) reported that Westerners (Caucasian American) showed longer durations on both objects and backgrounds, whereas East Asians (Chinese Singaporean) alternated more frequently between objects and backgrounds so that they had shorter fixation duration.

In addition, a number of previous studies have demonstrated cultural variations between Western and Eastern Asian countries in the visual attention to nature/scenery (Masuda & Nisbett, 2001; Chua et al., 2005; Goh et al., 2009), geometrical object (Kitayama et al., 2003), everyday objects (Goh et al., 2009), and human faces and bodies (Masuda et al., 2012). Masuda et al. (2012) conducted a study among European Canadians, Asian Canadians, Asian international students, and Japanese students by asking them questions related to the facial expression pictures. The study showed that East Asian participants were more easily influenced by the facial expressions in the backgrounds when they evaluated the facial expressions in the center of the pictures than North American participants did. Besides, the results showed that North Americans were more easily to locate their attention to the center of the pictures compared to East Asians.

2. Influences of visual cues on food perception

2.1. Influences of visual cues on smell and taste perception

It is known that color influences flavor intensity and pleasantness (DuBose et al., 1980; Johnson & Clydesdale, 1982; Christensen, 1983; Stillman, 1993; Clydesdale, 1993; Imram,

1999; Morrot et al., 2001; Bayarri et al., 2001; Delwiche, 2004; 2007; Zampini et al., 2007; Spence et al., 2010). Previous research showed that colored foods tend to have stronger flavor and better quality (Christensen, 1983). Also, in Bayarri et al. (2001)'s study, four kinds of juices or nectars (orange juice, peach nectar, kiwifruit nectar and berries nectar) were used. The results showed that colors of the drinks enhanced subjects' sweetness perception on orange juice and also enhanced the flavor intensity of all drinks. Morrot et al. (2001)'s study showed obvious visual cue bias. The "white wine" samples which were artificially colored into "red" were regarded as "red wine" by the participants, indicating that color significantly modulated people's olfactory perception.

Atmospheric visual cues, such as color and size of tableware (Harrar et al., 2011; Piqueras-Fiszman, & Spence, 2012; Piqueras-Fiszman et al., 2012; Spence et al., 2012) and packaging design (Peters-Texeira & Badrie, 2005; Mizutani et al., 2010; Piqueras-Fiszman & Spence, 2011), can also modulate a food perception. For example, Piqueras-Fiszman et al. (2012) demonstrated that participants rated flavor and sweetness of strawberry mouse on the white plate significantly higher than on the black plate. Piqueras-Fiszman and Spence (2011) conducted a study by using two types (i.e., different flavor) of potato chips in two different kinds (colors) of packaging. When the color of the packaging matched to the specific flavor, participants tended to recognize the flavor more quickly and easily. In that case, people would have less confusion and potentially more satisfaction for the products.

The backgrounds (e.g., pictures and advertising slogans) we look at when we consume foods affect individuals' smell and taste perception and preference (Elder & Krishna 2010; Ohla et al., 2012). For example, in a gum study, Elder and Krishna (2010) demonstrated that multisensory advertisements ("stimulate your senses") resulted in higher taste perception and

more positive sensory thoughts than the advertisements focused only on taste ("long lasting flavor"). Ohla et al. (2012) showed that taste stimuli were perceived as significantly more pleasant when they were served with high-calorie pictures than when served with low-calorie pictures.

2.2. Influences of visual cues on texture perception

Visual cues of foods modulate consumers' texture perception (Kennedy et al., 2005). Kennedy et al. (2005) demonstrated that participants' texture perception of different kinds of cooked chickens was modulated by color. Under normal lighting condition, participants showed that the wheat-fed chicken were tender than corn-fed chicken. However, under controlled yellow lighting, subjects showed that the corn-fed chicken were tender than the wheat-fed chicken.

2.3. Influences of visual cues on food consumption

Previous studies have shown that shape and size of serving containers alter food intake (Wansink & Van Ittersum, 2003; Rolls et al., 2004; Wansink, et al., 2005; Wansink & Kim, 2005). Wansink and Van Ittersum (2003) demonstrated that shape of glass containers modulated consumption of drink. For example, participants consumed drinks more when it was served in a short and wide glass than in a tall and slender glass. Wansink and Kim (2005) showed that the portion size of food altered the amount consumed. Specifically, participants consumed fresh popcorn 45.3% more when it was served in a large bucket (240 g) compared to when served in a medium bucket (120 g). In another study by Wansink (2005), participants consumed soup more when it was served in a self-refilled bowl than in a normal bowl, indicating that people consume more when they cannot visually evaluate the amount of their intake. Also, the proximity and

visibility of the foods altered people's food consumption (Hearn et al., 1998; Painter et al., 2002; Wansink et al., 2006; Privitera & Creary, 2013). In Wansink et al. (2006)'s study, a 4-week chocolate candy consumption experiment was conducted among 40 adult secretaries. The proximity was varied by placing the candies either on the desk or 2 m away from the desk, whereas the visibility was controlled by using either clear covered bowls or opaque covered bowls. The conclusion indicated that participants ate 2.2 more candies per day when the candies were visible (in clear covered bowls), while they ate 1.8 more candies per day when the candies were proximate (on their desk). Similarly, Privitera and Creary (2013) carried a similar study as Wansink et al. (2006)'s to detect how the proximity and visibility altered the fruit and vegetable intake among college students. By placing the apple slice and carrot cuts either on the table near participants or 2 m away from participants to control the proximity, and by placing the apple slice and carrot cuts into either clear covered bowls or opaque covered bowls to alter the visibility. The outcome showed that proximity increased intake of both apple slice and carrot cuts, while the visibility only increased the consumption of apple slices.

Furthermore, dining environment is another important factor to alter individuals' food consumption (Birch et al., 1989; Bellisle et al., 2004; Blass et al., 2006; Albarracin et al. 2009; Harris et al., 2009; Van Kleef et al., 2011; Ogden et al., 2013; Braude & Stebenson, 2014). Bellisle et al. (2004) carried a lunch study among 48 healthy females by providing three kinds of dining environment (television viewing, auditory sound and absence of the environmental stimuli) during the lunch. The conclusion showed that healthy females had larger lunch intake when either television viewing or auditory sound was presented. This might because the non-food environmental stimuli distracted participants' attention from their eating so that decreased their habitual dietary restraint. Another example was Van Kleef et al. (2011)'s study. They

provided 8 commercials during lunch time for 125 participants. The commercials were either all related to exercise or fitness or neutral products. The results indicated that participants who were exposed to exercise commercials reduced their food intake comparing to other kinds of commercial environment. Also, participants showed higher liking for the meal by watching exercise commercials. Similarly, Harris et al (2009) carried a study by using elementary-school-age children and adults as participants. Different advertisements were provided to participants, including food advertisements, other product advertisements or no food advertisements. Snacks were provided while watching. According to the results, children had 45% more snack consumption when they were exposed to food advertisements. Adults also showed more snack consumption when they were exposed to food advertisements.

Visual appealing of foods influenced consumers' food consumption (Imram, 1999; Bello Acebrón & Calvo Dopico, 2000; Jansen et al., 2010; Donadini et al., 2011; Font-i-Furnols et al., 2012; Toschi et al., 2012; Morales et al., 2013; Morales et al., 2013). In Jansen et al. (2010)'s study, the experiment was conducted in order to find out better way to improve children's fruit consumption. Seedless grapes, apple pieces, and strawberries were presented in two different ways and presented to participants simultaneously. One was a "visually appealing" way (i.e., the mix of three fruits, pierced with flagged cocktail sticks and stuck into a watermelon) and the other was a "regular" way (i.e., three kinds of fruits simply offered on a white plate). The results indicated that the total intake of fruits provided by "visually appealing" way was significantly larger than the total intake of fruits provided by "regular" way. Donadini et al. (2011) also conducted the study to detect how foam and lacing appearance affect Italian people's perception on beer, indicating that most Italian participants in the study preferred beer with medium foam

and no lacing. Also, Font-i-Furnols et al. (2012) showed that consumers had higher acceptability on the pork with higher intramuscular fat levels, which was based on their visual preferences.

3. Eye-tracker

Eye tracker is commonly used equipment which is aimed to observe people's eye position and eye movements. Eye tracker became increasingly easy to use instead of needing some awkward apparatuses (e.g., special lenses or helmets) (Galestic et al., 2008). Mostly, high-speed cameras are important parts of eye-tracker, which precisely record people's eye position and movements. These cameras are usually fixed on a flat and stable surface or are worn by the participant as a pair of glasses (Graham et al., 2012). Eye tracker technique has been widely used in TV commercial and advertisement research (Pieters et al., 1999; Wedel & Pieters, 2000; Rayner et al., 2001; Liechty et al., 2003; Woltman-Elpers et al., 2003), food science research (Nijs et al., 2010; Graham et al., 2012; Piqueras-Fiszman et al., 2013), and cultural visual difference research (Chua et al. 2005; Nisbett et al., 2005; Wu & Keysar, 2007; Boduroglu et al., 2009). Rayner et al. (2001) demonstrated that participants read the large print and then the smaller print and then looked at the pictures. In another study, Piqueras-Fiszman et al. (2013) used an eye-tracker to detect how packaging modulated consumers' visual attention to the jar jams. Also, Chua et al. (2005)'s eye tracking study showed that compared to Chinese participants, Americans focused quicker and longer on the focal objects, while Chinese participants, in comparison to Americans, made more saccades to the backgrounds.

Eye tracker is an effective tool to investigate mechanisms of human eye movements. It directly reflects nature cognition of the eye-mind link. With the development of the eye tracker technology, research can be done under relatively nature condition by fixing the cameras on a

flat and stable surface, such as tables. People can move their heads freely during the eye tracking tests. However, every coin has two sides. That is, eye tracking technique also has its limitations. The eye tracking condition may lack of realism. In other words, sometimes people would react unnaturally and differently on condition that their eye movements are recorded. In addition, the eye tracking technique does not provide researchers with subjects' cognitive information underlying eye movements. In that case, it is better to conduct an interview with the subjects as a compensation section in order to get to know how the subjects think during the eye tracking test (Graham et al., 2012).

4. Chronic stress

Arguably, we are living in the world full of challenge and competition. Different people play different roles in this world. Different environmental conditions around us are the source of stressors for us, such as stressful working environment. Individuals have different responses to stressors. It is known that stress feeling is unpleasant and could cause lots of psychological or biological issues on human being. Generally, people with optimistic personality appear to handle stress better than those with pessimistic personality.

It might be true that some people tended to eat less when they were under high stress. However, emotional eaters tended to eat the same amount or even more when they were under high stress (Oliver et al., 2000; van Strien & Ouwens, 2003). Previous studies showed that chronic stress plays a negative role in modulating people's eating behavior and body health. (Dallman et al., 2003; Ng & Jeffery, 2003; Epel et al., 2004; Eriksson et al., 2008; Heraclides et al., 2009; Block et al., 2009; Tannenbaum et al., 2010; Groesz et al., 2012; Tsenkova et al., 2013). For example, Ng & Jeffery (2003) demonstrated a negative effect of perceived stress on

people's health behaviors. By sampling 12,110 individuals in 26 work-sites, the study showed that people with high stress appeared to have higher fat diet, less hyper life style, less self-control on smoking. Another example is that Block et al. (2009) conducted a nationally representative longitudinal test among 1,355 males and females in United States to access the psychosocial stress effect on their body weight gain. Both males and females who had a high baseline body mass index (BMI) showed that weight gain was related to the increasing level of psychosocial stress, such as job related demands, lack of skill discretion, perceived constraints in life, or relationship with family. In Groesz et al. (2012)'s study, 561 females ranged from normal weight to obesity were recruited. The relationship between stress and drive-to-eat was detected in the study. The results showed that females who had higher greater life-stress reported higher drive-to-eat, especially for the food high in fat and sugar, potentially resulted in great weight gain.

REFERENCE

Allison, T., Humea, A.L., Wood, C.C., & Goff, W.R. (1984). Developmental and aging changes in somatosensory, auditory and visual evoked potentials. Electroencephalography and Clinical Neurophysiology, 58, 14-24.

Albarracin, D., Wang, W., & Leeper, J. (2009). Immediate increase in food intake following exercise messages. Obesity, 17, 1451-1452.

Buttner-Ennever, J., & Holstege,G. (1986). Anatomy of premotor centers in the reticular formation controlling oculomotor, skeletomotor and autonomic motor systems. Progress in Brain Research, 64, 89-98.

Birch, L.L., McPhee, L., Sullivan, S., & Johnson,S.(1989).Conditioned meal initiation in youngchildren. Appetite, 13, 105–113.

Bouhuys, A.L., Bloem, G.M., & Groothuis, T.G.G. (1995). Induction of depressed and elated mood by music influences the perception of facial emotional expressions in healthy subjects. Journal of Affective Disorders, 33, 215–226.

Ball, K., Berch, D. B., Helmers, K. F., Jobe, J. B., Leveck, M. D., & Marsiske, M., et al. (2002). Effects of cognitive training interventions with older adults: Arandomized controlled trial. The Journal of The American Medical Association, 288, 2271–2281.

Bimler,D.L., Kirkland, J., & Jameson, K.A. (2004). Quantifying variations in personal color spaces: are there sex differences in color vision? Color Research & Application, 29, 128-134.

Bellisle, F., Dalix, A.M., & Slama, G. (2004). Nonfood-related environmental stimuli induce increased meal intake in healthy women: comparison of television viewing versus listening to a recorded story in laboratory settings. Appetite, 43, 175–180.

Blass, E.M., Anderson, D.R., Kirkorian, H.L., Pempek, T.A., Price, I., & Koleini, M.F. (2006). On the road to obesity: Television viewing increases intake of high-density foods. Physiology & Behavior. 88, 597-604.

Bar-Haim,Y., Lamy, D., Pergamin, L., Bakermans-Kranenburg, M. J., & Ijzendoorn, M. H. (2007).Threat related attentional bias in anxious and nonanxious individuals: a meta-analytic study. Psychological Bulletin, 133, 1–24.

Bayarri, C., Calvo, C., Costell, E. & Duran, L. (2001). Influence of color on perception of sweetness and fruit flavor of fruit drinks. Food Science and Technology, 7, 399-404.

Bello, Acebrón L., Calvo, & Dopico D. (2000). The importance of intrinsic and extrinsic cues to expected and experienced quality: An empirical application for beef. Food Quality and Preference, 11, 229–238.

Block, J. P., He, Y., Zaslavsky, A. M., Ding, L., & Ayanian, J. Z. (2009). Psychosocialstress and change in weight among US adults. American Journal of Epidemiology,170 (2), 181–192.

Boduroglu, A., Shah, P., & Nisbett, R. E. (2009). Cultural differences in allocation of attention in visual information processing. Journal of Cross-Cultural Psychology, 40, 349-360.

Bello Acebrón, L., & Calvo Dopico, D. (2000). The importance of intrinsic and extrinsiccues to expected and experienced quality: An empirical application for beef. Food Quality and Preference, 11, 229–238.

Bradley, B. P., Mogg, K., & Millar, N. H. (2000). Covert and overt orienting of attention to emotional faces in anxiety. Cognition and Emotion, 14,789–808.

Braude, L., & Stevenson, R.J. (2014). Watching television while eating increases energy intake: Examining the mechanisms in female participants. Appetite, 76, 9-16.

Christensen, C.M. (1983). Effects of color on aroma, flavor and texture judgments of foods. Journal of Food Science, 48 , 787-790.

Cheung, C.H.M., Rutherford, H.J.V., Mayes, L.C., & McPartland J.C. (2010). Neural responses to faces reflect social personality traits. Social Neuroscience, 5, 351–359.

Chua, H.F., Boland, J.E. & Nisbett, .R.E. (2005). Cultural variation in eye movements during scene perception. Proceedings of the National Academy of Sciences of the United States of America, 102 ,12629–12633.

Chiu, L.H. (1972). A cross-cultural comparison of cognitive styles in Chinese and American children. International Journal of Psychology, 7, 235–242.

Cliff ,M., Joyce, D.W., Lamar, M., Dannhauser, T., Tracy, D.K., & Shergill, S.S. (2013). Aging effects on functional auditory and visual processing using fMRI with variable sensory loading. Cortex, 49, 1304–1313.

Clydesdale, F. M. (1993). Color as a factor in food choice. Critical Reviews in Food Science and Nutrition, 33, 83-101.

Dallman, M. F., Akana, S. F., Laugero, K. D., Gomez, F., Manalo, S., Bell, M. E., & Bhatnagar, S. (2003). A spoonful of sugar. Feedback signals of energy stores and corticosterone regulate responses to chronic stress. Physiology and Behavior, 79 (1), 3–12.

Delwiche, J. (2004). The impact of perceptual interactions on perceived flavor. Food Quality and Preference, 15, 137-146.

Darley, W. K., & Smith, R. E. (1995). Gender differences in information processing strategies: Anempirical test of the selectivity model in advertising response. Journal of Advertising, 24, 41-56.

Donadini, G., Fumi, M.D., & De Faveri, M.D. (2011). How foam appearance influences the italian consumer's beer perception and preference. Journal of The Institute of Brewing, 117, 523-533.

Eysenck, S.B.G., Eysenck, H.J., & Barrett, P. (1985). A revised version of the Psychoticism scale. Personality and Individual Differences, 6, 21-29.

Eriksen, C.W., Hamunand, R. M., & Breitmeyer, R.G. (1970). Temporal factors in visual perception as related to aging. Psychonomic Journals, 7,354-356.

Epel, E., Jimenez, S., Brownell, K., Stroud, L., Stoney, C., & Niaura, R. (2004). Are stress eaters at risk for the metabolic syndrome? Annals of the New York Academy of Sciences, 1032, 208–210.

Eriksson, A. K., Ekbom, A., Granath, F., Hilding, A., Efendic, S., & Ostenson, C. G. (2008). Psychological distress and risk of pre-diabetes and Type 2 diabetes in a prospective study of Swedish middle-aged men and women. Diabetic Medicine, 25(7), 834–842.

Elder, R.S., & Krishna, A. (2010). The effects of advertising copy on sensory thoughts and perceived taste. Journal of Consumer Research, 36,748-756.

Fuchs, A.F., Kaneko C.R.S., & Scudder C.A. (1985). Brainstem control of saccadic eye movements. Annual Review of Neuroscience, 8, 307-337.

Fredrickson, B. L. (1998). What good are positive emotions? Review of General Psychology, 2 , 300–319.

Font-i-Furnols ,M., Tous, N., Esteve-Garcia, E., & Gispert, M. (2012). Do all the consumers accept marbling in the same way? The relationship between eating and visual acceptability of pork with different intramuscular fat content. Meat Science, 91,448–453.

Fredrickson, B. L. (2003). The value of positive emotions: The emerging science of positive psychology is coming to understand why it's good to feel good. American Scientist, 91, 330–335.

Frühholz, S., Prinz, M., & Herrmann, M. (2010). Affect-related personality traits and contextual interference processing during perception of facial affect. Neuroscience Letters, 469 , 260-264.

Goh, J.O., Tan, J.C. & Park, D.C. (2009). Culture modulates eye-movements to visual novelty. PLOS ONE, 4, e8238.

Grelotti, D. J., Gauthier, I., & Schultz, R. T. (2002). Social interest and the development of cortical face specialization: What autism teaches us about face processing. Developmental Psychobiology, 40, 213–225.

Gur, R.C., Gunning-Dixon, F., Bilker, W.B., & Gur, R.E. (2002).Sex differences in temporo-limbic and frontal brain volumes of healthy adults. Cereb Cortex, 12, 998–1003.

Galesic, M., Tourangeau, R., Couper, M.P., & Conrad, F.G. (2008). Eye-Tracking data new insights on response order effects and other cognitive shortcuts in survey responding. Public Opinion Quarterly, 72, 892-913.

Graham, D.J., Orquin, J.L., & Visschers, V.H.M. (2012). Eye tracking and nutrition label use: A review of the literature and recommendations for label enhancement. Food Policy, 37, 378-382.

Groesz, L. M., McCoy, S., Carl, J., Saslow, L., Stewart, J., Adler, N., Laraia, B., & Epel, E. (2012). What is eating you? Stress and the drive to eat. Appetite, 58(2), 717–721.

Paoletti, J.B. (1987). Clothing and gender in American children's fashions 1890–1920. Signs, 13,136–143.

Hearn, M.D., Baranowski ,T., Baranowski, J., Doyle, C., Smith, M., Lin, L.S., & Resnicow, K. (1998). Environmental influences on dietary behavior among children: availability and accessibility of fruits and vegetables. Journal of Health Education. 29, 26–32.

Hermans, D., Vansteenwegen, D., & Eelen, P. (1999). Eye movement as a continuous index of attention deployment: Data from a group of spider anxious students. Cognition and Emotion, 13,419–434.

Harris, J.L., Bargh, J.A., & Brownell, K.D. (2009). Priming effects of television food advertising on eating behavior. Health Psychology, 28, 404-413.

Heraclides, A., Chandola, T., Witte, D. R., & Brunner, E. J. (2009). Psychosocial stressat work doubles the risk of type 2 diabetes in middle-aged women. Evidence from the Whitehall II study. Diabetes Care, 32(12), 2230–2235.

Harrar, V, Piqueras-Fiszman, B, & Spence, C. (2011). There's more to taste in a coloured bowl. Perception, 40,880–882.

Issanchou, S. (1996). Consumer expectations and perceptions of meat and meat products quality. Meat Science, 43, 5-19.

Imram, N. (1999). The role of visual cues in consumer perception and acceptance of a food product. Nutrition & Science, 99, 224-230.

Jackson, G. R., Owsley, C., Cordle, E. P., & Finley, C. D. (1998). Aging and scotopic sensitivity. Vision Research, 38, 3655–3662.

Jackson, G. R., & Owsley, C. (2000). Scotopic sensitivity during adulthood. Vision Research, 40, 2467–2473.

Johnson, J., & Clydesdale, F.M. (1982). Perceived sweetness and redness in colored sucrose solutions. Journal of Food Science, 47, 747-752.

Jain, N., Verma, P., Mittal, S., Mittal, S., Singh, A.K., & Munjal, S. (2010). Gender based alteration in color perception. Indian Journal of Physiology and Pharmacology, 54, 366–370.

Jansen, E., Mulkens, S., & Jansen, A. (2010). How to promote fruit consumption in children. Visual appeal versus restriction. Appetite, 54, 599–602.

Jeong, J.W., Diwadkar, V.A., Chugani, C.D., Sinsoongsud, P., Muzik, O., Behen, M.E., Chugani , H.T., & Chugani, D.C. (2011) Congruence of happy and sad emotion in music and faces modifies cortical audiovisual activation. NeuroImage, 54, 2973–2982.

Jolij, J., & Meurs, M. (2011). Music alters visual perception. PLOS ONE, 6, e18861.

Koch, C. (2005). The quest for consciousness: A neurobiological approach. The American Journal of Psychiatry,162,407.

Karama, S., Lecours, A.R., Leroux, J.M., Bourgouin, P., Beaudoin, G., Joubert, S., & Beauregard, M. (2002). Areas of brain activation in males and females during viewing of erotic film excerpts, Human Brain Mapping, 16, 1 – 13.

Kitayama, S., Duffy S., Kawamura, T. & Larsen, J. T. (2003). Perceiving an object and its context in different cultures: a cultural look at new look. Psychological Science, 14, 201–206.

Klein, R., Klein, B.E., & Lee, K.E. (1996). Changes in visual acuity in a population. The beaver dam eye study. Ophthalmology, 103, 1169-1178.

Kennedy, O.B., Stewart-Knox, B.J., Mitchell, P.C., & Thurnham, D.I. (2005). Flesh colour dominates consumer preference for chicken. Appetite, 44, 181–186.

Lee, T.M.C., Liu H.L., Hoosain, R., Liao, W.T., Wu, C.T., Yuen, K.S.L., Chan, C.C.H., Fox, P.T., & Gao, J.H. (2002). Gender differences in neural correlates of recognition of happy and sad faces in humans assessed by functional magnetic resonance imaging. Neuroscience Letters, 333, 13–16.

Liechty, J., Pieters, R., & Wedel, M. (2003). Global and Local Covert Visual Attention: Evidence from a Bayesian Hidden Markov Model. Psychometrika, 68, 519-541.

Milosavljevic, M., & Cerf, M. (2008). First attention then intention Insights from computational neuroscience of vision. International Journal of Advertising, 27, 381–398.

Montagne, B., Kessels, R.C., Frigerio, E., de Haan, E.F., & Perrett , D. (2005). Sex differences in the perception of affective facial expressions: Do men really lack emotional sensitivity? Cognitive Processing, 6,136-141.

Masuda, T., & Nisbett, R.E. (2001).Attending holistically versus analytically: Comparing the context sensitivity of Japanese and Americans. Journal of Personality and Social Psychology, 81, 922–934.

Miyamoto, Y, Nisbett, R.E. & Masuda, T. (2006).Culture and the physical environment: Holistic versus analytic perceptual affordances. Psychol Science, 17, 113–119.

Masuda1, T.,Wang, H., Ishii, K., & Ito, K.(2012). Do surrounding figures' emotions affect judgment of the target figure's emotion? Comparing the eye movement patterns of European Canadians, Asian Canadians, Asian international students, and Japanese. Frontiers in Integrative Neuroscience, 6(72).

McGuinness, D, & Lewis, I. (1976).Sex differences in visual persistence: Experiments in the Ganzfield and afterimages. Perception, 5, 295–301.

McPartland, J., Dawson, G., Webb, S. J., Panagiotides, H., & Carver, L. J. (2004). Event-related brain potentials reveal anomalies in temporal processing of faces in autism spectrum disorder. Journal of Child Psychology and Psychiatry, 45, 1235–1245.

Mogg, K., McNamara, J., Powys, M., Rawlinson, H., Seiffer, A., & Bradley, B. P. (2000). Selective attention to threat: A test of two cognitive models of anxiety. Cognition and Emotion, 14, 375–399.

Mogg, K., Millar, N., & Bradley, B. P. (2000). Biases in eye movements to threatening facial expressions in generalized anxiety disorder and depressive disorder. Journal of Abnormal Psychology, 109, 695–704

Mathews, A., Fox, E., Yiend, J., & Calder, A. (2003). The face of fear: effects of eye gaze and emotion on visual attention. Visual Cognition, 10, 823–835.

Mizutani, N., Okamoto, M., Yamaguchi, Y., Kusakabe, Y., Dan, I., & Yamanaka, T. (2010). Package images modulate flavor perception for orange juice. Food Quality and Preference, 21, 867–872.

Moralesa, R., Guerrero, L., Aguiar, A.P.S., Guardia, M.D., & Gou, P. (2013). Factors affecting dry-cured ham consumer acceptability. Meat Science, 95, 652-657.

Morales, R., Aguiar, A.P.S., Subiabrea ,I., & Realini, C.E. (2013). Beef acceptability and consumer expectations associated with production systems and marbling. Food Quality and Preference, 29, 166–173.

Morrot ,G., Brochet, F. & Dubourdieu, D. (2001). The color of odors. Brain and Language, 79, 309-320.

Newton, T., Slade, P., Butler, N. M., & Murphy, P. (1992). Personality and performance on a simple visual search task. Personality and Individual Differences, 13, 381-382.

Ng, D. M., & Jeffery, R. W. (2003). Relationships between perceived stress and health behaviors in a sample of working adults. Health Psychology, 22(6), 638–642.

Nijs, I.M.T., Muris, P., Euser, A.S., & Franken, I.H.A. (2010). Differences in attention to food and food intake between overweight/obese and normal-weight females under conditions of hunger and satiety. Appetite, 54, 243-254.

Nisbett, R.E.(2003). The geography of thought: How Asians and Westerners think differently – and why. New York; Free Press.

Nisbett, R.E., Peng, K., & Choi, I . Norenzayan, A. (2001). Culture and systems of thought: Holistic vs. analytic cognition. Psychological Review, 108 , 291–310.

Nisbett ,R.E., & Masuda, T. (2003). Culture and point of view. Proceedings of the National Academy of Sciences of the United States of America, 100, 11163–11170.

Nisbett, R.E., & Miyamoto, Y. (2005). The influence of culture: Holistic versus analytic perception. Trends in Cognitive Science, 9, 467–473.

Oliver, G., Wardle, J., & Gibson, E. L. (2000). Stress and food choice. A laboratory study. Psychosomatic Medicine, 62(6), 853–865.

Owsley, C., Sloane, M.,McGwin, Jr.G., & Ball, K. (2002). Timed instrumental activities of daily living tasks: Relationship to cognitive function and everyday performance assessments in older adults. Gerontology, 48, 254-265.

Ohla ,K., Toepel, U., le Coutre, J., & Hudry, J. (2012). Visual-Gustatory interaction: orbitofrontal and insular cortices mediate the effect of high-calorie visual food cues on taste pleasantness. PLOS ONE, 7, e32434.

Ogden, J., Coop, N., Cousins, C., Crump, R., Field, L., Hughes, S., & Woodger, N. (2013). Distraction, the desire to eat and food intake. Towards an expanded model of mindless eating. Appetite, 62, 119-126.

Painter, J.E., Wansink, B, & Hieggelke, J.B. (2002). How visibility, convenience influence candy consumption. Appetite, 38, 237–238.

Peters-Texeira, A., & Badrie, N. (2005). Consumers' perception of food packaging in Trinidad, West Indies and its related impact on food choices. International Journal of Consumer Studies, 29,508–514.

Pieters, R., Rosbergen, E., & Wedel, M. (1999). Visual Attention to Repeated Print Advertising: A Test of Scanpath Theory. Journal of Marketing Research, 36, 424-438.

Piqueras-Fiszman, B., & Spence, C. (2012). The influence of the color of the cup on consumers' perception of a hot beverage. Journal of Sensory Studies, 27, 324-331.

Piqueras-Fiszman, B., Alcaide, J., Roura , E. & Spence, C.(2012). Is it the plate or is it the food? Assessing the influence of the color (black or white) and shape of the plate on the perception of the food placed on it. Food Quality and Preference, 24, 205-208.

Piqueras-Fiszman, B., Velasco, C., Salgado-Montejo, A., & Spence, C. (2013). Using combined eye tracking and word association in order to assess novel packaging solutions: A case study involving jam jars. Food Quality and Preference, 28, 328-338.

Perlman, S.B., Morris, J.P., Vander Wyk, B.C., Green, S.R., Doyle, J.L., & Pelphrey, K.A. (2009). Individual differences in personality predict how people look at faces. PLOS ONE, 4, 1-6.

Piqueras-Fiszman, B, & Spence, C. (2011). Cross modal correspondences in product packaging. Assessing color–flavor correspondences for potato chips (crisps). Appetite, 57, 753–757.

Privitera, G. J., & Creary, H. E. (2013). Proximity and visibility of fruits and vegetables influence intake in a kitchen setting among college students. Environment & Behavior, 45, 876-886.

Raphan, T., & Cohen, B. (1978). Brainstem mechanisms for rapid and slow eye movements. Annual Review of Physiology,40, 527-552.

Reichle, E.D., Reineberg, A.E., & Schooler, J.W. (2010). Eye movements during mindless reading. Psychological Science, 21, 1300 –1310.

Rayner, K., Rotello, C. M., Stewart, A.J., Keir, J, & Duffy, S. A. (2001). Integrating Text and Pictorial Information: Eye Movements When Looking at Print Advertisements. Journal of Experimental Psychology: Applied, 7, 219-226.

Rolls, E.T., & Baylis, L.L. (1994). Gustatory, olfactory, and visual convergence within the primate orbitofrontal cortex. The Journal of Neuroscience, 14, 5437-5452.

Rauthmann, J. F., Seubert, C. T., Sachse, P., & Furtner, M. R. (2012). Eyes as windows to the soul: gazing behavior is related to personality. Journal of Research in Personality, 46, 147–156.

Rolls, B.J., Roe, L.S., Kral, T.V.E., Meengs, J.S. & Wall, D.E. (2004). Increasing the portion size of a packaged snack increases energy intake in men and women. Appetite, 42, 63-69.

Spence, C, Levitan, CA, Shankar, MU, & Zampini, M. (2010). Does food color influences taste and flavor perception in humans? Chemosensory Perception, 3, 68-84.

Stillman , J.A. (1993). Color influences flavor identification in fruit-flavor beverages. Journal of Food Science, 58, 810-812.

Sturr, J. F., Zhang, L., Taub, H. A., Hannon, D. J., & Jackowski, M. M. (1997). Psychophysical evidence for losses in rod sensitivity in the aging visual system. Vision Research, 37, 475–481.

Spence, C., Harrar, V., & Piqueras-Fiszman, B. (2012). Assessing the impact of the tableware and other contextual variables on multisensory flavor perception. Flavour, 1, 7.

Spence, C, Levitan, C.A, Shankar, M.U., & Zampini, M. (2010). Does food color influence taste and flavor perception in humans? Chemosensory Perception, 3, 68–84.

Thesen, T., Vibell, J.F., Calvert, G.A., Osterbauer, R.A., Giard, M.H., & Wallace, M. (2004). Neuroimaging of multisensory processing in vision, audition, touch, and olfaction. Cognitive Processing, 5, 84-93.

Tannenbaum, B., Anisman, H., & Abizaid, A. (2010). Neuroendocrine stress response and its impact on eating behavior and body weight. In L. Dube, Bechara, A., Dagher, A., Drewnowski, A., LeBel, J., James, P., Yada, R. (Ed.), Obesity Prevention: Academic Press.

Toschi, T.G., Bendini1, A., Barbieri, S., Valli, E., Cezanne, M.L., Buchecker, K., & Canavari, M. (2012). Organic and conventional nonflavored yogurts from the Italian market: study on sensory profiles and consumer acceptability. Journal of the Science of Food and Agriculture, 92, 2788-2795.

Tsenkova, V., Boylan, J.M., & Ryff, C. (2013). Stress eating and health. Findings from MIDUS, a national study of US adults. Appetite, 69,151–155.

Van Strien, T., & Ouwens, M. A. (2003). Counterregulation in female obese emotional eaters: Schachter, Goldman, and Gordon's (1968) test of psychosomatic theory revisited. Eating Behaviors, 3(4), 329–340.

Van den Stock, J., Peretz, I., Grezes, J., & De Gelder, B. (2009) Instrumental music influences recognition of emotional body language. Brain Topography, 21, 216–220.

Van Kleef ,E., Shimizu, M., & Wansink, B. (2011). Food compensation: do exercise ads change food intake? International Journal of Behavioral Nutrition & Physical Activity, 8, 6-15.

Wrasea, J., Kleinb, S., Gruesserc, S.M., Hermannb, D., Florb, H., Mannb, K., Brausb, D.F., & Heinz, A. (2003). Gender differences in the processing of standardized emotional visual stimuli in humans: a functional magnetic resonance imaging study. Neuroscience Letters, 348, 41–45.

Wadlinger, H. A., & Isaacowitz, D. M. (2006). Positive mood broadens visual attention to positive stimuli. Motivation and Emotion, 30, 87–99.

Wansink, B., Painter ,J.E., & North, J. (2005). Bottomless bowels: Why visual cues of portion size may influence intake. Obesity Research,13, 93-100

Wansink, B., & Van Ittersum, K. (2003). Bottoms up! The influence of elongation on pouring and consumption volume. Journal of Consumer Research, 30, 455-463.

Wu, S., & Keysar, B. (2007). The effect of culture on perspective taking. Psychological Science,18, 600-606.

Wansink, B., & Kim, J. (2005). Bad popcorn in big buckets: portion size can influence intake as much as taste. Journal of Nutrition Education and Behavior, 37, 242-245.

WansinK, B., Painter, J.E. & Lee, Y.K. (2006). The office candy dish: proximity's influence on estimated and actual consumption. International Journal of Obesity, 30, 871–875.

Woltman-Elpers, J. L. C. M., Wedel, M., & Pieters, R. G. M. (2003). Why do consumers stop viewing television commericals? Two experiments on the influence of moment-to-moment entertainment and information value. Journal of Marketing Research, 40, 437-453.

Wedel, M, & Pieters, R. (2000). Eye Fixations on Advertisements and Memory for Brands: A Model and Findings. Marketing Science, 19, 297-312.

Zihl, J., Von Cramon, D., & Mai, N. (1983). Selective disturbance of movement vision after bilateral brain damage. Brain, 106, 313-340.

Zeki, S., & Marini, L. (1998). Three cortical stages of colour processing in the human brain. Brain, 121, 1669-1685.

Zuber, I., & Ekehammar, B. (1988). Personality, time of day and visual perception: Preferences and selective attention. Personality and Individual Differences, 9, 345–352.

Zampini, M., Sanabria, D., Phillips, N., & Spence, C. (2007). The multisensory perception of flavor: Assessing the influence of color cues on flavor discrimination responses. Food Quality and Preference, 18, 975-984.

Zeki, S. (1993). A Vision of the Brain. Oxford, England: Blackwell Scientific Publications.

CHAPTER 3

INFLUENCES OF FASTED AND FED STATES ON IMPLICIT VIUSAL ATTENTION TOWARDS THE IMAGES OF FOOD AND NON-FOOD ITEMS

1. Introduction

People's appetite towards food decreases after eating a certain amount of food. The process of eating generates signals to the brain, resulting in a decrease in the sense of hunger and the amount of consumption (Mehta et al., 2012). In other words, individuals' desire to eat and their amount of consumption vary depending on how hungry or full they are (Hill et al., 1984; Neumark-Sztainer et al., 1999; Carnell & Wardle, 2007; Talbot & Avery, 2011; Park et al., 2012). When people are asked why they consumed a particular food, a large portion of them often report that they were hungry or they liked the food (Neumark-Sztainer et al., 1999).

Previous empirical studies have shown that individuals' satiety status alters their visual attention towards food-related stimuli (Channon & Hayward, 1990; Lavy & van den Hout, 1993; Mogg, Bradley et al., 1998; Placanica et al., 2002; Stockburger et al., 2008; Siep et al., 2009; Stockburger et al., 2009; Frank et al., 2010; Mehta et al., 2012). For example, using functional magnetic resonance imaging (fMRI), Siep et al. (2009) showed that satiated participants paid more attention to low calorie foods, while hungry participants focused more on high calorie foods. Similarly, Mehta et al. (2012) demonstrated that participants with higher level of hunger showed higher visual attention towards "fattening food". However, no significant correlation was found between visual attention towards "non-fattening food" and satiety status.

There is increasing evidence that the Body Mass Index (BMI) is associated with eating behavior (Faith et al., 1997; Craeynest et al., 2005; Batterink et al., 2010) and visual perception (Roefs et al., 2008; Castellanos et al., 2009; Nijs et al., 2010; Nummenmaa et al., 2011; Yokum et al., 2011). Generally, it appears that overweight or obese individuals are more likely to consume high-calorie foods compared to normal-weight individuals. In addition, people with different BMI show different visual attention towards not only body images (Faith et al., 1997;

Annis et al., 2004; Schwartz & Brownell, 2004; Roefs et al., 2008), but also food-related stimuli (Schachter & Rodin, 1974; Craeynest et al., 2005; Castellanos et al., 2009; Nijs et al., 2010; Batterink et al., 2010; Nummenmaa et al., 2011; Yokum et al., 2011). Nijs et al. (2010) demonstrated that overweight/obese participants, in comparison to normal-weight counterparts, focused more on food stimuli, especially when they were hungry. Nummenmaa et al. (2011) also found that the latency of visual detection of food image became shorter with an increase of BMI. That is, participants with higher BMI visually detected the food image more quickly than did those with lower BMI.

There are individual variations in eating behaviors. It has been reported that restrained eaters show better control on energy intake in everyday life (Johnson et al., 2012). By contrast, emotional eaters are likely to have poor control on energy intake, which in turn result in weight gain (Koenders & van Strien, 2011). Earlier studies show a plausible connection between individuals' eating behavior and their visual attention towards foods. That is, restrained eaters, in comparison to emotional eaters, would pay less attention to the foods or their images in daily life.

Building on previous findings, this study aimed to determine whether fasted and fed states can affect implicit visual attention towards the image of food and non-food items. In addition, the hunger/fullness status-induced visual attention to the image of food items can be different between normal-weight and obese participants. Based on earlier findings, it would be expected that in a fasted state, participants implicitly look at the images of food items sooner and longer than those of non-food items. Furthermore, compared to normal-weight participants, overweight/obese participants would be expected to still look at the images of food items sooner and longer even in a fed state.

2. Materials and Methods

2.1. Ethics statement

This study was conducted in conformance with the Declaration of Helsinki for studies on human subjects. The protocol was approved by the University Institutional Review Board of the University of Arkansas (Fayetteville, AR).

2.2. Participants

Sixty-one volunteers (all Caucasians; 30 males and 31 females) aged from 20 to 50 years old took part in this study. According to their BMIs, the participants were divided into normal-weight group ($18.5 \leq BMI \leq 24.9$; 15 males and 16 females) and overweight/obese group ($BMI \geq 25.0$; 15 males and 15 females), respectively. There was significant difference between the two BMI groups in terms of their BMIs: normal-weight group [mean ± standard deviation (SD) = 22.1 ± 1.7] and overweight/obese group (31.2 ± 5.6) ($P < 0.001$). The participants whose BMI is lower than 25 were assigned to normal-weight group (31 subjects; 15 males and 16 females). There was no significant difference between the two BMI groups in terms of mean age: normal-weight group [mean ± standard deviation (SD) = 32 ± 9 years] and overweight/obese group (36 ± 9 years) (P =0.07). In addition, the two groups did not differ from each other in gender ratio (P = 0.70). All participants have normal or corrected-to-normal vision. No color blindness or food allergy was reported. Color blindness was determined based on results obtained through the Ishihara color test (Ishihara, 1986).

2.3. Visual stimuli

A total of 24 different pictorial slides were used as visual stimuli. As shown in Figure 1, each slide included four same-sized pictures of four different categories: high-calorie food (e.g., pizza, hamburger, or donut, etc.), low-calorie food (e.g., fruits, vegetables, or salads, etc.), nature (e.g., wildlife, animal, or plants, etc.), and activity (e.g., sports balls, running track, running shoes, etc.). All pictures were obtained from web-providers. To match color and brightness, the pictures were manipulated by using Photoshop® software (Adobe Systems Inc., San Jose, CA) where appropriate. The pictures of the four categories were randomly laid out in each slide. Additionally, two pictorial slides were used as warm-up slides prior to the onset of the experimental slides; these data were not used for data analysis.

Figure 3.1. An example of visual slide used in this study. Each slide includes 4 images of the 4 different categories: high-calorie food, low-calorie food, nature, and activity.

2.4. Eating behavior questionnaires

Dutch Eating Behavior Questionnaire (DEBQ)

Participants' eating behavior was measured by using the Dutch Eating Behavior Questionnaire (DEBQ). The DEBQ consists of 33 items with 5-point Likert scales (Appendix II). There are three scales in the DEBQ, including "restrained eating scale" (10 items), "emotional

eating scale" (13 items), and "external eating scale" (10 items). "Restraint eating" represents overeating after a period of diet. "Emotional eating" represents eating regarding the emotional states (e.g., anger or anxiety). Finally, "external eating" represents eating in response to the external food cues (e.g., smell of food) (van Strien et al., 1986).

The Three Factor Eating Questionnaire (TFEQ)

The TFEQ is composed of 51 questions which measures "cognitive restraint", "disinhibition", and "susceptibility to hunger" (Stunkard & Messick, 1985; Appendix II). The cognitive restraint scale (21 items; score range 0-21) is intended to measure dietary restraint which means the control over food intake for body weight and body shape. The disinhibition scale (16 items; score range 0-16) detects episodes of loss of control over eating. Finally, the hunger scale (14 items; score range 0-14) is intended to measure sensitivity to and awareness of hunger and food cravings (Karlsson et al., 2000).

2.5. Procedure

This study was composed of a total of three eye-tracking sessions. That is, using eye tracker, participants' visual attention towards visual slides were measured at three times: 15 min before breakfast, 15 min and 30 min after breakfast. All participants were asked to refrain from consuming any foods and beverages for 12 hours prior to the eye-tracking study.

On the testing day, upon arrival, the experimental procedure was thoroughly explained to participants and a written informed consent was obtained. Participants' height and weight were measured. Next, participants were asked to sit on a chair 60 cm from the 22-in. monitor integrated with an eye-tracker (Model: RED, SensoMotoric Instruments GmbH, Teltow,

Germany). The sampling rate of eye-tracker was 120 Hz and its tracking spatial resolution was 0.03°. By using the five-point calibration method, the equipment was calibrated individually with a low tracking error (less than 0.4°). Prior to an eye-tracking test, general instructions for the experimental procedure and eye-tracking were given. The experimenter explained that the participants' task was to freely view a total of 10 different pictorial slides, including two warm-up slides, one after another in the absence of a particular task. Following the warm-up slides, 8 pictorial slides were randomly presented via stimulus presentation software (Experiment Suite 360°^{TM}, SensoMotoric Instruments GmbH, Teltow, Germany). Each slide was presented for 10,000 ms on a monitor. An inter-stimulus interval (ISI) was allowed for approximately 5,000 ms. During the ISI, participants were asked to look at a fixed black cross displayed on a white background. Since this study was designed to focus on implicit visual attention, no instruction and task were given during the presentation of visual slides. All the participants were presented the same stimuli (2 warm-up slides + 8 experimental slides) in each session. All the experimental slides were presented in a random order within each session. The randomization of the experimental slides was performed via stimulus presentation software (Experiment Suite 360°^{TM}, SensoMotoric Instruments GmbH, Teltow, Germany). Subsequently, participants' hunger/satiety status was self-rated on a 10-cm visual analogue scale (VAS) ranging from 0 (extremely hungry) to 10 (extremely full).

Following the first session of eye-tracking test, two blueberry muffins (Little Debbie, McKee Foods, Collegedale, TN; 190 kcal of each) and 262-mL orange juice (Tropicana, PepsiCo, Inc., Purchase, NY; 120 kcal of total) were presented to the participants as breakfast. All participants were asked to consume all of the served breakfast; the energy content of the breakfast was 500 kcal in total. The second and third sessions of eye-tracking test were

conducted at 15 min and 30 min after the breakfast, respectively. All slides were presented only one time during the study. Following the eye-tracking session, participants were asked to rate their hunger/satiety status on the VAS as shown in the first session.

After completing all three sessions of eye-tracking test, participants were asked to fill out two questionnaires: the Dutch Eating Behavior Questionnaire (DEBQ) and the Three Factor Eating Questionnaire (TFEQ).

2.6. Data analysis

Using BeGaze^{TM} software (SensoMotoric Instruments GmbH, Teltow, Germany), the images of the four categories were selected as "Areas of Interest (AOI)" for "high-calorie food", "low-calorie food", "nature", and "activity", respectively. Again, the sizes of the images of the four categories were same. Three parameters of visual attention were used: 1) entry time, 2) revisit count, and 3) fixation time. Entry time refers to the latency required for the first fixation into the AOI. Revisit count refers to the total number of re-fixations into the AOI. Finally, fixation time is the sum of fixation duration to the AOI.

As six participants (2 normal-weight and 4 overweight/obese participants) were not able to complete the experiment, their data were not used for data analysis. The data of individual slides whose recording time was less than 70% (< 7,000 ms) were regarded as incomplete data. Therefore, 9.8% of the total data was not used for data analysis.

Statistical analysis was performed using SPSS 20.0 for Windows^{TM} (IBM SPSS Inc., Chicago, IL, USA). To compare the mean scores of eating behavior questionnaires (DEQB and TFEQ) between normal-weight and overweight/obese groups, Student's *t*-tests were used. In addition, to examine whether the breakfast given during the experiment could increase

participants' satiety as a function of BMI level, the authors used a two-way repeated measures analysis of variance (RM-ANOVA) treating 1) session (i.e., -15 min, + 15 min, and +30 min) as within-participants factor and 2) BMI level (i.e., normal-weight *vs.* overweight/obese) as between-participant factor on the ratings of hunger/fullness.

To determine the effects of the four factors: 1) session and 2) image type as within-participants factors, and 3) BMI level and 4) gender as between-participants factors on participants' implicit visual attentions to the images of given during the experiment, a three-way RM-ANOVA was used. If the Sphericity assumption was violated via the Mauchly sphericity test, the degrees of freedom were adjusted by using the Huynh-Feldt correction. If a significant difference of means was indicated by RM-ANOVAs, post hoc comparisons between independent variables were performed using Bonferroni *t*-tests. A statistically significant difference was defined as $P < 0.05$.

3. Results

3.1. Eating behaviors of the normal-weight and overweight/obese groups

Table 3.1 summarizes participants' eating behaviors as a function of BMI level (i.e., normal-weight *vs.* overweight/obese groups). Compared to normal-weight group, overweight/ obese group was higher in the mean scores of "restrained" ($P = 0.003$) and "emotional" ($P = 0.03$) subscales in the DEBQ. There was no significant difference between the two groups in the mean score of "external" subscale ($P = 0.71$) in the DEBQ. For the TFEQ, overweight/obese group showed significantly higher mean score of "disinhibition" subscale than normal-weight group ($P = 0.004$).

Table 3.1. Comparisons between normal-weight and overweight/obese groups in the mean scores (± standard error of the mean) of eating behavior questionnaires

	Normal-weight group (*N* = 29)	**Overweight/obese group (*N* = 26)**
Dutch eating behavior questionnaire (DEBQ)		
Restrained	2.63 (± 0.15)b	3.30 (± 0.15)a
Emotional	2.19 (± 0.14)b	2.67 (± 0.17)a
External	3.39 (± 0.09)	3.44 (± 0.11)
Three factor eating questionnaire (TFEQ)		
Cognitive Restraint	9.72 (± 1.02)	11.73 (± 1.16)
Disinhibition	5.66 (± 0.54)b	7.92 (± 0.53)a
Susceptibility to Hunger	4.90 (± 0.55)	5.27 (± 0.51)

Mean ratings with different letters within the same row show a significant difference ($P < 0.05$).

3.2. Comparisons in the subjective ratings of hunger/fullness between fasted and fed states as a function of BMI level

A two-way RM-ANOVA revealed no significant interaction between session and BMI level [F (2, 106) = 1.42, P = 0.25]. As shown in Table 3.2, participants rated that they were significantly fuller 15 min and 30 min after consuming breakfast when compared to their fasted state ($P < 0.001$); there was no significant difference in their fullness between the second (+15 min) and third (+30 min) sessions ($P = 1.00$). In addition, there was no significant effect of BMI level on the ratings of hunger/fullness ($P = 0.68$).

Table 3.2. Changes in the mean ratings (± standard error of the mean) of hunger/fullness across the three sessions

	1st session (-15 min)	**2nd session (+15 min)**	**3rd session (+30 min)**
Total	2.31 (± 0.16)b	7.47 (± 0.22)a	7.46 (± 0.23)a
Normal-weight group	2.31 (± 0.21)b	7.75 (± 0.30)a	7.37 (± 0.35)a
Overweight/obese group	2.31 (± 0.24)b	7.17 (± 0.33)a	7.56 (± 0.31)a

Mean ratings with different letters within the same row show a significant difference ($P < 0.05$).

3.3. Comparisons in the implicit visual attention towards the images of food and non-food items as a function of hunger/fullness status

A four-way RM-ANOVA found that there was no significant four-way interaction among session, BMI level, gender, and image type for the entry time ($P = 0.80$), revisit count ($P = 0.55$), and fixation time ($P = 0.85$). Additionally, since there were no significant effects of BMI level and gender on these three parameters ($P > 0.05$), further analysis did not include the factors of BMI level and gender.

Entry time

A two-way RM-ANOVA revealed a significant interaction between session and BMI level in the entry time [F (2, 108) = 14.78, $P < 0.001$]. As shown in Figure 2 (a), in a fasted state, participants looked at the images of food item more quickly than those of non-food item ($P < 0.001$). By contrast, in a fed state (at 15 min after breakfast consumption), participants looked at the images of non-food items sooner than those of food item ($P = 0.004$). However, at 30 min after the breakfast, there was no significant difference in the participants' entry time between the images of food and non-food items ($P = 0.40$).

Revisit count

There was a significant interaction of session and BMI level [Huynh-Feldt correction: F (1.50, 10.17) = 27.36, $P < 0.001$] in the revisit count [Figure 3.2 (b)]. When they were hungry, participants more frequently revisited to the images of food item than those of non-food item ($P < 0.001$). In contrast, the participants' visual fixation more often revisited the images of non-food

item than those of food item when they were full: at 15 min (P = 0.013) and at 30 min (P = 0.010) after breakfast consumption.

Fixation time

As shown in Figure 3.2 (c), there was a significant interaction between session and BMI level in the fixation time [Huynh-Feldt correction: F (1.44, 77.91) = 25.78, P < 0.001]. When they were hungry, participants looked at the images of food item significantly longer than those of non-food item (P < 0.001). On the contrary, the participants looked at the images of food item significantly longer the images of non-food item than those of food item in the fed state: at 15 min (P = 0.039) and at 30 min (P = 0.004).

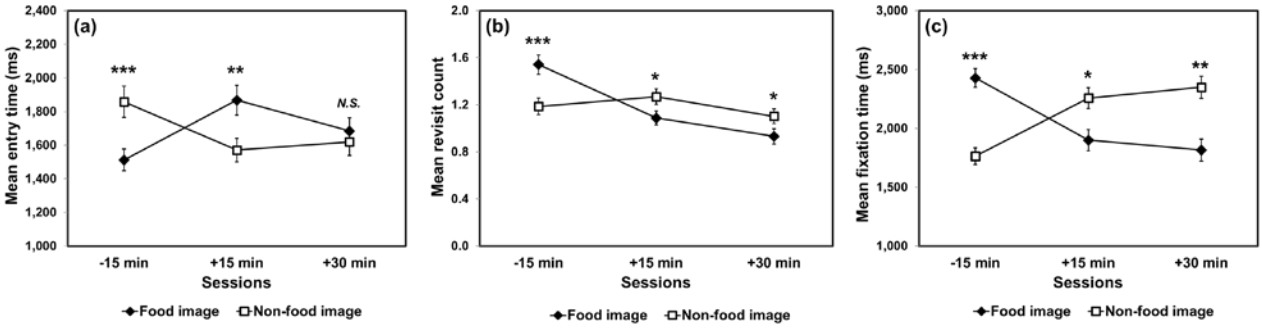

Figure 3.2. Comparisons between the implicit visual attentions towards the images of food and non-food items as a function of hunger/fullness status. Three eye-tracking parameters, such as (a) entry time, (b) revisit count, and (c) fixation time, were measured at three times: at 15 min before breakfast, at 15 min and 30 min after breakfast. Error bars represent the standard error of the mean. *, **, and *** represents a significant difference at P < 0.05, P < 0.01, and P < 0.001, respectively. *N.S.* represents no significant difference (P > 0.05).

3.4. Comparisons in the implicit visual attention towards the image of high-calorie food items between fasted and fed states

It was tested whether participants' hunger/fullness state affects participants' implicit visual attention towards the image of high-calorie food items.

Entry time

As shown in Figure 3.3 (a), the time required for the first fixation onto the image of high-calorie food was significantly different among the three sessions [F (2, 108) = 4.27, P = 0.02]. Participants looked at the image of high-calorie food more quickly when they were hungry compared to at 15 min after consuming the breakfast (P = 0.03). However, there was no significant difference in the entry time between the two fed states (+15 min *vs.* +30 min; P = 0.60).

Revisit count

Figure 3.3 (b) shows that participants' visual fixation less often revisited the image of high-calorie food when they were fed compared to when they were fasted [Huynh-Feldt correction: F (1.73, 93.30) = 39.44, P < 0.001]. Furthermore, the revisit count was significantly lower at 30 min than at 15 min after the breakfast (P = 0.004).

Fixation time

Figure 3.3 (c) demonstrates a significant difference in the fixation time among the three eye-tracking sessions [Huynh-Feldt correction: F (1.35, 73.01) = 22.06, P < 0.001]. Participants looked at the image of high-calorie food significantly longer when they were hungry compared to at 15 min (P < 0.001) and 30 min (P < 0.001) after consuming the breakfast. The fixation time was significantly shorter at 30 min than at 15 min after the breakfast (P = 0.02).

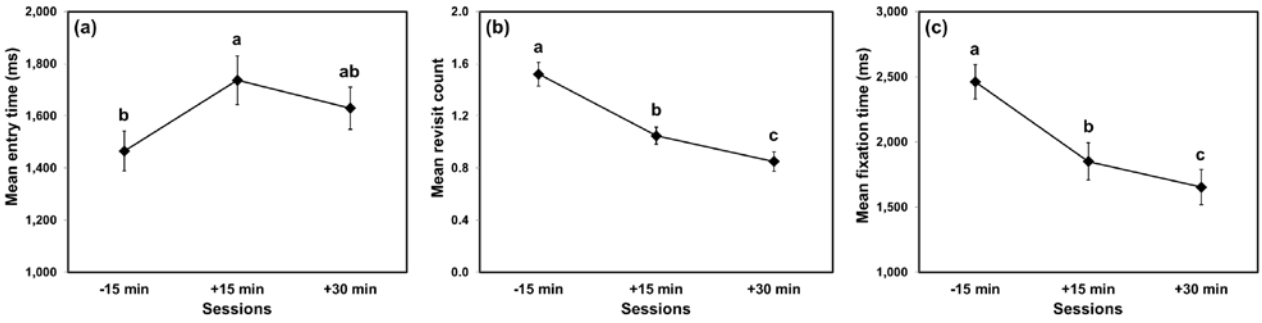

Figure 3.3. Comparisons in the implicit visual attention towards the images of high-calorie food items between fasted and fed states. Three eye-tracking parameters, such as (a) entry time, (b) revisit count, and (c) fixation time, were measured at three times: at 15 min before breakfast, at 15 min and 30 min after breakfast. Error bars represent the standard error of the mean. Mean ratings with different letters represent a significant difference at $P < 0.05$.

3.5. Comparisons in the implicit visual attention towards the image of low-calorie food items between fasted and fed states

It was tested whether participants' hunger/fullness state affects participants' implicit visual attention towards the image of low-calorie food items.

Entry time

Figure 3.4 (a) shows that the time required for the first fixation onto the image of low-calorie food was significantly different among the three sessions [F (2, 108) = 10.96, $P < 0.001$]. Participants looked at the image of low-calorie food more quickly when they were hungry when compared to at 15 min after consuming the breakfast ($P < 0.001$). However, there was no significant difference in the entry time between the two fed states (+15 min *vs.* +30 min; $P = 0.23$).

Revisit count

Figure 3.4 (b) demonstrates a significant difference among the three eye-tracking sessions in the revisit count [Huynh-Feldt correction: F (1.65, 88.95) = 26.45, $P < 0.001$]. Participants'

visual fixation less often revisited the image of low-calorie food when they were hungry compared to at 15 min ($P < 0.001$) and 30 min ($P < 0.001$) after consuming the breakfast. There was no significant difference in the revisit count between the two fed states (+15 min *vs.* +30 min; $P = 0.15$).

Fixation time

As shown in Figure 3.4 (c), a significant difference in the fixation time among the three eye-tracking sessions [Huynh-Feldt correction: F (1.79, 96.72) = 8.56, $P = 0.001$]. Participants looked at the image of low-calorie food significantly longer when they were hungry compared to at 15 min ($P = 0.002$) and 30 min ($P = 0.013$) after consuming the breakfast. There was no significant difference in the fixation time between the two fed states (+15 min *vs.* +30 min; $P = 1.00$).

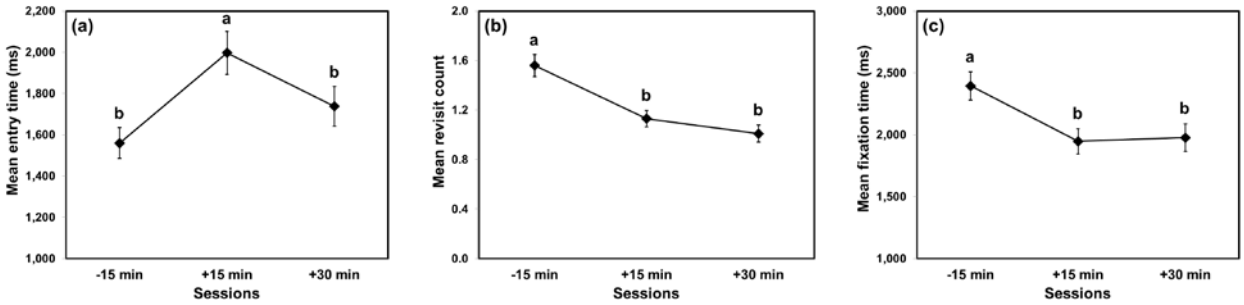

Figure 3.4. Comparisons in the implicit visual attention towards the images of low-calorie food items between fasted and fed states. Three eye-tracking parameters, such as (a) entry time, (b) revisit count, and (c) fixation time, were measured at three times: at 15 min before breakfast, at 15 min and 30 min after breakfast. Error bars represent the standard error of the mean. Mean ratings with different letters represent a significant difference at $P < 0.05$.

3.5. Relationships of implicit visual attentions towards the images of food and non-food items with individual ratings of hunger/fullness

Table 3.3 shows correlations between individual ratings of hunger/fullness and implicit visual attention towards the image of food and non-food items. As participants rated fuller, their visual fixation to the image of food items were significantly slower (i.e., higher entry time) and shorter (i.e., lower fixation time). In addition, as the participants felt fuller, their visual re-fixation to the image of food items were decreased (i.e., lower revisit count). By contrast, as participants rated as fuller, their visual fixation to the image of non-food items (e.g., activity- or nature-related images) were significantly sooner (i.e., lower entry time) and longer (i.e., higher fixation time).

Table 3.3. Pearson correlation coefficients (*r*) for the relations between individual ratings of hunger/fullness and implicit visual attentions towards the images of food and non-food items

	Entry time	Revisit count	Fixation time
Ratings of hunger/fullness (*N* = 165)			
Food items	0.25**	-0.49***	-0.50***
High-calorie foods	0.22**	-0.45***	-0.41***
Low-calorie foods	0.22**	-0.45***	-0.32***
Non-food items	-0.22**	0.01	0.46***
Activity	-0.05	-0.09	0.28***
Nature	-0.31***	0.11	0.41***

Hunger/satiety status was self-rated on a 10-cm visual analogue scale (VAS) ranging from 0 (extremely hungry) to 10 (extremely full).
*, **, and *** represent a significance at $P < 0.05$, $P < 0.01$, and $P < 0.001$, respectively.

4. Discussion

It would be expected that participants implicitly pay more attention towards food-related images when they are hungry, whereas they would pay more attention towards non-food images when they were full. These expectations were supported by the current results of eye-tracking test (Figures 3.2, 3.3, and 3.4). In addition, significant correlations were found between ratings of hunger/fullness and visual attention parameters, such as entry time (r = 0.25), revisit count (r = -0.49), and fixation time (r = -0.50), for the images of food items (Table 3.3). In other words, the more the participants felt hungry, the more quickly they tended to look at the food related images. Furthermore, they paid less attention towards food-related images when they felt more satiated. These results are consistent with the previous studies (Lavy & van den Hout, 1993; Mogg, Bradley et al., 1998; Stockburger et al., 2008; Siep et al., 2009; Stockburger et al., 2009; Frank et al., 2010) which demonstrated that hunger drove participants' attention towards food-related stimulus. For example, Mogg et al. (1998) demonstrated that participants with higher levels of hunger showed more attention to food-related words compared to participants with lower levels of hunger.

Unlike our expectation, there was no effect of BMI level on the hunger-induced visual attention towards the food-related images, which was not in line with previous findings (Nijs et al., 2010; Nummenmaa et al., 2011). For example, Nijs et al. (2010) showed that compared to normal-weight participants, overweight/obese participants focused more on food stimuli when they were hungry. In addition, Nummenmaa et al. (2011) found that participants with higher BMI visually detected the food-related images sooner when compared to those with lower BMI. However, previous results regarding to the hunger-induced visual attention to the food-related images have been inconsistent (Castellanos et al., 2009).

5. Conclusion

To summarize, this study showed that individuals' fasted and fed states can modulate their implicit visual attention towards the images of food and non-food items. The significant correlation between the ratings of hunger/fullness and visual attention towards the food-related images suggests that eye-tracking methodology can be alternative to measure the satiety effect of foods which were designed for the lasting of fullness.

REFERENCE

Annis, N. M., Cash, T. F., & Hrabosky, J. I. (2004). Body image and psychosocial differences among stable average weight, currently overweight, and formerly overweight women: Therole of stigmatizing experiences. Body Image, 1, 155–167.

Batterink, L, Yokum, S, & Stice, E. (2010).Body mass correlates inversely with inhibitory control in response to food among adolescent girls: an fMRI study. Neuroimage, 52, 1696–1703.

Channon, S., & Hayward, A. (1990). The effect of short-term fasting on processing of food cues in normal subjects. International Journal of Eating Disorders, 9, 447–452.

Craeynest, M, Crombez, G, De Houwer, J ., Deforche, B., Tanghe, A., & De Bourdeaudhuij, I. (2005). Explicit and implicit attitudes towards food and physical activity in childhood obesity. Behaviour Research and Therapy, 43, 1111–1120.

Carnell, S., & Wardle, J. (2007). Measuring behavioral susceptibility to obesity. Validation of the child eating behavior questionnaire. Appetite, 48, 104–113.

Castellanos, E.H., , Charboneau, E., Dietrich, M.S., Park, S., Bradley, B.P., Mogg, K., & Cowan, R.L. (2009). Obese adults have visual attention bias for food cue images: evidence for altered reward system function. International Journal of Obesity, 33, 1063–1073.

Faith, M. S., Leone, M. A., & Allison, D. B. (1997). The effects of self-generated comparison targets, BMI, and social comparison tendencies on body image appraisal. Eating Disorders: The Journal of Treatment and Prevention, 5, 128–140.

Frank, S., Laharnar, N., Kullmann, S., Veit, R., Canova, C., Hegner, Y.L., Andreas Fritsche, A., & Preissla, H. (2010). Processing of food pictures: Influence of hunger, gender and calorie content. Brain Research, 1350, 159–166.

Hill, A.J., Magson, L.D., & Blundell,J.E. (1984). Hunger and palatability: Tracking ratings of subjective experience before, during and after the consumption of preferred and less preferred food. Appetite, 5,361–371.

Johnson, E., Pratt, M., & Wardle, J. (2012). Dietary restraint and self-regulation in eating behavior. International Journal of Obesity, 36, 665–674.

Karlsson, J., Persson, L. O., Sjostrom, L., & Sullivan, M. (2000). Psychometric properties and factor structure of the Three-Factor Eating Questionnaire (TFEQ) in obese men and women. Results from the Swedish Obese Subjects (SOS) study. International Journal of Obesity and Related Metabolic Disorders, 24, 1715–1725.

Koenders, PG., & van Strien, T. (2011). Emotional eating, rather than lifestyle behavior, drives weight gain in a prospective study in 1562 employees. Journal of Occupational and Environmental Medicine, 53(11), 1287-1293.

Lavy, E. H., & van den Hout, M. A. (1993). Attentional bias for appetitive cues: effects of fasting in normal subjects. Behavioural and Cognitive Psychotherapy, 21, 297–310.

Mogg, K., Bradley, B.P., Hyare, H., & Lee, S. (1998). Selective attention to food-related stimuli in hunger: are attentional biases specific to emotional and psychopathological states, or are they also found in normal drive states? Behaviour Research and Therapy, 36, 227–237.

Mehta, S., Melhorn, S.J., Smeraglio, A., Tyagi, V., Grabowski, T., Schwartz, M.W., & Schur, E.A. (2012). Regional brain response to visual food cues is a marker of satiety that predicts food choice. The American Journal of Clinical Nutrition, 96, 989–999.

Neumark-Sztainer, D., Story, M., Perry, C., & Casey, M.A. (1999). Factors influencing food choices of adolescents: findings from focus-group discussions with adolescents. Journal of the American Dietetic Association, 99, 929–937.

Nummenmaa, L., Hietanen, J.K., Calvo, M.G., & Hyona, J. (2011). Food catches the eye but not for everyone: a BMI–contingent attentional bias in rapid detection of nutriments. PLOS ONE, 6, e19215.

Nijs, I.M.T., Muris, P., Euser, A.S., & Franken, I.H.A. (2010). Differences in attention to food and food intake between overweight/obese and normal-weight females under conditions of hunger and satiety. Appetite, 54, 243–254.

Placanica, J. L., Faunce, G. J., & Soames, Job, R. F. (2002). The effect of fasting on attentional biases for food and body shape/weight words in high and low Eating Disorder Inventory scorers. International Journal of Eating Disorders, 32, 79–90.

Park, E., Thomas, S., Wuchner, B., Huang, Y., Alandete, L., Inuit, T., Kergoat, S., Edirisinghe, I., & Burton-Freeman, B. (2012). Short term effects of chewing gum on satiety and snack intake in healthy weight and obese women. The FASEB Journal, 26, 40.8.

Roefs, A., Jansen, A., Moresi, S., Willems, P., van Grootel, S., & van der Borgh, A. (2008). Looking good: BMI, attractiveness bias and visual attention. Appetite, 51, 552-555.

Schachter, S, & Rodin, J. (1974). Obese Humans and Rats. Washington DC: Halsted Press.

Schwartz, M. B., & Brownell, K. D. (2004). Obesity and body image. Body Image, 1, 43–56.

Stockburger, J., Hamm, A. O., Weike, A. I., & Schupp, H. T. (2008). Deprivation selectively modulates brain potentials to food pictures. Behavioral Neuroscience, 122, 936–942.

Stockburger, J., Schma¨lzle, R., Flaisch, T., Bublatzky, F., & Schupp, H. T. (2009). The impact of hunger on food cue processing: an event-related brain potential study. NeuroImage, 47, 1819–1829.

Stunkard, A. J., & Messick, S. (1985). The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. Journal of Psychosomatic Research, 29, 71-83.

Siep, N., Roefs, A., Roebroeck, A., Havermans, R., Bonte, M.L., & Jansen, A. (2009). Hunger is the best spice: An fMRI study of the effects of attention, hunger and calorie content on food reward processing in the amygdala and orbitofrontal cortex. Behavioural Brain Research, 198, 149–158.

Talbot, A.M., & Avery, A. (2011). An investigation into how satiety and hunger they influence food choice in slimmers and nonslimmers. Journal of Human Nutrition and Dietetics, 24, 404.

Van Strien, T., Frijters, J.E.R., Bergers, G.P.A., & Defares, P.B. (1986). The Dutch Eating Behaviour Questionnaire (DEBQ) for assessment of restrained, emotional and external eating behaviour. International Journal of Eating Disorders, 5, 747-755.

Yokum, S., Ng, J., & Stice, E. (2011). Attentional bias to food images associated with elevated weight and future weight gain: an fMRI study. Obesity, 19, 1775–1783.

CHAPTER 4

AN EFFECT OF CRHONIC STRESS ON IMPLICIT VISUAL ATTENTION TOWARDS FOOD IMAGES

1. Introduction

Emotion and moods, arguably, play an important role in modulating people's perception and attitude to the world. Individuals' emotion and mood can also alter how they perceive and react to visual stimuli. Previous studies have shown that negative emotion/mood (e.g., stress, anxiety, sadness, fear, and fatigue) and positive emotion/mood (e.g., happiness and joy) modulated people's visual perception in different ways (Callaway & Dembo, 1958; MacLeod & Mathews, 1988; Elaine, 1993; Williams et al., 1997; Hermans et al., 1999; Bradley et al., 2000; Gasper & Clore, 2002; Witt et al., 2004; Fredrickson & Braningan, 2005; Wadlinger & Isaacowitz, 2006; Riener et al., 2011; Zadra & Clore, 2011; Shechner et al., 2013; Wegbreit et al.,2014). For example, Fredrickson and Braningan (2005) demonstrated that the participants who experienced positive emotions showed broader scopes of visual attention than those who experienced negative or neutral emotions. Also, Riener et al. (2011) showed that participants with sad mood tended to perceive the hill steeper than those with happy mood.

Many studies have shown plausible relationships between stress and food consumption, but the links have not been consistent among the studies (Oliver & Wardle, 1999; for a review, see Maniam & Morris, 2012; Sominsky & Spencer, 2014). That is, individuals' food consumption varies in response to acute mental stress. For example, when individuals are under acute stress, some individuals tend to eat more, whereas others are likely to eat less (Oliver & Wardle, 1999). Compared to the influence of acute mental stress, relatively little is known about how chronic stress affects food choice and amount of consumption. Although earlier studies have been still contradictory, people with chronic stress tend to consume energy dense foods (Ng & Jeffery, 2003). In addition, positive or negative emotions appear to regulate the effects of chronic stress on food intake.

With these backgrounds, this study was designed to examine whether chronic stress affects implicit visual attention towards food-related images. It was expected that compared to individuals with lower chronic stress, those with higher chronic stress would have more negative mood/emotion in their everyday lives, which might increase their implicit visual attention to the images of foods, in particular high-calorie food items.

2. Materials and Methods

2.1. Ethics statement

This study was conducted in conformance with the Declaration of Helsinki for studies on human subjects. The protocol was approved by the University Institutional Review Board of the University of Arkansas (Fayetteville, AR).

2.2. Participants

A total of 411 volunteers aged from 18 to 88 years (120 males and 291 females) completed an on-line screener including the Perceived Stress Scale (PSS) which is a self-administrated instrument for measuring the perception of stress (Cohen et al., 1983). The PSS has been found to predict not only psychological stress, but also the stress-related biological markers such as cortisol (Malarkey et al., 1995). Based on scores of the PSS, 22 volunteers (7 males and 15 females) whose scores were between 0 and 14 were chosen as “low stress group”. Also, 21 volunteers (6 males and 15 females) whose scores were higher than 24 were selected as “high stress group.” As shown in Table 4.1, two groups were not significantly different in terms of mean age, gender ratio, and body mass index ($P > 0.05$).

All participants reported that they have normal or corrected-to-normal vision. No color blindness or food allergy was reported. Color blindness was determined based on results obtained through the Ishihara color test (Ishihara, 1986). The experimental procedure, except the objective of this study, was thoroughly explained to all participants, and a written informed consent was obtained.

Table 4.1. Comparison between low and high stress groups in the demographic profiles

	Chronic Stress Level		*P*-value
	Low Stress Group	**High Stress Group**	
Demographic profiles			
Mean age (± SD)	36 (± 8) years	36 (± 9) years	0.92
Gender ratio	7 males : 15 females	6 males : 15 females	0.81
Mean BMI (± SD)	28 (± 6)	28 (± 7)	0.85

SD: Standard Deviation; BMI: Body Mass Index.

2.3. Positive and Negative Affect Schedule-X (PANAS-X) questionnaire

The PANAS-X consists of 60 items (words or phrases) that describe different emotions and feelings (for details, see Watson and Clark, 1994). Participants were asked to rate their specific feelings and emotions (60 items) during the past few weeks on a 5-point Likert scale ranging from 1 (very slightly or not at all) to 5 (extremely). The measure includes not only the two higher order scales (i.e., general positive affect and general negative affect), but also 11 specific affects: fear, sadness, hostility, guilt, fatigue, shyness, joviality, surprise, self-assurance, attentiveness, and serenity (Watson and Clark, 1994).

2.4. Visual stimuli

As visual stimuli, a total of 8 pictorial slides were used. As shown in Figure 4.1, each slide (1,500 x 1,125 pixels) includes 4 images of the 4 different categories: high-calorie food (e.g., pizza, ice cream, etc.), low-calorie food (e.g., vegetable salad, fruits, etc.), nature (e.g., flowers, animal, etc.), and activity (e.g., balls, baseball gloves, sports shoes, etc.). The pictures were purchased from web providers, and those were manipulated, by using Photoshop® software (Adobe Systems Inc., San Jose, CA), to match their color, brightness, and size among the four images shown in each slide. The four categorical images were randomly positioned in each visual slide.

Figure 4.1. An example of visual slide used in this study. Each slide includes 4 images of the 4 different categories: high-calorie food, low-calorie food, nature, and activity.

2.5. Procedure

Participants were asked to refrain from foods, coffee/tea, soft drinks, coffee/tea, and smoking for two hours prior to the eye-tracking study. After completing the PANAS-X questionnaire, the participants were asked to sit on a chair 60 cm from a 22-in monitor integrated with an eye-tracker (Model: RED, SensoMotoric Instruments GmbH, Teltow, Germany). The sampling rate of eye-tracker was 120 Hz and its tracking resolution was 0.03°. General

instructions for the experimental procedure and eye-tracking were given to all participants. Five-point calibration method was used to calibrate participants' eye fixation/movement individually, with a low tracking error (less than 0.4°).

Participants were asked to freely view a total of 10 different slides, including 2 warm-up slides, one after another in the presence of a particular task. Since the main objective of this study was to examine the implicit influence of chronic stress on visual attention to foods (especially, high-calorie foods), no specific task was given during the eye-tracking test.

As warm-up stimuli, a couple of additional slides, including four different geometric objects (e.g., triangle, circle, square, etc.) per each slide, were presented to minimize the first order-carry-over effect (Plemmons & Resurreccion, 1998). Subsequently, a total of 8 slides were randomly presented by means of presentation software (Experiment Suite 360°TM, SensoMotoric Instruments GmbH, Teltow, Germany). Each slide was presented for 10,000 ms on a 22-in widescreen monitor. In a preliminary test, participants were comfortable to explore the pictorial slide when 10,000 ms were given. An inter-stimulus interval (ISI) was given for 4,800 ms to 5,500 ms. During the ISI, participants were asked to look at a fixed black cross displayed on a white background. For each participant, all pictorial slides were presented only one time.

2.6. Data analysis

Using BeGaze^{TM} software (SensoMotoric Instruments GmbH, Teltow, Germany), the individual images of the four categories were determined as "Areas of Interest (AOI)" for "high-calorie food", "low-calorie food", "nature", and "activity", respectively. The images of the four categories were same. Three parameters of visual attention were used: 1) entry time, 2) revisit count, and 3) fixation time. Entry time is the latency required for the first fixation into the AOI.

Revisit count refers to the total number of re-fixations into the AOI. Finally, fixation time refers to the sum of fixation duration to the AOI.

As one female participant from the high-stress group was not able to complete the experiment, this data was discarded, leaving 42 participants' data for the data analysis.

Statistical analysis was performed using JMP Pro 11 software (SAS Institute, Cary, NC). To compare the mean scores of the PANAS-X questionnaire between high and low chronic stress groups, Student's *t*-tests were used. In addition, to test whether chronic stress level modulates implicit visual attentions towards the images of 4 categories, two-way analyses of variance (ANOVAs), treating chronic stress level as a main effect and participant as a random effect, were used. The data of 4 AOIs (high-calorie food, low-calorie food, nature, and activity) were analyzed separately. Finally, to examine whether positive or negative affect (PANAS-X) can be related to the three eye-tracking data parameters (entry time, revisit count, and fixation time), Pearson and Spearman correlations were used. A statistical significance was defined as $P < 0.05$.

3. Results

3.1. Comparisons between high and low chronic stress groups in the positive and negative emotions

As shown in Table 4.1, general positive ($P = 0.03$) and negative ($P = 0.001$) affects were significantly different between the participants with high and low chronic stress. The high stress group, in comparison to low stress group, showed higher and lower scores in the negative and positive affect, respectively.

In addition, the high and low chronic stress groups significantly differed in the specific affects. High stress groups showed significantly higher scores in fear and sadness than low stress

group. By contrast, low stress group was higher in the mean scores of joviality, self-assurance, and serenity. The results shows that the participants under higher chronic stress feel negative emotions more in their daily lives than those under lower stress.

Table 4.2. Comparisons between high stress and low stress groups in the mean scores (± standard deviation) of eating behavior questionnaires

PANAS-X factors	High stress group (*N* = 20)	Low stress group (*N* = 22)	*P*-value
General Positive Affect	29.80 (± 7.82)	34.64 (± 6.20)	0.03
General Negative Affect	21.45 (± 7.49)	15.36 (± 3.32)	0.001
Fear	11.55 (± 4.95)	9.00 (± 2.02)	0.03
Sadness	12.20 (± 5.62)	7.40 (± 2.75)	0.001
Guilt	12.30 (± 4.34)	10.50 (± 2.39)	0.10
Hostility	10.95 (± 4.25)	8.73 (± 3.33)	0.07
Shyness	5.75 (± 1.62)	5.41 (± 1.89)	0.54
Fatigue	12.55 (± 4.47)	10.27 (± 3.68)	0.08
Surprise	5.15 (± 2.58)	6.27 (± 2.66)	0.17
Joviality	21.90 (± 7.83)	28.41 (± 6.55)	0.006
Self-Assurance	14.50 (± 4.55)	18.50 (± 5.44)	0.01
Attentiveness	12.80 (± 2.84)	14.41 (± 2.84)	0.07
Serenity	7.35 (± 2.50)	10.09 (± 1.87)	< 0.001

3.2. Influences of chronic stress level on the implicit visual attention towards to food images

Figure 4.2 shows implicit visual attentions towards food and non-food images as a function of chronic stress level.

Entry time

Participants in the high stress group looked at the images of high-calorie foods significantly sooner than those of low stress group [F (1, 40) = 5.32, P = 0.03]. No significant differences between the high and low stress groups were observed in the visual attentions to the images of low-calorie foods (P = 0.68), activity (P = 0.34), and nature (P = 0.91).

Revisit count

Participants of high stress group showed higher revisits toward the images of both high-calorie foods [F (1, 40) = 10.24, P = 0.003] and low-calorie foods [F (1, 40) = 4.61, P = 0.04] more frequently than those in the low stress group. There were no significant differences between the high and low stress groups in the visual attentions to the images of activity (P = 0.15) and nature (P = 0.09).

Fixation time

There were no significant differences between the high and low stress groups in the visual attentions towards the images of high-calorie foods (P = 0.94), low-calorie foods (P = 0.72), activity (P = 0.57), and nature (P = 0.93).

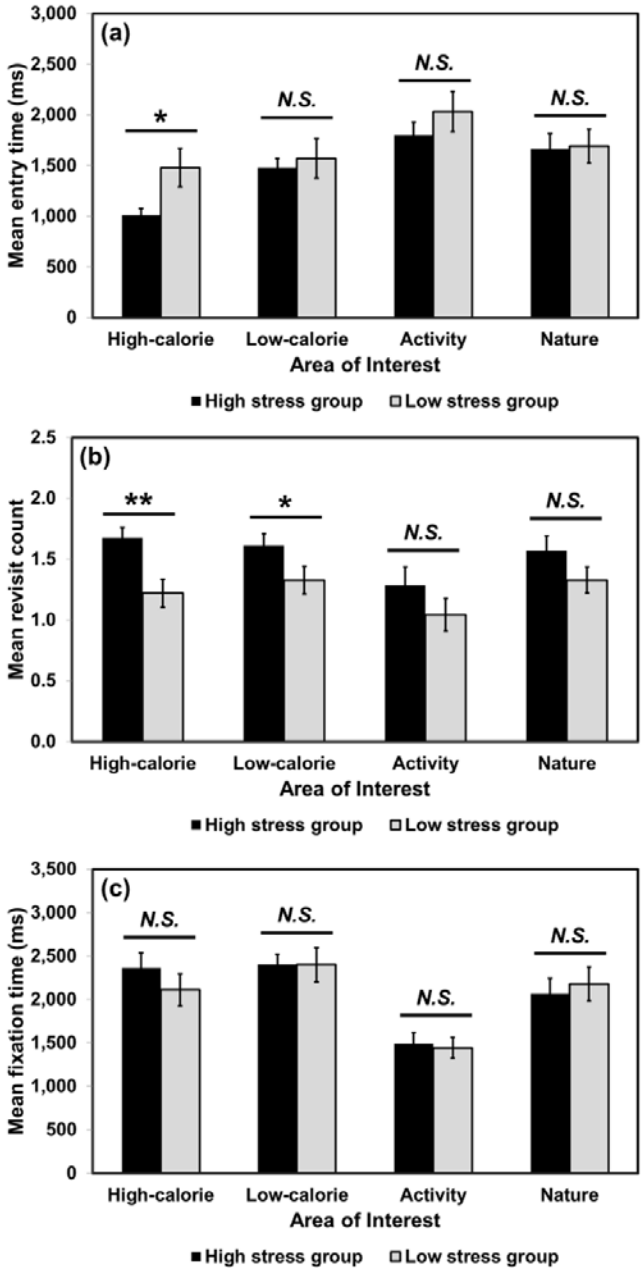

Figure 4.2. Comparisons in the implicit visual attention towards the images of food and non-food items between the high and low stress groups. Three eye-tracking parameters, such as (a) entry time, (b) revisit count, and (c) fixation time, were measured. *N.S.* represents no significance at $P < 0.05$. * and ** represent significant differences at $P < 0.05$ and $P <$ 0dfd.01, respectively. Error bars represent the standard error of the mean.

3.3. Influences of emotions on the implicit visual attention towards high-calorie foods

General positive affect had no significant relationship with the entry time of the implicit visual attention on towards high-calorie foods (r_{42} = -0.09, P = 0.58; rho_{42} = 0.11, P = 0.50). However, general negative affect appeared to show a negative relationship with the entry time of the implicit visual attention on towards high-calorie foods (r_{42} = -0.29, P = 0.06; rho_{42} = -0.34, P = 0.03). In other words, as participants have stronger negative mood, they focus on the image of high-calorie foods more quickly.

The individual scores of general positive affect were not significantly related to the other parameters of eye-tracking: revisit count (r_{42} = -0.11, P = 0.50; rho_{42} = -0.17, P = 0.29) and fixation time (r_{42} = 0.14, P = 0.37; rho_{42} = 0.11, P = 0.48). In addition, the individual scores of general negative affect were not significantly correlated to the revisit count (r_{42} = 0.17, P = 0.28; rho_{42} = 0.19, P = 0.23) and fixation time (r_{42} = -0.07, P = 0.64; rho_{42} = -0.02, P = 0.89) of the eye-tracking data.

4. Discussion

4.1. Influences of chronic stress level on positive and negative emotions

We expected that people with high stress would have more negative moods, such as fear, sadness, guilt, hostility, fatigue than those with low stress. By contrast, compared to the high stress group, the low stress group would have more positive moods, such as joviality, self-assurance, attentiveness, serenity, and surprise. This assumption was proved by the results of PANAS-X questionnaire. Although not all the affective factors showed significant differences between the two stress groups, the overall trend was consistent with our assumption or hypothesis. Specially, the high stress group showed significantly higher general negative affect

(e.g., afraid, scared, nervous, upset), fear (e.g., frightened, shaky), and sadness (e.g., blue, downhearted, alone, lonely) than the low stress group. Furthermore, the high stress group showed significantly lower general positive affect (e.g., active, enthusiastic, excited, inspired, determined), joviality (e.g., cheerful, joyful, lively, energetic), and serenity (e.g., calm, relaxed, at ease) than the low stress group. These results indicate that people with lower stress are likely to have more happiness and less sadness. Conversely, people with higher stress appear to have less happiness and more sadness.

Although similar stressors could induce different emotional responses on different individuals (Zimmer-Gembeck et al. 2012), in our study the emotional trends on both low and high stress groups were obvious. The high stress group showed higher negative emotion than the low stress group, whereas the low stress group showed higher positive emotion than the high stress group.

4.2. Influences of chronic stress level on the implicit visual attention

In this study, participants in the high stress group showed significantly lower entry time, higher revisits towards the images of high-calorie foods than those in the low stress group. Also, the high stress group showed higher revisits to low-calorie images than did the low stress group. However, for the high-calorie food images, no significant difference was found on the fixation time.

People’s desire to eat may be driven by mental stress, which would be a plausible explanation for visual differences between the two stress groups. Previous studies supported this notion (McCann et al., 1990; Michaud et al., 1990; Weidner et al., 1996; Westenhoefer et al., 1994; Weinstein et al., 1997; Wardle et al., 2000; Newman et al., 2007; Groesz et al., 2012). To

examine individuals' diet, weight, and perceived stress, Wardle et al. (1997) conducted a 6-month study for 90 participants. Work-related stress was the main stress reported in that study. The results demonstrated that participants who had high work-related stress showed modest increase in energy, fat, and sugar intakes during the study period. Furthermore, it also showed that restrained eaters were particularly vulnerable to lose control on food intake under stress. Groesz et al. (2012) tested whether chronic stress exposure could influence eating behavior. The results showed that chronic stress increased participants' drive-to-eat, which potentially caused unhealthy life style. Based on the previous study, the results of our study, i.e., participants with higher stress paid their attention to the food-related images more quickly and more often than those with lower stress, can be understandable. However, we did not find any differences in the visual attention towards non-food images (e.g., activity- or nature-related images) between the low and high stress groups.

4.3. Relationships between implicit visual attention and positive/negative emotions

Our findings showed that participants with higher "general negative affect" tend to look at the high-calorie food images more quickly, indicating that participants with more negative feeling (e.g., nervous or upset) could be more attentive to the high-calorie foods in everyday life. When people feel upset, nervous or other negative emotions, they are likely to have stronger desire to eat, which was supported by Van Strien et al. (2013)'s study. Sixty females were tested in that study to examine the difference in food intake following mood induction to either joy or sad mood condition. It was found that low emotional eaters ate similar in both joyful and sad mood condition, whereas high emotional eaters showed significantly higher amount of food consumption in the sad mood condition than in the joyful mood condition. Similar results were

also observed in other studies (Macht et al., 2004; Loxton et al., 2011). As mentioned earlier, high stress people had stronger desire to eat than low stress people so that they focused on high-calorie food images more quickly and more often. Therefore, it made sense that people with higher “General Negative Affect” score also tended to pay attention to the high-calorie food images more quickly.

5. Conclusion

To summarize, this study provides empirical evidence that people under higher chronic stress have more negative emotion such as sadness and fear than those under lower stress. In addition, chronic stress level could modulate implicit visual attention towards the images of foods. Specifically, participants with higher stress looked at high-calorie food images more quickly and more often when compared to those with lower stress. Furthermore, our findings showed the relationships between negative emotions and implicit visual attention to food-related images. That is, as participants felt more negative emotion, they tended to implicitly look at the high-calorie food images more quickly. These results suggest that negative emotions may mediate the chronic stress-induced implicit visual attention towards the images of foods, in particular high-calorie foods.

REFERENCE

Allison, T., Humea, A.L., Wood, C.C., & Goff, W.R. (1984). Developmental and aging changes in somatosensory, auditory and visual evoked potentials. Electroencephalography and Clinical Neurophysiology, 58, 14-24.

Albarracin, D., Wang, W., & Leeper, J. (2009). Immediate increase in food intake following exercise messages. Obesity, 17, 1451-1452.

Bradley, B. P., Mogg, K., & Millar, N. H. (2000). Covert and overt orienting of attention to emotional faces in anxiety.Cognition and Emotion, 14,789–808.

Callaway, E., & Donald, D. (1958). Narrowed attention: A psychological phenomenon that accompanies a certain physiological change. A.M.A. Archives of Neurology and Psychiatry, 79, 74-90.

Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. Journal of Health and Social Behavior, 24, 385-396.

Fredrickson, B. L., & Braningan, C. (2005). Positive emotions broaden the scope of attention and thought-action repertoires. Cognition and Emotion, 19, 313–332.

Gasper, K., & Clore, G. L. (2002). Attending to the big picture: Mood and global versus local processing of visual information. Psychological Science, 13, 34–40.

Hermans, D., Vansteenwegen, D., & Eelen, P. (1999). Eye movement as a continuous index of attention deployment: Data from a group of spider anxious students. Cognition and Emotion. 13,419–434.

Loxton, NJ., Dawe, S., & Cahill, A. (2011). Does negative mood drive the urge to eat? The contribution of negative mood, exposure to food cues and eating style. Appetite, 56,368–374.

Malarkey, W.B., Pearl, D.K, Demers, L.M., Kiecolt-Glaser, J.K, & Glaser, R. (1995). Influence of academic stress and season on 24-hour mean concentrations of ACTH, cortisol, and β-endorphin. Psychoneuroendocrinology, 20, 499-508.

Maniam, J., & Morris, M.J. (2012) The link between stress and feeding behavior. Neuropharmacology, 63, 97-110.

MacLeod, C, & Mathews, A. (1988). Anxiety and the allocation of attention to threat. The Quarterly Journal of Experimental Psychology Section A: Human Experimental Psychology, 38, 659–670.

McCann, B.S, Warnick, G.R, & Knopp, R.H. (1990). Changes in plasma lipids and dietary intake accompanying shifts in perceived workload and stress. Psychosomatic Medicine, 52(1), 97- 108.

Michaud, C.I, Kahn, J.P, Musse, N., Burlet, C., Nicolas, J.P., & Mejean, L. (1990). Relationships between a critical life event and eating behavior in high-school students. Stress Medicine, 6(1), 57-64.

Macht, M., Haupt, C., & Salewsky, A. (2004). Emotions and eating in everyday life. Application of the experience-sampling method. Ecology of Food and Nutrition, 43(4), 11–21.

Newman, E., O'Connor, D.B., & Conner, M. (2007). Daily hassles and eating behavior.The role of cortisol reactivity status. Psychoneuroendocrinology, 32, 125–132.

Ng, D.M., & Jeffery, R.W. (2003) Relationships between perceived stress and health behaviors in a sample of working adults. Health Psychol, 22, 638–642.

Oliver, G., & Wardle, J. (1999) Perceived effects of stress on food choice. Physiol Behav, 66, 511–515.

Plemmons, L.E., & Resurreccion, A.V.A.(1998). A warm-up sample improves reliability of responses in descriptive analysis. Journal of Sensory Studies, 13 (4), 359-376.

Riener, C.R, Stefanucci, J.K, Proffitt,D.R, & Clore,G.L. (2011). An effect of mood on the perception of geographical slant. Cognition and Emotion, 25 (1), 174-182.

Shechner, T., Jarcho, J.M., Britton, J.C., Leibenluft, E., Pine, D.S., & Nelson, E.E. (2013). Attention bias of anxious youth during extended exposure of emotional face pairs: and eye-tracking study. Depression and Anxiety, 30, 14-21.

Sominsky, L., & Spencer, S.J. (2014) Eating behavior and stress: a pathway to obesity. Front Psychol, 5, 434.

Van Strien, T., Cebolla, A., Etchememendy, E., Gutiérrez-Maldonado, J., Ferrer-García, M., Botella, C., & Baños, R. (2013). Emotional eating and food intake after sadness and joy. Appetite, 66, 20–25.

Watson, D., & Clark, L. A. (1994). The PANAS-X: Manual for the positive and negative affect schedule-Expanded form. Iowa City: University of Iowa.

Weidner, G., Kohlmann, C.W, Dotzauer, E., & Burns, L.R. (1996). The effects of academic stress on health behaviors in young adults. Anxiety, Stress & Coping: An International Journal, 9(2), 123-133.

Wegbreit, E., Franconeri, S., & Beeman, M. (2014). Anxious mood narrows attention in feature space. Cognition and Emotion, DOI: 10.1080/02699931.2014.922933.

Wadlinger, H. A., Isaacowitz, D. M. (2006). Positive mood broadens visual attention to positive stimuli. Motivation and Emotion, 30, 87–99.

Williams, J., Watts, F., MacLeod, C., & Mathews, A. (1997). Cognitive psychology and the emotional disorders. 2nd ed. Chichester, England: John Wiley & Sons.

Witt,J.K., Proffitt, D.R., & Epstein, W. (2004). Perceiving distance: a role of effort and intent. Perception, 33(5), 577–590.

Westenhoefer, J., Broeckmann, P., Munch, AK., & Pudel, V. (1994). Cognitive control of eating behavior and the disinhibition effect. Appetite, 23, 27–41.

Zadra, J.R., & Clore, G.L. (2011). Emotion and perception: the role of affective information. Emotion and perception, 2, 676-685.

Zimmer-Gembeck ,M.J., Skinner, E.A., Morris, H., & Thomas, R. (2012). Anticipated coping with interpersonal stressors: links with the emotional reactions of sadness, anger, and fear. Journal of Early Adolescence, 33 (5), 684-709.

CHAPTER 5

VISUAL ATTENTION TOWARDS FOOD IMAGES CAN VARY AS A FUNCTION OF BACKGROUND SALIENCY AND CULTURE

1. Introduction

The rapid development of the information technology (IT) industry has allowed people to purchase food items anywhere by using mobile devices such as smartphones, tablets PCs, and laptops. In most cases, consumers decide to purchase the food items based on the visual cues, such as photos and video clips, which websites have presented.

It is also worth noting that many people are likely to purchase unplanned product while they are shopping, but not actively searching for a particular product (Rebollar et al., 2015). That is, many products are bought on impulse (Bellenger et al., 1978). In this situation, visual cues of products (e.g., visual elements of packing design) play a major role in capturing the attention of prospective consumers at the point of sale (Fenko et al., 2010; Rebollar et al., 2012). Hence, to attract potential customers' attention to their food items, foodservice and hospitality industries have begun paying more attention to improving the visual impression of food items by manipulating table decoration, place setting, and lighting color.

There is increasing empirical evidence that food perception and amount of consumption vary depending on atmospheric visual cues of tableware items (Hummel et al., 2003; Wansink & Cheney, 2005; Zellner et al., 2010; Piqueras-Fiszman et al., 2012; Harrar et al., 2013; García-Segovia et al., 2015) and ambient lighting conditions (Hasenbeck et al., 2014; Spence et al., 2014). For example, sweet popcorn was rated significantly saltier when it was served in a blue bowl rather than when served in a white bowl (Harrar et al., 2011). Harrar et al. (2011) reported that the colored bowl-induced saltiness might be mediated by specific color-flavor association; for example, the blue color being reminiscent of the ocean's salty water. In addition, García-Segovia et al. (2015) demonstrated that consumers liked the appearance of roast chicken and

wanted to eat the chicken when it was served at a gourmet table setting more than when it was served using a plastic tray.

Likewise, based on participants' subjective ratings, previous studies have highlighted the impacts of cutlery and ambient contexts on sensory perception and liking of foods. In most studies, participants were asked to rate their perception, expectation, or motivation to purchase/consume the food samples with varying visual cues of cutlery, ambience, or packing contexts (Ares & Deliza, 2010; Becker et al., 2011; Piqueras-Fiszman & Spence, 2011, 2012; Piqueras-Fiszman et al., 2012; Hasenbeck et al., 2014; Spence et al., 2014; García-Segovia et al., 2015). That is, people might rely on particular elements (e.g., a picture of food product or a nutrition label) of visual cues to answer the questions given during the "goal-oriented" (or "top-down") task. For example, if a participant, who is sensitive to a gluten diet, is asked to rate her/his willingness to eat a certain food product, the participant may convey mainly the nutrition label (or the "gluten-free" label) shown on the product package. In fact, recent studies using eye-tracking techniques provided empirical evidence that particular elements of packaging can capture consumers' visual attention when they are conducting a specific task, such as judging their willingness to purchase/consume the product presented in the test (van Herpen & van Trijp, 2011; Piqueras-Fiszman et al., 2013; Ares et al., 2014). However, for the reason that many people often purchase unplanned items while they are shopping (Bellenger et al., 1978), the current study was designed to determine whether visual cues of cutlery and table setting contexts could affect visual attention towards food image in the absence of a specific task. In other words, the "stimulus-driven" (or "bottom-up") attention towards the image of food menu was investigated by varying the saliency level of background context. So far, little is known about the stimulus-driven (or bottom-up) attention in the food-related contexts. Recently, Rebollar et al.

(2015) demonstrated how the layout of packaging design elements could affect participants' visual attention in the absence of a particular task (e.g., in an impulse buying condition). More specifically, by using eye tracker techniques, the stimulus-driven attention was compared as a function of the layout of the four packaging design elements: 1) a fictitious manufacturing company, 2) its own logo, 3) a picture of the snack, and 4) additional information on the weight and calorie content of the snack. The surface size of packaging elements was found to be the most important factor in modulating participants' visual attention on the chocolate snack packaging during impulse buying process.

Previous cultural and social psychological studies have demonstrated that culture shapes visual perception and cognitive behavior (Morris & Peng, 1994; Masuda & Nisbett, 2001; Nisbett et al., 2001; Kitayama et al., 2003; Chua et al., 2005). Generally, Western culture emphasizes independence, while East Asian culture highlights interdependence (Chiu, 1972). Furthermore, Western people tend to look at visual stimuli more analytically, focusing on objects and their individual components, whereas East Asian people pay more attention to the contextual information such as background (Masuda & Nisbett, 2001; Nisbett et al., 2001; Nisbett, 2003; Nisbett & Masuda, 2003; Nisbett & Miyamoto, 2005; Masuda & Nisbett, 2006; Miyamoto et al., 2006; Masuda et al., 2008; see also Masuda et al., 2012a). For example, in the study conducted by Masuda and Nisbett (2001), Japanese and American participants were asked to look at underwater animations in which a certain fish was regarded as a focal object. The animations also included other fish and objects (e.g., plants) in the background. After looking at the animations two times, participants were asked to describe the animations. Japanese participants reported background objects 65% more than did American participants. In another study tracking participants' eye movement, Chua et al. (2005) demonstrated the cross-cultural differences

between European Americans and Chinese. Americans participants looked at the focal object (e.g., a tiger in a jungle) significantly more quickly and longer than Chinese participants. Similarly, Goh et al. (2009) demonstrated that Westerners focused for longer durations on both objects and backgrounds, whereas Asians alternated more frequently between objects and backgrounds so that they had shorter fixation durations.

A number of studies have shown cross-cultural variations between Western and Eastern countries in visual attention, although culture-induced visual attention was not consistently observed across earlier studies (see Rayner et al., 2007; Evans et al., 2009). However, most studies investigating the cultural variation in visual perception have used scenery (Nisbett et al., 2005; Boduroglu et al., 2009) and human faces/bodies (Masuda et al., 2008; Masuda et al., 2012b) as visual stimuli. Little is known as to whether culture can modulate visual attention to food images placed in various atmospheric contexts. Considering earlier findings that visual impression of food items modulates food choice and acceptance (for a review, see Imram, 1999), it would be valuable to answer the question of whether cultural background affects consumers' visual attention to the images of food items.

Building on previous findings, the current study aimed to determine whether consumers' visual attention towards food items varies in relation to background saliency. Again, since many consumers frequently buy unplanned items at the point of sale, participants were asked to freely view the pictures of food items with varying background saliency in the absence of a particular task or question (e.g., willingness to eat or liking of the food item). It would be expected that as the background images, defined as all space/items except for the image of the focal food in the picture, become more salient, participants' visual attention to the food items shown becomes less. For example, when a strawberry cake is presented on a white plate, people may focus more

on the cake itself than the plate. However, when the strawberry cake is presented using a fashionable cutlery set, people can be vulnerable to be distracted by the cutlery set, which may lessen their visual attention towards the strawberry cake. Another objective is to determine whether the influence of background contexts on the visual attention towards the food items can be different between Western (i.e., North American) and Eastern (i.e., Chinese) cultures. Given previous research that Western people tend to focus more on the focal objects, while East Asians are likely to focus more on the surrounding background, it was hypothesized that North American participants would look at the food items (i.e., focal objects) themselves more than Chinese participants.

2. Materials and Methods

2.1. Ethics statement

This study was conducted in conformance with the Declaration of Helsinki for studies on human subjects. The protocol was approved by the University Institutional Review Board of the University of Arkansas (Fayetteville, AR).

2.2. Participants

Thirty-nine American volunteers (all Caucasians; 14 men and 25 women) born in the United States of America and 39 Chinese volunteers (14 men and 25 women) took part in this study. Chinese participants were recruited from the Chinese community at the University of Arkansas (Fayetteville, AR). All of the Chinese participants were born in China and had completed their undergraduate and/or high school education in that country. Chinese participants had been in the United States for less than two years at the time of data collection. There was no

significant difference between the two culture groups in terms of mean age: American [mean ± standard deviation (SD) = 26 ± 4 years] and Chinese (26 ± 4 years) ($P > 0.05$). In addition, the two groups did not differ from each other in education level and gender ratio, respectively ($P > 0.05$). All participants reported that they have normal or corrected-to-normal vision. No participants reported color blindness or food allergy. Color blindness was determined based on results obtained through the Ishihara color test (Ishihara, 1986). Prior to an experimental session, the experimental procedure was thoroughly explained to all participants, and a written informed consent was obtained.

2.3. Visual stimuli

As visual stimuli, pictures of food items with various background contexts (e.g., tableware, tablecloth, and table decoration) were used. A total of 43 pictures were obtained from web providers. To create pictures with varying saliency levels of the background (i.e., all space except for the space/image of focal food), the pictures were manipulated by using Photoshop® software (Adobe Systems Inc., San Jose, CA) where appropriate.

To select a total of 18 pictures of food items with low, medium and high levels of background saliency, a preliminary norming test was conducted. Seventy-one volunteers, including 50 North Americans (24 men and 26 women) and 21 Asians (Chinese, Korean, Japanese, Indian, or Thais; 9 men and 12 women) participated in this preliminary survey. The participants were aged between 18 and 45 years (mean age ± SD = 25 ± 6 years). The experimenter explained that the participants' task was to view individual pictures one after another and to rate the level of visual attention towards the background images (i.e., all space except for the space/image of food items; tableware, tablecloth, and table decoration) of each

picture on a 9-point category scale ranging from 1 (no attention) to 9 (extreme attention). The 43 pictures were ranked according to mean score on the rating. Subsequently, 6 pictures each, from the lowest and the highest mean scores, were selected as "low-saliency background (LSB)" and "high-saliency background (HSB)," respectively. Additionally, 6 pictures with mean scores ranging between 5.0 and 5.6 (i.e., middle ranks) were selected as "medium-saliency background (MSB)." Repeated measures analysis of variance (RM-ANOVA) showed that the three groups of pictures (i.e., LSB, MSB, and HSB) significantly differed in the attention level of the background: LSB (mean ± SD = 2.66 ± 1.09), MSB (5.31 ± 1.12), and HSB (7.77 ± 1.77) [Huynh-Feldt correction: $F(1.62, 113.40) = 343.51$, $P < 0.001$]. Figure 5.1 shows examples of the pictures of food items with low (a), medium (b), and high (c) levels of background saliency.

All food items (Table 5.1) shown in the three groups of pictures are commonly consumed in both countries. As shown in Table 5.1, a one-way RM-ANOVA, treating background saliency level as a fixed effect, revealed that the three groups of pictures (i.e., LSB, MSB, and HSB) were not significantly different in terms of the familiarity ratings (see procedure) of food items shown in the pictures [$F(2, 150) = 1.44$, $P = 0.24$]. In addition, the three groups of pictures were not significantly different in participants' willingness to eat the food items (see procedure) [$F(2, 150) = 2.80$, $P = 0.06$]. Rebollar et al. (2015) demonstrated that participants' viewing pattern in food packaging design was determined mainly by the surface size of packaging elements (e.g., logo, picture of food, etc.). In our study, the three groups of pictures (i.e., LSB, MSB, and HSB) were not significantly different in terms of the mean ratio of food-to-background (12.3%) [$F(2, 15) = 0.04$, $P = 0.96$].

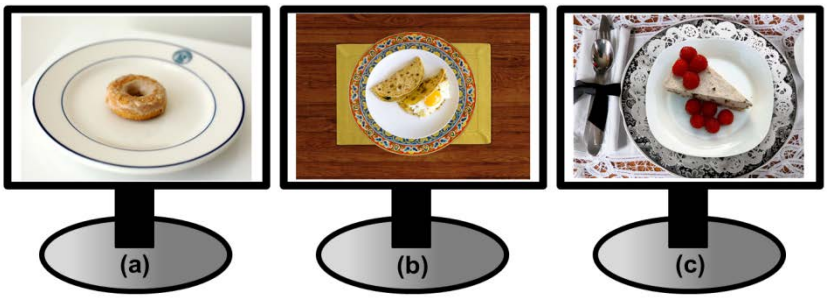

Figure 5.1. Examples of pictures of food items with low (a), medium (b), and high (c) levels of background saliency.

Table 5.1. A list of food items, familiarity ratings of the food items, and willingness to eat in relation to background saliency level

	Background saliency level		
	Low	**Medium**	**High**
A list of food items	Vegetable salad	Tacos	Noodle
	Donut	Vegetable salad	Cake
	Shrimp & asparagus	Cookies	Spaghetti
	Chocolate cake	Tomato spaghetti	Cup muffins
	Asian-style noodle	Noodle	Cake
	Grilled chicken & roasted tomato salad	Grilled sausage & vegetables	Sushi & Asian-style soup
Familiarity of food items	6.83 (± 0.11)[a]	6.59 (± 0.14)	6.52 (± 0.16)
Willingness to eat	6.92 (± 0.16)[a]	6.43 (± 0.20)	6.43 (± 0.18)

[a] Mean rating (± standard error of the mean)

A total of 18 pictures of food items were randomly presented via stimulus presentation software (Experiment Suite 360°™, SensoMotoric Instruments GmbH, Teltow, Germany).

2.4. Procedure

To control any potential effect of hunger on visual attention to pictures of food items (Frank et al., 2010), participants were asked to refrain from food, soft drinks, coffee/tea, and smoking for two hours prior to the eye-tracking study. Participants were seated on a chair 60 cm from the 22-in. monitor integrated with an eye-tracker (Model: RED, SensoMotoric Instruments GmbH, Teltow, Germany). The sampling rate of eye-tracker was 120 Hz and its tracking spatial

resolution was 0.03°. Using the five-point calibration method, the equipment was calibrated individually with a low tracking error (less than 0.4°).

Prior to an eye-tracking test, general instructions for the experimental procedure and eye-tracking (e.g., restricted head movements) were given. The experimenter explained that the participants' task was to freely view a total of 20 different pictures of foods one after another without any other specific instruction and task.

Prior to the onset of the experimental pictures, two different pictures of food items were provided as warm-up stimuli to increase a reliability of the test (Plemmons & Resurreccion, 1998). Plemmons and Resurreccion (1998) demonstrated that a warm-up sample minimized the first sample bias so that reliability of ratings could be increased. The warm-up stimuli also helped participants understand their task during the experiment. Following the warm-up stimuli, 18 pictures of food items (i.e., 6 LSB, 6 MSB, and 6 HSB) were randomly presented via stimulus presentation software (Experiment Suite 360°^{TM}, SensoMotoric Instruments GmbH, Teltow, Germany). In previous eye-tracking studies, the duration of presentation for each visual stimulus varied from 1,500 ms (Rebollar et al., 2015) to 30,000 ms (Shadel et al., 2006). In the current study, each picture (40-cm wide x 30-cm high) was presented for 6,000 ms on a 22-in widescreen monitor; in a preliminary test, participants were comfortable to explore the pictures of food items for 6,000 ms. An inter-stimulus interval was allowed for 6,500 to 7,500 ms during which participants were asked to look at a fixed black cross displayed on a white background. For each participant, all pictures were presented only one time (i.e., no repetition) to minimize any potential effect of the repeated visual cue on eye-tracking data.

Using BeGaze^{TM} software (SensoMotoric Instruments GmbH, Teltow, Germany), the image of food items in each picture was selected as "Areas of Interest (AOI)." Performance

parameters used in the study included 1) entry time, 2) revisit count, and 3) fixation time for the AOI. Entry time refers to duration required for the first fixation into the AOI (i.e., the image of food items). Revisit count refers to the total number of re-fixations into the AOI. Finally, fixation time is the sum of fixation duration to the AOI. The more participants are captured by background image (e.g., with an increase of background saliency), the longer their duration required for the first fixation into the image of food items (i.e., entry time) becomes. In addition, the participants are expected to look at the background context more frequently with the increase of background saliency, which may increase the count of revisit to the food image. As a result, the sum of fixation duration to the image of food items becomes less with the increase of background saliency.

Following the eye-tracking session, Chinese and American participants' "familiarity" and "willingness to eat" toward the food in all three levels of pictures (LSB, MSB, and HSB) were detected. To set up a "stimulus-driven" (or "bottom-up") process condition, these two questions were presented following the whole session of eye-tracking test. All picture stimuli were again presented to the participants in the identical manner shown in the eye-tracking session. All participants were asked to rate familiarity of food items shown in each picture on a 9-point category scale ranging 1 (extremely unfamiliar) to 9 (extremely familiar). The participants were also asked to rate their willingness, based on these images, to eat the food items on a 9-point category scale ranging 1 (extremely unwilling) to 9 (extremely willing). As mentioned above, the three groups of pictures (i.e., LSB, MSB, and HSB) were not significantly different in terms of the familiarity of food items and willingness to eat the food items (Table 1).

2.5. Data analysis

As two participants (one American and one Chinese) were not able to complete the experiment, their data were not used. The data of individual picture stimuli whose recording time was less than 70% (i.e., < 4,200 ms) were regarded as incomplete data; thus, 2.2% of the total data was not used for data analysis.

Statistical analysis was performed using SPSS 21.0 for Windows ™ (IBM SPSS Inc., Chicago, IL, USA). To determine the effects of two factors: 1) background saliency as within-participants factor and 2) culture (i.e., American versus Chinese group) as between-participants factor on the visual attention towards the food items, a two-way repeated measures analysis of variance (RM-ANOVA) was used. If the Sphericity assumption was violated via the Mauchly sphericity test, the degrees of freedom were adjusted by using the Huynh-Feldt correction. If a significant difference of means was indicated by RM-ANOVAs, post hoc comparisons between independent variables were done using Bonferroni *t*-tests. A statistically significant difference was defined as $P < 0.05$.

3. Results

3.1. Influences of background saliency and culture on visual attention towards food items

Entry time

As shown in Figure 5.2 (a), the time required for the first fixation onto the food items was significantly augmented as background saliency increased [Huynh-Feldt correction: F (1.29, 95.88) = 36.30, $P < 0.001$]. Post hoc comparison tests revealed that the entry time to the food items was significantly different among the three levels of background saliency (for all comparisons, $P < 0.001$). The entry time significantly differed between American and Chinese

groups [F (1, 74) = 4.34, P = 0.04]. Specifically, American participants [mean ± standard error of the mean (SEM) = 319 ± 17 ms] looked at the food items more quickly than Chinese participants (369 ± 17 ms). In other words, compared to American counterparts, Chinese participants were more distracted by background context while they were freely viewing the picture of food items.

There was no significant interaction between culture and background saliency in the entry time [Huynh-Feldt correction: F (1.29, 95.88) = 0.69, P = 0.46].

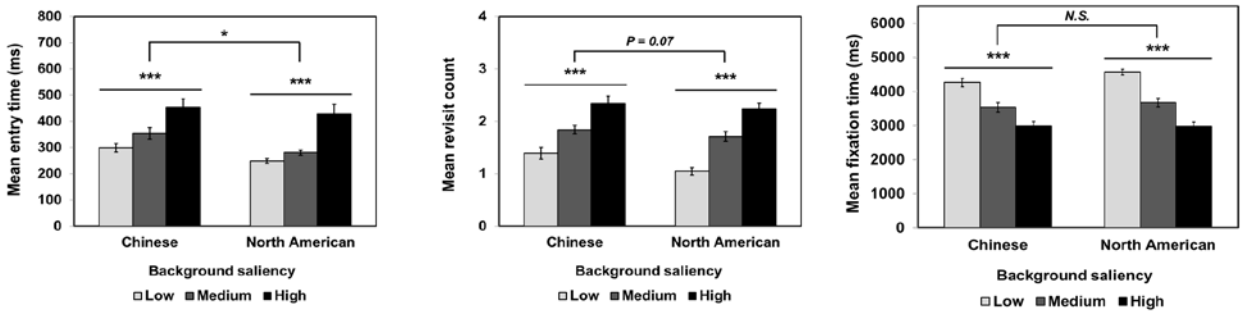

Figure 5.2. Cultural variations in visual attention towards food items as a function of background saliency. Entry time (a) refers to duration required for the first fixation on the image of the food items. Revisit count (b) refers to the total number of re-fixation onto the image of the food items. Fixation time (c) refers to the sum of fixation duration on the image of the food items. *N.S.* indicates no significance at $P < 0.05$. * and *** indicate significance at $P < 0.05$ and $P < 0.001$, respectively. Error bars represent the standard error of the mean.

Revisit count

Figure 5.2 (b) demonstrates that participants more often revisited the food items as the background context became more salient [Huynh-Feldt correction: F (1.65, 122.15) = 75.68, P < 0.001], indicating that they looked at the background context such as table setting and decoration more frequently with the increase of background saliency.

The revisit count to food items appeared to be higher in the Chinese group than in the American group, although there was a lack of significance [F (1, 74) = 3.45, P = 0.07], reflecting

that Chinese participants tended to be more attentive to the background context compared to American participants. Figure 3 shows examples of the culture-induced difference in visual attention towards the food item. In that figure, the number of bubble represents the number of visual fixation and the color of bubble indicates the amount of fixation time with a range from short (blue) to long (red) time (e.g., see the color bars). As shown in Figure 5.3, while an American participant (a) focuses more on the food item (i.e., donut), a Chinese participant (b) explores the background context (i.e., tableware items and table decoration) more frequently than the food item (i.e., more number of blue bubbles around the donut). That is, Chinese participants were likely to look back and forward between the food item and background context more frequently, which resulted in the higher revisit count.

No significant interaction between culture and background saliency occurred in the revisit count [Huynh-Feldt correction: F (1.65, 122.15) = 1.11, P = 0.33].

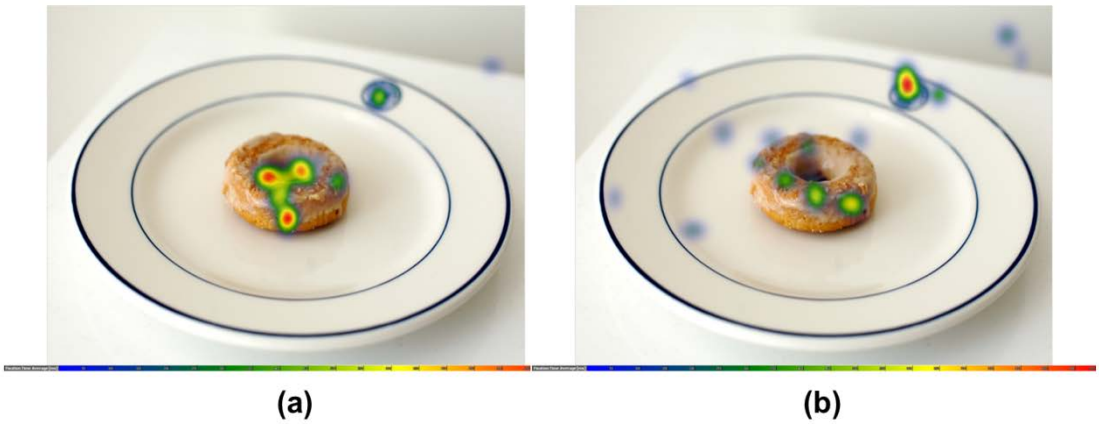

Figure 5.3. Typical examples of culture-induced visual attention towards the food item. An American woman participant (a) focused more on the food item (i.e., donut), while a Chinese woman participant (b) explored the background context (i.e., tableware items and table decoration) more than the food item. The color of bubble indicates the amount of fixation time with a range from short (blue) to long (red) time (e.g., see the color bars).

Fixation time

As shown in Figure 5.2 (c), participants looked at the food items significantly shorter as the background context became more salient [F (2, 148) = 291.68, $P < 0.001$]. Post hoc comparison tests revealed that the fixation time to the food items was significantly different among the three levels of background saliency (for all comparisons, $P < 0.001$).

There was no significant effect of culture in the fixation time (i.e., the sum of fixation duration on the food items) [F (1, 74) = 0.88, P = 0.35]. However, there was a significant interaction between culture and background saliency in the fixation time [F (2, 148) = 3.57, P = 0.03]. The culture-induced difference in the fixation time was obtained at the low-saliency background (P = 0.04), but not at the medium-saliency (P = 0.46) and high-saliency (P = 0.95) background contexts. That is, compared to Chinese participants (mean ± SEM = 4,258 ± 120 ms), American participants (4,565 ± 81 ms) looked at the food items significantly longer when the surrounding background was not highly salient. Interestingly, as shown in Figure 5.3, while an American participant focuses longer on the donut (i.e., yellow and red bubbles) than its surrounding context, a Chinese participant focuses longer on the design of the plate.

4. Discussion

Food perception and acceptance can vary by not only the sensory attributes of the food itself, but also by the individuals and eating situation (Meiselman, 1996; García-Segovia et al., 2015). Focusing on the latter, this study aimed to determine whether visual attention to food items can be modulated by 1) atmospheric contexts such as table setting and decoration and 2) culture (i.e., North American versus Chinese) when participants freely view the pictures of food menus without any specific tasks (i.e., “stimulus-driven” or “bottom-up” process). It is worth

noting that many people are unintentionally exposed to the pictures of food menus through mobile devices such as smartphones and tablets PCs in our modern society. Further, people often purchase food items on impulse based on their visual cues through the mobile devices.

4.1. Visual attention towards food image is different as a function of background saliency

It would be expected that as the table setting and decoration placed on a dining table are more salient and complex, people are likely to pay less attention to the food itself on the table. This prediction was supported by the results of the eye-tracking study. This study demonstrated that participants' visual attention towards the food items decreased as the background contexts, such as table setting and decorations, became more salient and complex. Specifically, with the increase of background saliency, participants' visual fixation on the food items became significantly slower (i.e., higher entry time) and shorter (i.e., lower fixation time). Furthermore, participants looked back and forward between the food items and background contexts more frequently (i.e., higher revisit count) when the surrounding background was more salient. These outcomes indicate that as background contexts (e.g., table setting and decoration) become more complex and salient, participants are more inclined to explore the background in more detail to identify the contexts more obviously (Seo et al., 2010). Previous studies also demonstrated that highly salient objects get visual fixations more frequently and quickly (Itti & Koch, 2000; Rao et al., 2002; Wolfe et al., 2004; Underwood & Foulsham, 2006). For example, using an eye-tracker, Underwood and Foulsham (2006) showed that visually conspicuous objects caught participants' visual attention more quickly than the less conspicuous objects.

Using an eye-tracking technique, our findings suggest a plausible explanation as to how the visual cues (e.g., color, shape, and decoration) of tableware items and containers can

influence participants' sensory perception and pleasure of foods (Hummel et al., 2003; Wansink & Cheney, 2005; Zellner et al., 2010; Piqueras-Fiszman & Spence, 2011, 2012; Piqueras-Fiszman et al., 2012; Harrar & Spence, 2013; García-Segovia et al., 2015). That is, while participants are viewing the picture of the food item, they look at not only the food item itself, but also the tableware items and containers, which may lead participants' expectations for the flavor and texture of the food product to be based on the combination of food and non-food items. Subsequently, the visual cues-induced expectation may alter sensory perception and pleasure (Cardello et al., 1985; Cardello & Sawyer, 1992; Seo et al., 2008).

4.2. The effect of background saliency on visual attention towards food image is different between American and Chinese participants

This study shows that the American group looked at the food items more immediately after the onset of picture presentation compared to the Chinese group. In addition, American participants looked at the food items placed in the low-saliency background significantly longer compared to Chinese participants. As shown in Figure 5.3, Chinese participants explored the plate and decoration in more detail, whereas American participants concentrated on the donut itself. These outcomes are in agreement with previous findings that Western individuals gave more attention to the focal object than the surrounding background, whereas East Asian individuals were the opposite (Masuda & Nisbett, 2001; Nisbett et al., 2001; Kitayama et al., 2003; Nisbett, 2003; Nisbett & Masuda, 2003; Nisbett & Miyamoto, 2005; Miyamoto et al., 2006;). Nisbett and his colleagues (Peng & Nisbett, 1999; Nisbett et al., 2001; Nisbett, 2003; Nisbett & Masuda, 2003; Nisbett & Miyamato, 2005) explained the cultural variation in visual attention under the rubric of "holistic" versus "analytic" epistemology. For example, East Asians

view the world (or visual stimuli) holistically with a focus on the entire relations among individual objects and events (Masuda & Nisbett, 2006; Masuda et al., 2012b). By contrast, Westerners view the world (or visual stimuli) analytically, attending to the attributes of focal objects (Masuda & Nisbett, 2006; Masuda et al., 2012b). In this way, our findings can be explained under the rubric of "holistic" vs. "analytic" thought. For example, since Chinese people are likely to view visual images holistically, Chinese participants, in comparison to American counterparts, might focus more on not only the food items, but also the surrounding background (see Figure 5.3). Compared to Americans, Chinese participants tended to alternate more frequently between food items and the surrounding background, resulting in the higher revisit count to the food items [Figure 5.2 (b)]. On the contrary, as North American people appear to view visual images analytically, Americans, in comparison to Chinese participants, might pay more attention to the focal objects (i.e., food items).

4.3. Limitations and future research

Our results should be interpreted with caution due to limitations of this study. Firstly, in this study, Chinese participants were recruited from the Chinese community in the United States. Even though all of them were born in China and had been in the U.S. for less than two years at the time of data collection, further study should be conducted with a larger and more controlled population to generalize our findings. Secondly, since visual images with a variety of color and brightness were used in this study, one may raise a question as to whether visual characteristics such as color and brightness of the pictures might influence participants' visual attention (Theeuwes et al., 2006; Frey et al., 2008). However, it should be noted that the authors tried to use a variety of pictures of food menu to simulate the pictures observed in commercial

advertisements of foodservice and dining industries, which may be closer to realistic situation. In addition, each group of pictures (i.e., low-, medium-, and high-saliency background) was composed of 6 pictures with a variety of color and brightness, and their mean values in eye-tracking data were used for comparing the three groups. The group mean comparison might lessen the impacts of color and brightness shown in the individual pictures on the eye-tracking data. Furthermore, as mentioned in the Materials and Methods, the three groups of pictures were not significantly different in terms of the mean ratio of food-to-background, the familiarity of food items, and the willingness to eat. Finally, since the data acquired by the eye-tracker do not explain why the participants are looking at the specific object (Graham et al., 2012) it would be valuable to conduct post-surveys or interviews to provide a better insight into the relationship between eye movements and behavioral data.

5. Conclusion

This study provides empirical evidence that background saliency and culture can modulate participants' visual attention while they are looking at picture of food items in the absence of a particular task. Specifically, as table setting and decoration became more complex and salient, participants' visual attention towards the food items shown in the picture decreased. In addition, compared to American participants, Chinese participants were more attentive to the background contexts such as table setting and decoration. However, it must be noted that cultural variation in the visual attention towards food images decreased at medium- and high-saliency background contexts. This result emphasizes that background contexts play a major role in modulating consumers' visual attention, whether they are American or Chinese, towards food items at middle- and high-levels of dining decoration. Thus, foodservice professionals and

business owners should consider improving dining environments to lead customers' attention to their restaurants and visual advertisements.

REFERENCE

Ares, G., & Deliza, R. (2010). Studying the influence of package shape and colour on consumer expectations of milk desserts using word association and conjoint analysis. Food Quality and Preference, 21, 930-937.

Ares, G., Mawad, F., Giménez, A., & Maiche, A. (2014). Influence of rational and intuitive thinking styles on food choice: Preliminary evidence from an eye-tracking study with yogurt labels. Food Quality and Preference, 31, 28-37.

Becker, L., van Rompay, T. J. L., Schifferstein, H. N. J., & Galetzka, M. (2011). Tough package, strong taste: The influence of packaging design on taste impressions and product evaluations. Food Quality and Preference, 22, 17-23.

Bellenger, D. N., Roberston, D. H., & Hirschman, E. C. (1978). Impulse buying varies by products. Journal of Advertising Research, 18, 15-18.

Boduroglu, A., Shah, P., & Nisbett, R. E. (2009). Cultural differences in allocation of attention in visual information processing. Journal of Cross-Cultural Psychology, 40, 349–360.

Cardello, A. V., Maller, O., Masor, H. B., Dubose, C., & Edelman, B. (1985). Role of consumer expectancies in the acceptance of novel foods. Journal of Food Science, 50, 1707-1714.

Cardello, A. V., & Sawyer, F. M. (1992). Effects of disconfirmed consumer expectations on food acceptability. Journal of Sensory Studies, 7, 253-277.

Chiu, L. H. (1972). A cross-cultural comparison of cognitive styles in Chinese and American children. International Journal of Psychology, 7, 235–242.

Chua, H. F., Boland, J. E., & Nisbett, R. E. (2005). Cultural variation in eye movements during scene perception. Proceedings of the National Academy of Sciences of the United States of America, 102, 12629–12633.

Evans, K., Rotello, C. M., Li, X., & Rayner, K. (2009). Scene perception and memory revealed by eye movements and receiver-operating characteristic analyses: Does a cultural difference truly exist?. The Quarterly Journal of Experimental Psychology, 62, 276-285.

Fenko, A., Schifferstein, H. N. J., & Hekkert, P. (2010). Shifts in sensory dominance between various stages of user-product interactions. Applied Ergonomics, 41, 34-40.

Frank, S., Laharnar, N., Kullmann, S., Veit, R., Canova, C., Hegner, Y. L., Fritsche, A., & Preissl, H. (2010). Processing of food pictures: influence of hunger, gender and calorie content. Brain Research, 1350, 159-166.

Frey, H. –P., Honey, C., & König, P. (2008). What's color got to do with it? The influence of color on visual attention in different categories. Journal of Vision, 8, 1-17.

García-Segovia, P., Harrington, R. J., & Seo, H. S. (2015). Influences of table setting and eating location on food acceptance and intake. Food Quality and Preference, 39, 1-7.

Goh, J. O., Tan, J. C., & Park, D. C. (2009). Culture modulates eye-movements to visual novelty. PLoS ONE, 4, e8238.

Graham, D. J., Orquin, J. L., & Visschers, V. H. M. (2012). Eye tracking and nutrition label use: A review of the literature and recommendations for label enhancement. Food Policy, 37, 378-382.

Harrar, V., Piqueras-Fiszman, B., & Spence, C. (2011). There's more to taste in a coloured bowl. Perception, 40, 880-882.

Harrar, V., & Spence, C. (2013). The taste of cutlery: how the taste of food is affected by the weight, size, shape, and colour of the cutlery used to eat it. Flavour, 2, 21. Doi: 10.1186/2044-7248-2-21.

Hasenbeck, A., Cho, S., Meullenet J. F., Tokar, T., Yang, F., Huddleston, E. A., & Seo, H. S. (2014). Color and illuminance level of lighting can modulate willingness to eat bell peppers. Journal of the Science of Food and Agriculture, 94, 2049-2056.

Hummel, T., Delwiche, J. F., Schmidt, C., & Hüttenbrink, K. B. (2003). Effects of the form of glasses on the perception of wine flavors: a study in untrained subjects. Appetite, 41, 197-202.

Imram, N. (1999). The role of visual cues in consumer perception and acceptance of a food product. Nutrition & Food Sciences, 99, 224-230.

Itti, L., & Koch C. (2000). A saliency-based search mechanism for overt and covert shifts of visual attention. Vision Research, 40, 1489-1506.

Kitayama, S., Duffy, S., Kawamura, T., & Larsen, J. T. (2003). Perceiving an object and its context in different cultures: a cultural look at new look. Psychological Science, 14, 201–206.

Masuda, T., & Nisbett, R. E. (2001). Attending holistically versus analytically: Comparing the context sensitivity of Japanese and Americans. Journal of Personality and Social Psychology, 81, 922–934.

Masuda, T., & Nisbett, R. E. (2006). Culture and change blindness. Cognitive Sciences, 30, 381-399.

Masuda, T., Ellsworth, P. C., Mesquita, B., Leu, J., Tanida, S., & Van de Veerdonk, E. (2008). Placing the face in context: cultural differences in the perception of facial emotion. Journal of Personality and Social Psychology, 94, 365-381.

Masuda, T., Wang, H., Ito, K., & Senzaki, S. (2012a). Culture and cognition: Implications for art, design, and advertisement. In S. Okazaki (Ed.), Handbook of research in international advertising (pp. 109-133). Cheltenham, England: Edward Elgar.

Masuda, T., Wang, H., Ishii, K., & Ito, K. (2012b). Do surrounding figures' emotions affect judgment of the target figure's emotion? Comparing the eye movement patterns of European Canadians, Asian Canadians, Asian international students, and Japanese. Frontiers in Integrative Neuroscience, 6, 1-9.

Meiselman, H. L. (1996). The contextual basis for food acceptance, food choice and food intake: the food, the situation and the individual. In H. L. Meiselman, & H. J. H. MacFie (Eds.), Food choice, acceptance and consumption (pp. 239-263). London: Blackie Academic & Professional.

Miyamoto, Y., Nisbett, R. E., & Masuda, T. (2006). Culture and the physical environment: Holistic versus analytic perceptual affordances. Psychological Science, 17, 113–119.

Morris, M. W., & Peng, K. (1994). Culture and cause: American and Chinese attribution for social and physical events. Journal of Personality and Social Psychology, 67, 949-971.

Nisbett, R. E., Peng, K., Choi, I., & Norenzayan, A. (2001). Culture and systems of thought: Holistic vs. analytic cognition. Psychological Review, 108, 291–310.

Nisbett, R. E. (2003). The geography of thought: How Asians and Westerners think differently – and why. New York: Free Press.

Nisbett, R. E., & Masuda, T. (2003). Culture and point of view. Proceedings of the National Academy of Sciences of the United States of America, 100, 11163–11170.

Nisbett, R. E., & Miyamoto, Y. (2005). The influence of culture: Holistic versus analytic perception. Trends in Cognitive Science, 9, 467–473.

Peng, K., & Nisbett, R.E. (1999). Culture, dialectics, and reasoning about contradiction. American Psychologist, 54, 741-754.

Piqueras-Fiszman, B., & Spence, C. (2011). Do the material properties of cutlery affect the perception of the food you eat? An exploratory study. Journal of Sensory Studies, 26, 358-362.

Piqueras-Fiszman, B., & Spence, C. (2012). The influence of the color of the cup on consumers' perception of a hot beverage. Journal of Sensory Studies, 27, 324-331.

Piqueras-Fiszman, B., Alcaide, J., Roura, E., & Spence, C. (2012). Is it the plate or is it the food? Assessing the influence of the color (black or white) and shape of the plate on the perception of the food placed on it. Food Quality and Preference, 24, 205-208.

Piqueras-Fiszman, B., Velasco, C., Salgado-Montejo, A., & Spence, C. (2013). Using combined eye tracking and word association in order to assess novel packaging solutions: A case study involving jam jars. Food Quality and Preference, 28, 328-338.

Rao, R. P., Zelinsky, G. J., Hayhoe, M. M., & Ballard, D. H. (2002). Eye movements in iconic visual search. Vision Research, 42, 1447-1463.

Rayner, K., Li, X., Williams, C. C., Cave, K. R., & Well, A. D. (2007). Eye movements during information processing tasks: Individual differences and cultural effects. Vision Research, 47, 2714–2726.

Rebollar, R., Lidón, I., Serrano, A., Martín, J., & Fernández, M. J. (2012). Influence of chewing gum packaging design on consumer expectation and willingness to buy. An analysis of functional, sensory and experience attributes. Food Quality and Preference, 24, 162-170.

Rebollar, R., Lidón, I., Martín, J., & Puebla, M. (2015). The identification of viewing patterns of chocolate snack packages using eye-tracking techniques. Food Quality and Preference, 39, 251-258.

Seo, H. S., Buschhüter, D., & Hummel, T. (2008). Contextual influences on the relationship between familiarity and hedonicity of odors. Journal of Food Science, 73, S273-S278.

Seo, H. S., Roidl, E., Müller, F., & Negoias, S. (2010). Odors enhance visual attention to congruent objects. Appetite, 54, 544-549.

Shadel, W. G., Lerman, C., Cappella, J., Strasser, A., Pinto, A., & Hornik, R. (2006). Evaluating smokers' reactions to advertising for new lower nicotine quest cigarettes. Psychology of Addictive Behaviors, 20, 80-84.

Spence, C., Velasco, C., & Knoeferle, K. (2014). A large sample study on the influence of the multisensory environment on the wine drinking experience. Flavour, 3, 8. Doi: 10.1186/2044-7248-3-8.

Theeuwes, J., Reimann, B., & Mortier, K. (2006). Visual search for featural singletons: No top-down modulation, only bottom-up priming. Visual Cognition, 14, 466-489.

Underwood, G., & Foulsham, T. (2006). Visual saliency and semantic incongruency influence eye movements when inspecting pictures. The Quality Journal of Experimental Psychology, 59, 1931-1949.

Van Herpen, E., & van Trijp, H. C. M. (2011). Front-of-pack nutrition labels. Their effect on attention and choices when consumers have varying goals and time constraints. Appetite, 57, 148-160.

Wansink, B., & Cheney, M. M. (2005). Super bowls: serving bowl size and food consumption. Journal of the American Medical Association, 293, 1727-1728.

Wolfe, J. M., Horowitz, T. S., Kenner, N., Hyle, M., & Vasan, N. (2004). How fast can you change your mind? The speed of top-down guidance in visual search. Vision Research, 44, 1411 -1426.

Zellner, D. A., Lankford, M., Ambrose, L. & Locher, P. (2010). Art on the plate: Effect of balance and color on attractiveness of, willingness to try and liking for food. Food Quality and Preference, 21, 575–578.

CHAPTER 6

GENERAL DISCUSSION

The present research provided empirical evidence demonstrating that individuals- and environmental-related contexts modulate individuals' visual perception towards food images. With the development of the information technology (IT) industry, it has allowed people to purchase food items anywhere by using mobile devices such as smartphones, tablets PCs, and laptops. In most cases, consumers decide to purchase the food items based on the visual cues, such as photos and video clips, which websites have presented. Therefore, visual perception towards food is very important for consumers to make their purchase decision.

Using eye-tracking techniques, this thesis was designed to answer the question as to how the contextual factors, such as fasted/fed status, chronic stress, and culture, can affect individuals' visual perception towards food images. The first study (Chapter 3) showed that participants paid more attention towards food-related images (e.g., high-calorie and low-calorie foods) when they were in the fasted state (i.e., before breakfast), whereas they focused more on non-food images (e.g., activity and nature) when they were in the fed state (after breakfast). As the participants felt hungrier, they looked at the food-related images more quickly. These were consistent with the previous studies (Mogg, Bradley et al., 1998; Stockburger et al., 2008; Siep et al., 2009; Frank et al., 2010) which showed that hunger induces individuals' attention towards food-related stimulus. Unlike previous studies (Nijs et al., 2010; Nummenmaa et al., 2011), we did not find a significant effect of BMI level (e.g., normal weight *vs.* overweight/obese) on the hunger-induced visual attention to the food images. The high restraint eaters showed shorter fixation on the high-calorie food images compared to the low restraint eaters, which was supported by the previous studies (Foster et al., 1998; Hays et al., 2002; Ouwens et al., 2003; Provencher et al., 2003; Johnson et al., 2012).

The second study (Chapter 4) demonstrated that people under high stress tended to have more negative affect than those under low stress, which might lead the participants with high stress to look at the high-calorie food images more quickly and more often than those with low stress. This idea could be supported by previous studies that people have more desire to eat when they are under stress (Westenhoefer et al., 1994; Weidner et al., 1996; Groesz et al., 2012).

The third study (Chapter 5) showed that participants' visual attention towards the food items could be different between Chinese and North American adults. North Americans looked at the focal objects (e.g. food) more quickly, while Chinese participants explored the details in the surrounding area. These outcomes are in agreement with previous findings that Western individuals gave more attention to the focal object than the surrounding background, whereas East Asian individuals were the opposite (Kitayama et al., 2003; Nisbett, 2003; Nisbett & Masuda, 2003; Nisbett & Miyamoto, 2005; Miyamoto et al., 2006). However, the culture-induced difference in the visual attention towards food images was decreased with increasing saliency level of background contexts such as table setting and decoration. These results mean two points: 1) cultural difference is present in the visual fixation on the food images and 2) the background contexts are also important for both Chinese and North American consumers when they look at the images of food menu.

This thesis showed that contextual factors are playing increasingly important roles in modulating consumers' visual perception towards food images. Therefore, it is crucial for foodservice and hospitality industries to take the contextual factors into the consideration when they try to improve the foodservice quality. Sensory perception and acceptability of foods appear to vary depending on culture, eating behavior, hunger status, emotion, and stress level. Based on the above findings, the context-induced sensory differences may initiate from the individuals'

expectation and attitudes towards visual cues of the foods. To confirm this assumption, further studies are necessary using real foods and realistic dining environments.

REFERENCE

Ares, G., & Deliza, R. (2010). Studying the influence of package shape and colour on consumer expectations of milk desserts using word association and conjoint analysis. Food Quality and Preference, 21, 930-937.

Ares, G., Mawad, F., Giménez, A., & Maiche, A. (2014). Influence of rational and intuitive thinking styles on food choice: Preliminary evidence from an eye-tracking study with yogurt labels. Food Quality and Preference, 31, 28-37.

Frank, S., Laharnar, N., Kullmann, S., Veit, R., Canova, C., Hegner, Y.L., Andreas Fritsche, A., & Preissla, H. (2010). Processing of food pictures: Influence of hunger, gender and calorie content. Brain Research, 1350, 159–166.

Foster, G.D., Wadden, T.A., Swain, R.M., Stunkard, A.J., Platte, P., & Vogt, R.A. (1998). The Eating Inventory in obese women: clinical correlates and relationship to weight loss. International Journal of Obesity and Related Metabolic Disorders, 22,778–85.

Groesz, L. M., McCoy, S., Carl, J., Saslow, L., Stewart, J., Adler, N., Laraia, B., & Epel, E. (2012). What is eating you? Stress and the drive to eat. Appetite, 58(2), 717–721.

Hays, N.P., Bathalon, G.P., McCrory, M.A., Roubenoff, R., Lipman, R., & Roberts, S.B. (2002). Eating behavior correlates of adult weight gain and obesity in healthy women aged 55–65 y. The American Journal of Clinical Nutrition,75, 476 – 483.

Johnson, E., Pratt, M., & Wardle, J. (2012). Dietary restraint and self-regulation in eating behavior. International Journal of Obesity, 36, 665–674.

Kitayama, S., Duffy S., Kawamura, T. & Larsen, J. T. (2003). Perceiving an object and its context in different cultures: a cultural look at new look. Psychological Science, 14,201–206.

Mogg, K., Bradley, B.P., Hyare, H., & Lee, S. (1998). Selective attention to food-related stimuli in hunger: are attentional biases specific to emotional and psychopathological states, or are they also found in normal drive states? Behaviour Research and Therapy, 36, 227–237.

Miyamoto, Y, Nisbett, R.E. & Masuda, T. (2006).Culture and the physical environment: Holistic versus analytic perceptual affordances. Psychol Science, 17, 113–119.

Nisbett, R.E.(2003). The geography of thought: How Asians and Westerners think differently – and why. New York; Free Press.

Nisbett ,R.E., & Masuda, T. (2003). Culture and point of view. Proceedings of the National Academy of Sciences of the United States of America, 100, 11163–11170.

Nisbett, R.E., & Miyamoto, Y. (2005). The influence of culture: Holistic versus analytic perception. Trends in Cognitive Science, 9, 467–473.

Nijs, I.M.T., Muris, P., Euser, A.S., & Franken, I.H.A. (2010). Differences in attention to food and food intake between overweight/obese and normal-weight females under conditions of hunger and satiety. Appetite, 54, 243-254.

Nummenmaa, L., Hietanen, J.K., Calvo, M.G., & Hyona, J. (2011). Food catches the eye but not for everyone: a BMI–contingent attentional bias in rapid detection of nutriments. PLOS ONE, 6, e19215.

Ouwens, M.A., van Strien, T., & van der Staak, C.P.F. (2003). Tendency toward overeating and restraint as predictors of food consumption. Appetite, 40, 291–298.

Provencher, V., Drapeau, V., Tremblay, A., Despres, J.P., & Lemieux, S. (2003). Eating behaviors and indexes of body composition in men and women from the Quebec family study. Obesity Research, 11,783–792.

Stockburger, J., Hamm, A. O., Weike, A. I., & Schupp, H. T. (2008). Deprivation selectively modulates brain potentials to food pictures. Behavioral Neuroscience, 122, 936–942.

Siep, N., Roefs, A., Roebroeck, A., Havermans, R., Bonte, M.L., & Jansen, A. (2009). Hunger is the best spice: An fMRI study of the effects of attention, hunger and calorie content on food reward processing in the amygdala and orbitofrontal cortex. Behavioural Brain Research, 198, 149–158.

Weidner, G, Kohlmann, C.W, Dotzauer, E,& Burns, L.R. (1996). The effects of academic stress on health behaviors in young adults. Anxiety, Stress & Coping: An International Journal, 9(2), 123-133.

Westenhoefer, J., Broeckmann, P., Munch, AK., & Pudel, V. (1994). Cognitive control of eating behavior and the disinhibition effect. Appetite, 23, 27–41.

APPENDIX I

INFORMED CONSENT FORM & IRB APPROVAL LETTER

INFORMED CONSENT

Title: Pattern analysis of visual attention during food choice

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Description: This study will determine how consumers observe food products while making a decision to purchase and try them. You will be asked to view either food products or photos of food products under different contexts as you would observe them in a market. You will be also asked to consume foods/beverages or to sniff odors. Next, you will be asked to answer several questions regarding your sensory perceptions and feelings towards served samples or visual images. Finally, you will be asked to complete questionnaires including demographics, food consumption, personality, and hunger/satiety status over testing session.

Risks and Benefits: The benefits include contributing to the knowledge base of food perception and attitude. Your risk is that your eyes will be exposed to low levels of infrared light. The infrared light will be emitted by LED lights, which are known not to be able to produce infrared light with the intensity that can harm humans. The eye tracker used in this study is an instrument commonly used in the research field from marketing to neuroscience. The participants with ocular-motor problems, cataracts will be asked not to participate.

Voluntary Participation: Your participation in the research is completely voluntary. There are no college credits for participation. A gift card will be presented for the participation reward.

Confidentiality: You will be assigned a code number and all information will be recorded anonymously. All information will be kept confidential to the extent allowed by law and University policy. Results from the research will be reported as aggregate data.

Right to Withdraw: You are free to refuse to participate in the research and to withdraw from this study at any time. Your decision to withdraw will bring no negative consequences — no penalty to you.

Informed Consent*:* I, _____(please print), have read the description, including the purpose of the study, the procedures to be used, the potential risks and side effects, the confidentiality, as well as the option to withdraw from the study at any time. Each of these items has been explained to me by the investigator. The investigator has answered all of my questions regarding the study, and I believe I understand what is involved. My signature below indicates that I freely agree to participate in this experimental study and that I have received a copy of this agreement

from the investigator.

_____

Signature **Date**

If you have questions or concerns about this study, please contact one of the researchers listed above. For questions or concerns about your rights as a research participant, please contact the University's IRB Coordinator listed as "Administrator" above.

UNIVERSITY OF ARKANSAS

Office of Research Compliance
Institutional Review Board

February 12, 2014

MEMORANDUM

TO:	Han-Seok Seo Tonya Tokar Curtis Luckett Jieun Min Baeyue Zhang
FROM:	Ro Windwalker IRB Coordinator
RE:	PROJECT CONTINUATION
IRB Protocol #:	12-08-056
Protocol Title:	*Pattern Analysis of Visual Attention During Food Choice*
Review Type:	☐ EXEMPT ☒ EXPEDITED ☐ FULL IRB
Previous Expiration Date:	08/26/2013
New Approval Period:	Start Date:02/10/2014 Expiration Date: 02/09/2015

Your request to extend the referenced protocol has been approved by the IRB. If at the end of this period you wish to continue the project, you must submit a request using the form *Continuing Review for IRB Approved Projects*, prior to the expiration date. Failure to obtain approval for a continuation on or prior to this new expiration date will result in termination of the protocol and you will be required to submit a new protocol to the IRB before continuing the project. Data collected past the protocol expiration date may need to be eliminated from the dataset should you wish to publish. Only data collected under a currently approved protocol can be certified by the IRB for any purpose.

This protocol has been approved for 900 total participants. If you wish to make *any* modifications in the approved protocol, including enrolling more than this number, you must seek approval *prior to* implementing those changes. All modifications should be requested in writing (email is acceptable) and must provide sufficient detail to assess the impact of the change.

If you have questions or need any assistance from the IRB, please contact me at 210 Administration Building, 5-2208, or irb@uark.edu.

APPENDIX II

QUESTIONAAIRES USED IN THIS STUDY

Dutch Eating Behavior Questionnaire

Source: van Strien et al. (1986) The Dutch Eating Behavior Questionnaire (DEBQ) for assessment of restrained, emotional, and external eating behavior. International Journal of Eating Disorders. 5, 295-315.

Items	Never	Seldom	Some-times	Often	Very often	Not relevant
	1	2	3	4	5	9
1. If you have put on weight, do you eat less than you usually do?						
2. Do you try to eat less at meal times than you would like to eat?						
3. How often do you refuse food or drink offered because you are concerned about your weight?						
4. Do you watch exactly what you eat?						
5. Do you deliberately eat foods that are slimming?						
6. When you have eaten too much, do you eat less than usual the following days?						
7. Do you deliberately eat less in order not to become heavier?						
8. How often do you try not to eat between meals because you are watching your weight?						
9. How often in the evening do you try not to eat because you are watching your weight?						
10. When you eat, do you take into account what you weigh?						
11. Do you have the desire to eat when you are irritated?						
12. Do you have a desire to eat when you have nothing to do?						
13. Do you have a desire to eat when you are depressed or discouraged?						
14. Do you have a desire to eat when you are feeling lonely?						
15. Do you have a desire to eat when somebody lets you down?						
16. Do you have a desire to eat when you are angry?						
17. Do you have a desire to eat when you are expecting something unpleasant to happen?						
18. Do you get the desire to eat when you anxious, worried or tense?						
19. Do you have a desire to eat when things are going against you or when things have gone wrong?						

Items	Never	Seldom	Some-times	Often	Very often	Not relevant
	1	2	3	4	5	9
20. Do you have a desire to eat when you are frightened?						
21. Do you have a desire to eat when you are disappointed?						
22. Do you have a desire to eat when you are emotionally upset?						
23. Do you have a desire to eat when you are bored or restless?						
24. If food tastes good to you, do you eat more than usual?						
25. If food smells and looks good, do you eat more than usual?						
26. If you see or smell something delicious, do you have a desire to eat it?						
27. If you have something delicious to eat, do you eat it right away?						
28. If you walk past a bakery do you have the desire to buy something delicious?						
29. If you walk past a snack bar or café, do you have the desire to buy something delicious?						
30. If you see others eating, do you also have the desire to eat?						
31. Can you resist eating delicious foods?						
32. Do you eat more than usual when you see others eating?						
33. Do you have the desire to eat something when preparing a meal?						

Three Factor Eating Questionnaire

Source: Stunkard AJ and Messick S (1985) The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. Journal of Psychosomatic Research. 29, 71-83.

Please complete this questionnaire.

No.	Questions	Answer	
1	When I smell a sizzling steak or see a juicy piece of meat, I find it very difficult to keep from eating, even if I have just finished a meal.	True	False
2	I usually eat too much at social occasions, like parties and picnics.	True	False
3	I am usually so hungry that I eat more than three times a day.	True	False
4	When I have eaten my quota of calories, I am usually good about not eating any more.	True	False
5	Dieting is so hard for me because I just get too hungry.	True	False
6	I deliberately take small helpings as a means of controlling my weight.	True	False
7	Sometimes things just taste so good that I keep on eating even when I am no longer hungry.	True	False
8	Since I am often hungry, I sometimes wish that while I am eating, an expert would tell me that I have had enough or that I can have something more to eat.	True	False
9	When I feel anxious, I find myself eating.	True	False
10	Life is too short to worry about dieting.	True	False
11	Since my weight goes up and down, I have gone on reducing diets more than once.	True	False
12	I often feel so hungry that I just have to eat something.	True	False
13	When I am with someone who is overeating, I usually overeat too.	True	False
14	I have a pretty good idea of the number of calories in common food.	True	False
15	Sometimes when I start eating, I just can't seem to stop.	True	False
16	It is not difficult for me to leave something on my plate.	True	False
17	At certain times of the day, I get hungry because I have gotten used to eating then.	True	False
18	While on a diet, if I eat food that is not allowed, I consciously eat less for a period of time to make up for it.	True	False
19	Being with someone who is eating often makes me hungry enough to eat also.	True	False
20	When I feel blue, I often overeat.	True	False
21	I enjoy eating too much to spoil it by counting calories or watching my weight.	True	False
22	When I see a real delicacy, I often get so hungry that I have to eat right away.	True	False
23	I often stop eating when I am not really full as a conscious means of limiting the amount that I eat.	True	False
24	I get so hungry that my stomach often seems like a bottomless pit.	True	False
25	My weight has hardly changed at all in the last ten years.	True	False

No.	Questions	Answer	No.
26	I am always hungry so it is hard for me to stop eating before I finish the food on the plate.	True	False
27	When I feel lonely, I console myself by eating.	True	False
28	I consciously hold back at meals in order not to gain weight.	True	False
29	I sometimes get very hungry late in the evening or at night.	True	False
30	I eat anything I want, any time I want.	True	False
31	Without even thinking about it, I take a long time to eat.	True	False
32	I count calories as a conscious means of controlling my weight.	True	False
33	I do not eat some foods because they make me fat.	True	False
34	I am always hungry enough to eat at any time.	True	False
35	I pay a great deal of attention to changes in my figure.	True	False
36	While on a diet, if I eat a food that is not allowed, I often then splurge and eat other high calorie foods.	True	False

37	How often are you dieting in a conscious effort to control your weight?			
	① rarely	② sometimes	③ usually	④ always
38	Would a weight fluctuation of 5 lbs affect the way you live your life?			
	① not at all	② slightly	③ moderately	④ very much
39	How often do you feel hungry?			
	① only at mealtimes	② sometimes between meals	③ often between meals	④ almost always
40	Do you feelings of guilt about overeating help you to control your food intake?			
	① never	② rarely	③ often	④ always

41	How difficult would it be for you to stop eating halfway through dinner and not eat for the next four hours?			
	① easy	② slightly difficult	③ moderately difficult	④ very difficult
42	How conscious are you of what you are eating?			
	① not at all	② slightly	③ moderately	④ extremely
43	How frequently do you avoid 'stocking up' on tempting foods?			
	① almost never	② seldom	③ usually	④ almost always
44	How likely are you to shop for low calorie foods?			
	① unlikely	② slightly unlikely	③ moderately likely	④ very likely
45	Do you eat sensibly in front of others and splurge alone?			
	① never	② rarely	③ often	④ always
46	How likely are you to consciously eat slowly in order to cut down on how much you eat?			
	① unlikely	② slightly likely	③ moderately likely	④ very likely
47	How frequently do you skip dessert because you are no longer hungry?			
	① almost never	② seldom	③ at least once a week	④ almost every day
48	How likely are you to consciously eat less than you want?			
	① unlikely	② slightly likely	③ moderately likely	④ very likely

49	Do you go on eating binges though you are not hungry?			
	① never	② rarely	③ sometimes	④ at least once a week
50	On a scale of 0 to 5, where 0 means no restraint in eating (eating whatever you want, whenever you want it) and 5 means totally restraint (constantly limiting food intake and never 'giving in'), what number would you give yourself?			
	⓪eat whatever you want, whenever you want it ①usually eat whatever you want, whenever you want it ②often eat whatever you want, whenever you want it ③often limit food intake, but often 'give in' ④usually limit food intake, rarely 'give in' ⑤constantly limiting food intake, never 'giving in'			
51	To what extent does this statement describe your eating behavior? 'I start dieting in the morning, but because of any number of things that happen during the day, by evening I have given up and eat what I want, promising myself to start dieting again tomorrow'?			
	① not like me	② little like me	③ pretty good description of me	④ describes me perfectly

PANAS-X Scale

Source: Watson D and Clark LA (1994) The PANAS-X: Manual for the positive and negative affect schedule-Expanded form. Iowa City: University of Iowa.

This scale consists of a number of words and phrases that describe different feelings and emotions.
Read each item and then mark the appropriate answer in the space next to that word.
Indicate **to what extent you have felt this way during the PAST FEW WEEKS**. Use the following scale to record your answers:

1	2	3	4	5
Very slightly or not at all	**A little**	**Moderately**	**Quite a bit**	**Extremely**

Examples)

3 Cheerful	*2* Sad	*1* Active	*3* Angry at self
_____ Cheerful	_____ Sad	_____ Active	_____ Angry at self
_____ Disgusted	_____ Calm	_____ Guilty	_____ Enthusiastic
_____ Attentive	_____ Afraid	_____ Joyful	_____ Downhearted
_____ Bashful	_____ Tired	_____ Nervous	_____ Sheepish
_____ Sluggish	_____ Amazed	_____ Lonely	_____ Distressed
_____ Daring	_____ Shaky	_____ Sleepy	_____ Blameworthy
_____ Surprised	_____ Happy	_____ Excited	_____ Determined
_____ Strong	_____ Timid	_____ Hostile	_____ Frightened
_____ Scornful	_____ Alone	_____ Proud	_____ Astonished
_____ Relaxed	_____ Alert	_____ Jittery	_____ Interested
_____ Irritable	_____ Upset	_____ Lively	_____ Loathing
_____ Delighted	_____ Angry	_____ Ashamed	_____ Confident
_____ Inspired	_____ Bold	_____ At ease	_____ Energetic
_____ Fearless	_____ Blue	_____ Sacred	_____ Concentrating
_____ Disgusted with self	_____ Shy	_____ Drowsy	_____ Dissatisfied with self