THE INFLUENCE OF STRESS ON “WANTING” AND “LIKING” BEHAVIOR FOR SWEET AND SAVOURY FOOD

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AUG 2017

THE INFLUENCE OF STRESS ON “WANTING” AND “LIKING” BEHAVIOR FOR SWEET AND SAVOURY FOOD

A THESIS SUBMITTED TO

THE GRADUATE SCHOOL OF SOCIAL SCIENCES

OF

IZMIR UNIVERSITY OF ECONOMICS

BY

NEZAHAT DEVECİ

AUG 2017

Approval of the Graduate School of Social Sciences

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ABSTRACT

THE INFLUENCE OF STRESS ON "WANTING" AND "LIKING" BEHAVIOR FOR SWEET AND SAVOURY FOOD

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May 2017

Abstract

The human reward system consists of two separate components, 'wanting' and 'liking' which are referred to as the incentive salience and hedonic component respectively. Previous studies showed that two components of reward system the 'wanting' and the 'liking' are generally correlated but can be distinguishable from each other under certain circumstances. The aim of the present study is to distinguish these two systems using stress manipulation. 'Wanting' behavior was assessed by a forced choice paradigm, whereas 'liking' behavior, by pleasantness rating of rewarding stimuli. Two types of food categories, savoury and sweet, which were further divided into high and low calorie food categories. Thirty-six female and twenty-six male participants who had not eaten for at least three hours were equally divided into either the stress condition or the non-stress condition. The results showed no significant difference for the 'liking' ratings between the stress group and non-stress group for either sweet or savoury food categories. However, statistically significant difference was found for 'wanting', participants in the stress group wanted high calorie sweet food more than participants in the non-stress group, and participants in the non-stress group wanted high calorie savoury food more than

participants in the stress group. Moreover, the effect of gender on ‘wanting’ and ‘liking’ was examined in the scope of present study. The results showed no significant effect of gender on ‘wanting, however males and females differ in their ‘liking’ ratings for sweet and savoury reward. Males liked savoury food more than females but females liked sweet food more than males.

Keywords: wanting, liking, stress, reward, incentive salience

ÖZET

TATLI VE İŞTAH AÇICI YİYECEKLER İÇİN STRESİN ‘İSTEK’ VE ‘BEĞENİ’ DAVRANIŞI ÜZERİNDEKİ ETKİSİ

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Tez Danışmanı: Yrd. Doç. Dr. Burak Erdeniz

Mayıs 2017

İnsanlarda ödül sistemi, ‘istek’ ve ‘beğeni’ olmak üzere iki ayrı bileşenden oluşur. Bunlar sırasıyla teşvik belirginliği ve hedonik bileşen olarak adlandırılır. Önceki çalışmalar, ödül sisteminin bu iki bileşeninin genel olarak birbirleriyle ilişkili olduğunu, ancak belli koşullar altında ayırt edilebilir olduklarını göstermektedir. Bu çalışmanın amacı, bu iki sistemi stres manipülasyonu kullanarak birbirlerinden ayrıştırmaktır. Ödüllendirici uyaranlara karşı olan ‘istek’ davranışı, zorunlu seçim paradigması ile değerlendirilmiş; ‘beğeni’ davranışında ise hoşluk değerlendirme ölçeği kullanılmıştır. Bu çalışma için tatlı ve iştah açıcı olmak üzere iki tür yiyecek kategorisi belirlenmiş ve bahsi geçen bu yiyecekler kendi içlerinde yüksek kalorili ve düşük kalorili olmak üzere iki alt kategoriye ayrılmıştır. Çalışma için, en az üç saat önce yiyecek tüketimini sonlandırmış olan otuz altı kadın ve yirmi altı erkek katılımcı belirlenmiştir. Katılımcılar, eşit olarak stres grubu ve stres dışı grup olarak ikiye ayrılmıştır. Sonuçlar değerlendirildiğinde, tatlı ve iştah açıcı yiyecek kategorileri için stres grubu ve stres dışı grup arasında 'beğeni' puanlamaları bakımından anlamlı bir fark görülmezken, 'istek' puanlamaları bakımından ise istatistiksel olarak anlamlı bir farklılık olduğu gözlemlenmiştir. Stres grubundaki katılımcılar, yüksek kalorili ve tatlı yiyecekleri, stres dışı gruptaki katılımcılardan daha fazla istemişler; stres dışı gruptaki katılımcılar ise yüksek kalorili ve iştah açıcı

yiyecekleri, stres grubundaki katılımcılardan daha fazla istemişlerdir. Ayrıca, bu çalışma kapsamında cinsiyetin ‘istek’ ve ‘beğeni’ üzerindeki etkisi de incelenmiş ve cinsiyetin ‘istek’ üzerinde önemli bir etkiye sahip olmadığını gösterilmiştir. Ancak bu çalışma, erkeklerin ve kadınların tatlı ve iştah açıcı ödül için ‘beğeni’ derecelerinde farklılık olduğunu ortaya koymuştur. Erkekler iştah açıcı yiyecekleri kadınlar ise tatlı yiyecekleri daha çok beğenmişlerdir.

Anahtar Kelimeler: istek, beğeni, stres, ödül, teşvik belirginliği

ACKNOWLEDGEMENTS

I would like to express my gratitude to my supervisor Asst. Prof. Dr. Burak Erdeniz for his useful comments, remarks and engagement at every stage of this study and for enlightening me whenever i was stuck. I will always be proud to be his "çekirge". Furthermore, i would like to thank Prof. Dr. Hakan Çetinkaya, my former advisor, for his previous contributions to my research, for his helpful recommendations for the research problem and, for all the information he willingly shared with me. Also, i wish to thank Assoc. Prof. Dr. Seda Dural for not hesitating to provide me with assistance when i was in need of help, and Assoc. Prof. Dr. Seda Can since her office was always open whenever i had a question about my statistical analyses. The completion of this thesis could not have been accomplished without the support of my labmates, Merve, Açelya, Ilgım, Nurdan and Sara, all of whom I will always remember.

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CHAPTER 1: INTRODUCTION

This thesis aims to answer two specific but interrelated questions of incentive salience theory. The first question is whether, 'liking' (hedonic pleasure) and 'wanting' (incentive motivation) can be dissociated by using stress manipulation? Secondly, is there any effects of stress on 'liking' and 'wanting' of high /low calorie (sweet or savoury) food reward. The thesis examines these two questions with a behavioral experiment. Furthermore, in the stress and stress free conditions, 'liking' (hedonic pleasure) was measured by using 9-unit visual analogue scale whereas 'wanting' (incentive motivation) was measured by using a forced choice methodology. Additionally, two types of photographic food stimuli (sweet and savoury) were used in the experiment which were further divided into high and low calorie food categories. In the following section, firstly, different definitions of rewards were reviewed and their relations with 'wanting' and 'liking' were discussed. Secondly, neural correlates of 'liking' and 'wanting' were discussed in detail and lastly, biological fundamentals of stress response and the relationship between stress and food choice was explained. Additionally, stress induced eating behaviors of males and females were examined.

1.1. Incentive Salience Theory of Rewards

Rewards are defined as desirable outcomes which are influence behavior of humans and animals. Many psychologist and neuroscientist tried to understand how people decide to invest their limited sources to obtain an available reward. In the history of psychology there are many different definitions of rewards. For instance, according to Rolls (1999; as cited in Keitz, 2003), reward refers to something which animal will want to work for whereas Schultz (1997; as cited in Keitz, 2003) suggested that there are three main features of rewarding stimuli. Initially, preparatory, consummatory and goal directed behavior of organism can be elicited

by rewarding stimulus. Secondly, that stimulus can increase the likelihood of reappearance of the goal directed behavior because animals make association between two stimuli and this leads to start the operant conditioning procedure where learning takes place. Finally, rewards cause subjective feelings of pleasure for the reward stimulus.

Drive reduction theory is the first theory of motivation that was developed by Clark Hull in 1943. The theory proposed that humans are deprived from physiological needs due to deviations from homeostasis, and the purpose of all motivated behavior is to reduce or ease the drive state and balance the homeostasis. In other words, if physiological needs are not satisfied, negative tension situation arises and the organism directs the behavior to the required object in order to bring the system back to homeostasis (Graham and Weiner, 1996). In contrary, incentive motivation theorists opposed this view because drive reduction theory could not explain why human and animals continued to explore their environments whether they are not hungry or thirsty. Proponents of the incentive motivation theory suggest that motivation of organism is proportional to the hedonic value of reward, such that when a reward related cue is associated with a reward that is more pleasurable, motivation of organism increase (Berridge, 2001; Bindra, 1974; Bolles, 1972; Toates, 1998). According to this view, if an organism attempts to acquire a reward, it must like it. This hedonic perspective of incentive motivation was criticized by some researchers through series of experiments conducted on rodents and they showed that a rodent can work to obtain a reward even though it does not like it (Berridge and Robinson, 1998; Wyvell and Berridge, 2000; Mahler and Berridge, 2012).

As an extension of incentive motivation theory, incentive salience hypothesis was first proposed by Kent C. Berridge and Terry E. Robinson in the late nineties. This hypothesis proposed that desire for an expected reward outcome is not always related to the hedonic feelings experienced during the consumption phase. In fact, many studies have shown that humans and animals continued to exert considerable effort to obtain reward even though they do not find it pleasurable (Pool et al., 2015). Proponents of incentive salience hypothesis proposed that the human reward system consist of two separate psychological components, 'wanting' (salience or motivational) and 'liking' (hedonic or affective). The 'wanting' component of rewards corresponds to the motivational process of incentive salience, whereas

‘liking’ component of rewards corresponds to the hedonic component. Previous studies showed that these two components of reward system are generally correlated but can be distinguished under certain circumstances.

The interaction between physiological state (e.g. stress, hunger or satiety) or brain state of organism (e.g. elevation of dopamine levels) and the types of stimuli in the environment (e.g. cues associated with reward) are crucial parts of the incentive salience hypothesis. In certain situations, cue triggered ‘wanting’ and hedonic ‘ liking’ during reward consumption can decrease or increase simultaneously depending on the organism's state, for example, satiety reduces the importance of food rewards for the organism and makes it less liked and wanted (Havermans et al., 2009). In other situations, motivational approach toward reward ‘wanting’ can be increased without any change of hedonic value of reward ‘liking’ depending on the organism’s physiological state. For example, stress induced eating can increase reward consumption without any increase or decrease in ‘liking’ (Pool et al., 2015).

In behavioral psychology, the question of whether these two systems can be distinguished or not, has been investigated in many studies that will be reviewed below. There are many different measurements for these two components. One such measurement was developed by Finlayson et al. (2007) where they applied a novel experimental procedure to measure two distinct components of reward in humans. In their paper, each component was measured with a different methodology; ‘liking’ was measured by using pleasantness ratings (visual analogue scale) and ‘wanting’ was measured by using a forced-choice methodology. In the experiments, they used photographic food stimuli which were divided into high fat and low fat foods and the same foods were also divided into savoury and sweet foods. They invited sixty participants to laboratory before lunch time and they instructed to not consume any food before at least three hours before the experiment. Experimental procedures for ‘liking’ and ‘wanting’ performed in a hungry state and a satiated state. In the ‘forced choice’ phase of the experiment, each food stimulus from one category was paired a different food stimulus from another category and participants needed to choose one of two stimuli on the screen as response to question ‘would most like to eat now’? For ‘liking’ they used visual analogue scale where each food stimulus was presented individually with a visual analogue scale from zero to hundred was presented beneath of the screen. Participants needed to indicate their ‘liking’ response by using

mouse and they made the choice from zero to hundred as response to the question 'How pleasant would it be to experience a mouthful of this food now?' After completion of the experimental procedures for hungry state, same participants instructed to eat until completely satiated. Later, all of the experimental procedures repeated on the satiated state. Finlayson et al. (2007) avoided using 'liking' and 'wanting' words in the experiment because experimental requirements could be understand by participants. Results indicated that in hungry state, high-fat savoury food wanted more than low-fat savoury foods whereas there were no changes in the 'liking' rating for these foods. 'Liking' ratings for high fat sweet foods were greater than low fat sweet foods, whereas there were no changes of 'wanting' value of these foods. On the other hand, in satiated state, participant wanted low-fat sweet food more than high-fat sweet food but hedonic ratings for these foods were not changed. Mean 'wanting' frequencies for high-fat savoury food were not different than mean wanting frequencies of low-fat savoury food but hedonic 'liking' scores for high-fat savoury food were higher than low-fat savoury food.

Similarly, in a different study developed by Epstein et al. (2003), there were seventeen females randomly assigned to either satiety condition or hungry condition. Different types food were given to participants in the satiety group throughout twenty minutes whereas, participants in the hungry group did not take any food and read magazine throughout twenty minutes. The subjective taste reactivity with visual analogue scale from zero to hundred and objective facial taste reactivity was assessed for pleasant, unpleasant and neutral food. Reinforcing value ('wanting') of food was measured with a computer game paradigm. In this game, participants tried to access pre-selected delicious food by earn points. Results showed that, in the hungry condition, reinforcing value of food was higher (motivation toward food reward or 'wanting' was higher) than in the satiety condition, but in both conditions (hungry or satiety) subjective or objective 'liking' ratings for food reward were not changed.

These two studies are examples of dissociable 'liking' and 'wanting' process for food reward. Epstein et al. (2003) and Finlayson et al. (2007) showed that 'wanting' and 'liking' components of food reward can be dissociable on the basis of organism's different physiological state (satiety or hungry).

1.1.1 'Wanting'

According to Berridge (1998), 'wanting' is a shorthand term of incentive salience that is attributed to reward related cues that predict actual reward, and determine its motivational value. 'Wanting' is independent from hedonic impact of stimulus and it is just motivational value of stimulus and has different physiological and neurobiological properties than 'liking'.

'Wanting' can be triggered by reward related cues in the absence or presence of a rewarding stimulus. According to Berridge (1998), mental representations of rewarding stimuli have an incentive value, that the stimuli become attractive, attention grabbing, and this reward stimulus and its associational cue become enhanced motivational targets. Berridge and his colleagues used quotation marks when talking about 'wanting' because 'wanting' is a unique module and fairly different from normal wanting (no quotation marks). Ordinary wanting (without quotation marks) or ordinary cognitive desire is different from 'wanting' because there are explicit thoughts about reward representation or actual reward. In the ordinary wanting, there are expectations or declarative goals about reward. Past experiences about this reward or imaginations of how can be nice when obtained it and these expectations guided by explicit memory. In such a situation, people know what they desire and how they like it while the experiencing of reward, and if people encounter a reward that they have never experienced before, they can estimate how they will feel about it. On the other hand, conscious experience does not needed in incentive salience and that is mediated generally by subcortical brain mechanisms, whereas normal wanting are more dependent on higher cortical brain systems (Berridge, 2009). Lamb et al. (1991) showed that humans can exert effort for available rewards even if they are not consciously aware of its' pleasure. In their experiment, five male participants needed to press lever for different dose of morphine or placebo. When participants took four different dose of morphine, pressed lever four times per second more than ten minutes but they did not press lever when they receive placebo. One of the interesting finding in their experiment is that participants were not consciously aware of the effects of low dose morphine. They pressed lever for low dose of morphine even though there were no significant difference between effect of placebo and low dose morphine. That indicates that conscious experience is not necessary for incentive salience and people can exert

their energies to obtain available reward even they not consciously aware of pleasure they have received.

Two different input factors were integrated by incentive salience or 'wanting'. These factors are current physiological state and previous associations that learned about the reward related cue or Pavlovian CS + (Berridge, 2012). Zhang et al., (2009) conceptualized the incentive salience ('wanting') with a mathematical equation. In this equation, $V = (r_t * K)$, V refers to incentive salience, r_t refers to previously learned association between a reward cue (CS) and reward (UCS), and K refers to physiological state of organism (appetite or satiety, stress etc.). According to this model, appropriate stimulus guides behavior by integration of current physiological state (appetite or satiety state, stress state etc.) and previously learned cues. When organism encountered with a cue, incentive salience is calculated dynamically based on previously learned association between a reward cue and reward, physiological state of organism.

For example, when a food reward associated with a Pavlovian cue, that reward became more attractive for a hungry animal. A vivid imagery of a reward or a Pavlovian CS of reward can trigger incentive salience. In the experiments, when reward related cue which is Pavlovian conditioned stimulus (CS) is shown to the participants, powerful, sudden and temporary 'wanting' peaks can occur. For instance, the scent of delicious food makes one feel hungry suddenly while he/she is not feeling hunger, or when he/she hears a lighter sound, they might feel intense desire to smoke if they are smokers. When a stimulus have motivational magnet, became attention grabbing and organism difficult to ignore it. In autoshaping experiments, sniffing, licking, even biting behaviour for an inedible object such a metal lever occur in animals because of previous reward experience when press the lever (Robinson, 2014).

1.1.2 'Liking'

According to Berridge et al. (2009), 'liking' refers to the psychological and neurobiological events associated with the subjective or objective experience of pleasure. People think that hedonic feeling need conscious awareness but conscious awareness may not be a necessary for 'liking' response. Pleasure can be divided into subjective liking (conscious) or objective liking (non-conscious). Winkielman et al.,

(2005) showed that subliminal presentation of happy vs. angry face pictures, influence food consumption in participants. Presentation of smiling face caused more incentive value of beverage and increased food consumption. Also, ‘’liking’’ state of participants was higher when they consumed this reward. In contrast, presentation of angry faces caused no feeling changes. Given these results, it can be said that ‘’liking’’ reaction can be affected by subliminal stimulus without any conscious awareness.

Expression of ‘liking’ is similar in both non-human animals and humans. In conscious humans, subjective liking for a reward can be measured verbally, whereas presence of the language is not needed to measure objective liking. Affective facial expression in a new born human infants or non-linguistic mammals is a strategy that can be used to find out which brain neural system is responsible for hedonic pleasure. To determine which brain neural system responsible for hedonic impact of rewards, Berridge et al. (2000), measured objective liking reactions to sweet reward in new-born human infants and adult rats. Positive facial reactions such as rhythmic tongue protrusions, lip licking were elicited for sweet taste and negative facial reactions such as gapes, frantic mouth wiping behavior and head shakes were elicited for bitter quinine taste (See Figure 1).

A hierarchy of the brain systems controls ‘liking’ and ‘disliking’ reactions in humans and non-human animals. Some neurochemical systems can influence ‘liking’ reactions and neurotransmitter such as opioid, GABA and endocannabinoid can generate ‘liking’ reactions, especially in some special areas in the limbic system. Berridge and co-workers have called these areas ‘hedonic hotspots’ (See Figure 2). Hedonic impact is mediated by two brain structures which are nucleus accumbens and ventral pallidum. Generally, reward motivation is contributed by opioid neurotransmission in these two structures. Opioids in these structures can amplify hedonic impact of rewards.

1.2 Neural Correlates of ‘Wanting’ and ‘Liking’

Many studies that conducted with humans and non-human animals indicated that ‘wanting’ and ‘liking’ are two distinct components of reward. Studies showed that, these two systems are controlled by different brain systems. Affective neuroscience tries to understand which brain regions are involved for motivational

and hedonic value of rewards, and responsible from 'wanting' and 'liking' reactions. Many brain structures (insula, orbitofrontal cortex, anterior cingulate) and subcortical structures (nucleus accumbens, ventral tegmentum, ventral pallidum, amygdala and mesolimbic dopamine projections) are activated by rewards such as sweet taste, smiling face, intravenous cocaine or winning money (Berridge et al., 2009).

Neuropsychological studies showed that 'liking' (hedonic pleasure) is related with opioid activation in the nucleus accumbens (especially in the shell) and the posterior ventral pallidum. However, 'wanting' (motivational approach), is related with mesolimbic dopamine activity (Berridge & Robinson, 1998)

1.2.1 The Role of OFC in 'Wanting' and 'Linking'

Orbitofrontal cortex (OFC) in the frontal lobes is an important cortical region for reward processing. Recent findings from neuroimaging and neural recording studies indicated that human orbitofrontal cortex is an important nexus for hedonic experience, sensory integration and emotional processing. The human orbitofrontal cortex plays an important role in encoding food reward and taste. Multiple sensory and affective signals about food reward are taken by OFC and these affective signals guide foraging behavior. It is believed that the essential role of the OFC in taste is encoding of affective value and the computation of reward value (Small et al., 2007). Kringelbach, (2005) suggested that orbitofrontal cortex receives information about reward value of the taste, olfactory and somatosensory components of a food reward in humans and higher primates and also subjective pleasantness of reward can be represented here. Kringelbach, (2005) offered a provisional model of the functional neuroanatomy of the human OFC. According to this model, sensory information is processed by posterior part of orbitofrontal cortex for further multimodal integration and reward value of reinforcement is determined in more anterior parts of orbitofrontal cortex (See Figure 3). This process can be modulated by hunger or other internal states.

Jiang et al. (2015) conducted an fMRI study with twelve healthy participants to show that orbitofrontal cortex activity is correlated with 'liking and 'wanting' separately. In the experiment, participants needed to rate 'liking' and 'wanting' of food odors and non-food odors in the hunger and satiated conditions. During the measurement of 'liking', participants indicated their 'liking' level for each food or

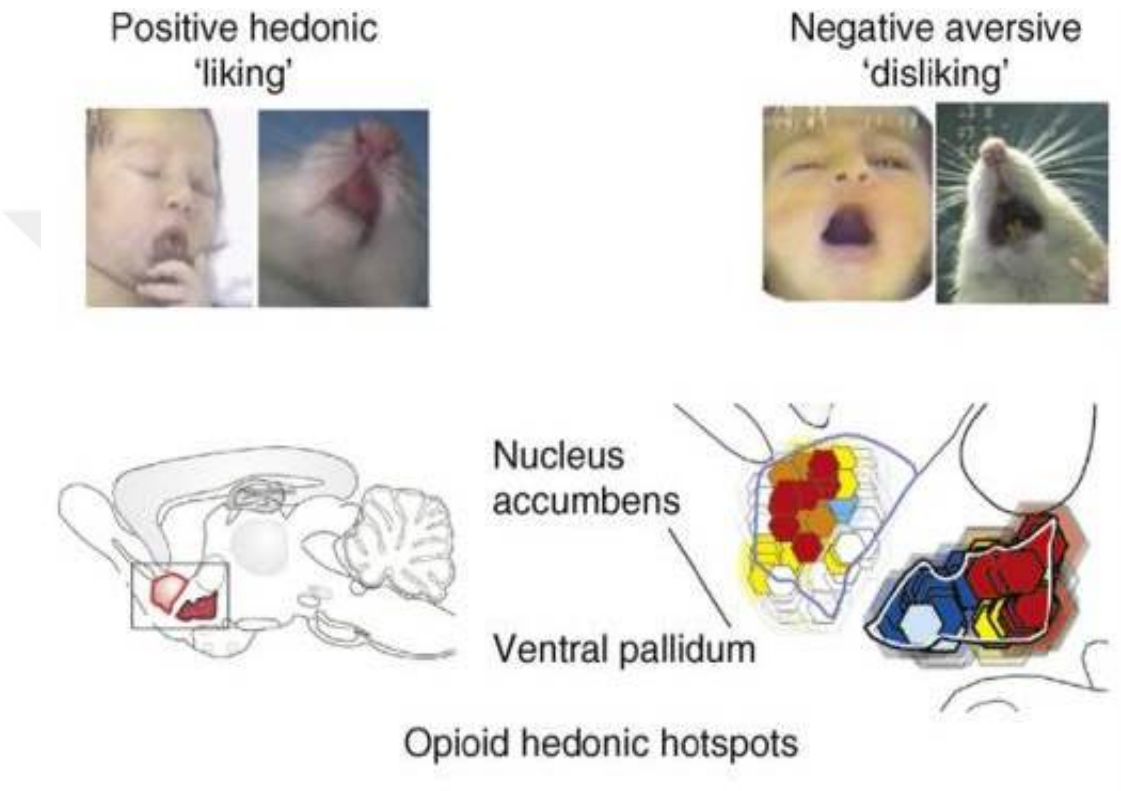

Figure 1. Top: Facial expression of different tastes in human babies and adult rats. Bottom: Brain hedonic hotspots in Nucleus accumbens and Ventral pallidum (Adapted from Berridge et al., 2009).

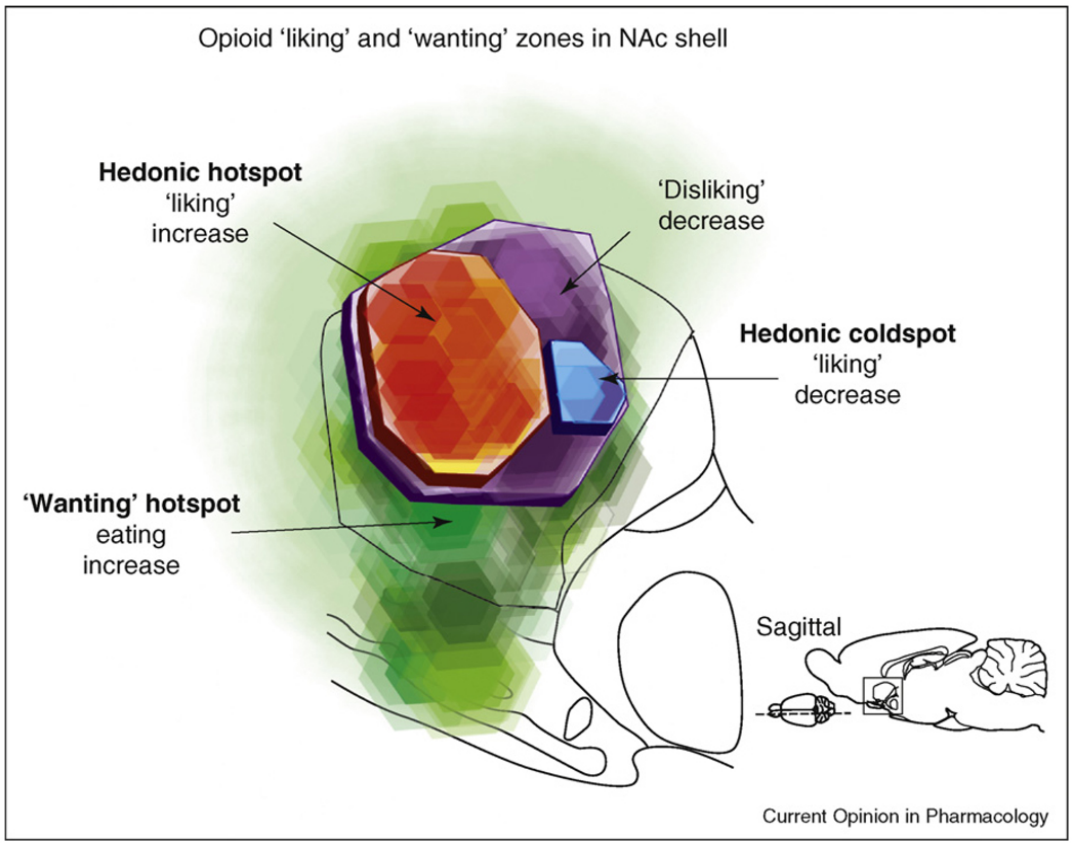

Figure 2. Opioid hotspots and colspot in the nucleus accumbens with different effects in different subregions. Green: Opioid stimulation in this part, increases 'wanting' to sucrose reward. Orange-red: Opioid stimulation in this hedonic hotspot enhances 'liking' to sucrose reward. Blue: Opioid stimulation in small part of the hedonic coldspot suppresses 'liking' to sucrose reward. Purple: Same stimulation in this area decreases 'disliking' to quinine (Adapted from Berridge et al., 2009).

non-food odors by using five buttons with corresponding finger, thumb finger (very pleasant) to pinkie finger (very unpleasant). During the measurement of 'wanting', they needed to indicate their desire to eat that evoked by food and non-food odors with same five buttons. They used same buttons with corresponding finger, thumb finger (intense desire) to pinkie finger (completely undesired). When the odor was not evoked any desire to eat, they did not press any button. Results showed, when participants rated a food odor as highly liked, stronger activation occurred in the posterior orbitofrontal cortex in the satiety state, whereas when participant indicated a food as highly desired, stronger activation occurred in the medial orbitofrontal cortex in the hunger state.

Reward value of a taste is represented in orbitofrontal cortex but identity of taste is represented in the primary taste cortex. Responses of taste neurons in orbitofrontal cortex are modulated by hunger. There are some evidences come from animal study showed that in monkeys who are satiated, orbitofrontal cortex taste neurons stopped firing (Rolls et al., 1989). Hungry monkeys exert effort for electrical stimulation in related brain region but when they are satiated they did not exert any effort to experience same stimulation (Mora et al., 1979; Rolls, 1999). Orbitofrontal cortex activation also occurs when a reward related visual stimulus being seen. Rolls, 2000 reported that neural activation in orbitofrontal cortex occurred when a monkey see reward related cue and also activation in these neurons tracks changes of predictive value of stimulus or changes of sensory pleasure of stimulus.

1.2.2 The role of Nucleus Accumbens in 'Wanting' and 'Liking'

The nucleus accumbens that located at the front of the brain under neocortex have two subdivisions which are core and shell. Core is important for reward learning but actual affective ('liking') and motivational ('wanting') components of rewards are produced in shell. In the medial shell of the nucleus accumbens, hedonic hotspot covers an area about 1 cubic millimeter volume in rats. Natural brain neurotransmitters, opioids, exist in the medial shell and act on the same receptors such as heroin or morphine (Kringelbach & Berridge, 2010).

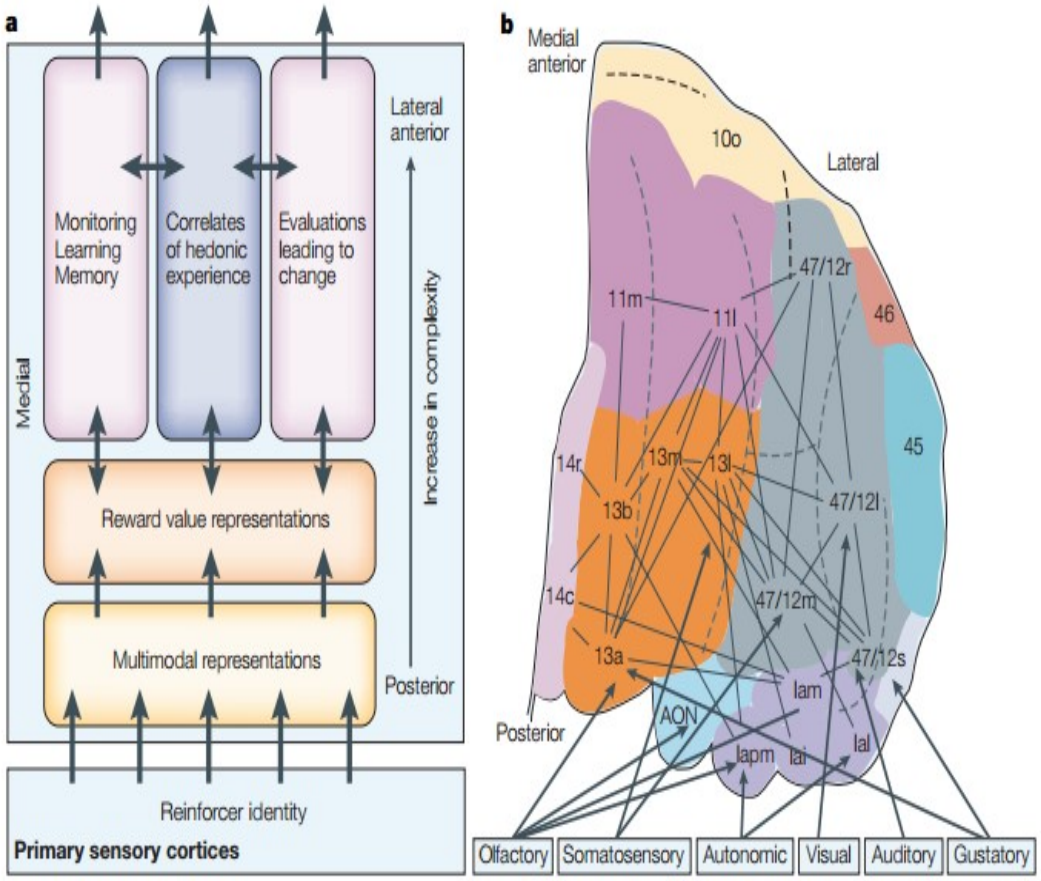

Figure 3. a. A model of the interactions between sensory and hedonic systems in the human brain b. Sensory information in the figure flows from bottom to top. Sensory information comes from primary sensory cortices (stimulus identity can be olfactory, somatosensory, visual etc.) and this information is then transmitted to the brain structures in the posterior parts of the OFC for multimodal representation. The reward value is determined in the more anterior part of OFC (Adapted from Kringelbach, M. L., 2005).

Berridge and Pecina (2000), indicated that morphine (opioid agonist) microinjection into posterior shell of the nucleus accumbens caused more eating behavior ('wanting') and more hedonic reaction ('liking') for a food reward in rats. Additionally, a specific site which is activated by morphine microinjection in the nucleus accumbens shell was found. Medial caudal subregion of the nucleus accumbens shell includes this area and that area has been called 'opioid eating site'. Opioids play a critical role in modulating food reinforcement. Excessive opioid activation in hedonic hot spot where is located in nucleus accumbens can cause more eating behavior in individuals because of food taste is better. Opioid activation increase in areas around the nucleus accumbens shell (not in the hotspots) can cause more eating behavior because of motivational reasons. Mu (μ) type of opioid receptor is activated by opioid neurotransmitters and leads to occur 'liking' and 'wanting' for food reward.

In many brain regions, μ-opioid receptors play an important role in mediating reward and enhancing hedonic impact, for this reason DAMGO (μ-opioid agonist) has been widely used in many experiments (Contarino et al., 2002; Kelley et al., 2002; Pecina & Berridge, 2005; Smith & Berridge, 2005). Opioid hedonic hotspot exists in the dorsal part of the anterior half of the medial shell (Figure 2). Mu (μ)-opioid receptors boost 'liking' reaction to sucrose taste up to four times the normal number in this region (Pecina and Berridge, 2005). On the all other parts of the nucleus accumbens, microinjection of opioid drug (DAMGO) fail to enhance hedonic 'liking' reaction to sweet reward in rats. Indeed, posterior half of the medial shell includes a cold spot, and DAMGO microinjection in this region suppresses 'liking' reaction to sweet reward.

1.2.3 The role of Ventral Pallidum in 'Wanting' and 'Liking'

Another hot spot where is located in the posterior half of the ventral pallidum can increase 'liking' behavior for reward by opioid microinjection. This hedonic hotspot covers an area about 0.80 cubic millimeter volumes within the posterior ventral pallidum. Hedonic properties of this hotspot are similar with hedonic properties of nucleus accumbens hotspot.

Mu opioid stimulation leads to increase hedonic 'liking' for food reward in posterior parts of ventral pallidum, whereas same stimulation leads to increase

motivational ‘wanting’ for food reward in the anterior and central part of the ventral pallidum. Smith et al. (2005) suggested that in all part of the ventral pallidum, hedonic impact (‘liking’) for reward was not observed by μ-opioid stimulation, unlike, this stimulation may suppress hedonic impact in the anterior parts. In the posterior of the ventral pallidum, hedonic ‘liking’ reaction was increased by μ-opioid agonist DAMGO whereas, in the anterior and central ventral pallidum, hedonic ‘liking’ reaction suppressed by same DAMGO microinjection. Similarly, in the posterior and central ventral pallidum, eating behavior (‘wanting’) was increased but in the anterior ventral pallidum eating behavior was suppressed by using DAMGO microinjection. In humans, same hotspot and coldspot in ventral pallidum are used for food pleasure. When appetitive food pictures like chocolate were presented to participants, activation occurred in the posterior hotspot of ventral palladium whereas, when disgusting food pictures such as rotten food were presented to participants, activation occurred in anterior part that is called coldspot of ventral pallidum (Calder et al., 2007).

Multiple neurochemical signals are used by ventral pallidum hotspot to generate motivational eating behavior (‘wanting’) but hedonic ‘liking’ is not generated by all of them. For instance, eating behavior was enhanced by $GABA_A$ antagonist bicuculline microinjection in all part of the ventral pallidum, but ‘liking’ reaction was failed to enhanced (Smith and Berridge, 2005). Motivational ‘wanting’ without hedonic ‘liking’ can be dissociated purely by bicculine microinjection. The differences in these sub regions emphasizes that ‘wanting’ and ‘liking’ behavior can be different for same reward.

1.2.4 The role of Dopamine in ‘Wanting’ and ‘Liking’

Subcortical brain circuits, especially, mesolimbic dopamine system generates incentive salience (‘wanting’). It has been suggested that opioids mediates ‘liking’ and dopamine mediates ‘wanting’ (Flavia Barbano, 2007; Berridge, 2007).

Animal studies indicated that dopamine impairment cause ‘liking’ without ‘wanting’ for food reward. The loss of dopamine from the nucleus accumbens and neostriatum in rats, did not affect hedonic value of reward and that rats still liked rewards but they no longer wanted to receive reward which they liked before. When mesolimbic dopamine system are destroyed by drugs which are blocking receptors,

incentive salience or 'wanting' value of food reward is dramatically reduced but this manipulation did not affect affective facial expressions of "liking" for the same food reward (Berridge and Robinson, 1998; Peciña et al., 1997). Dopamine-deficient (DD) rats have almost no dopamine because of genetic deficiency. If they do not feed artificially, they can die from starvation because rewards have no incentive value for those rats. However, when rats with dopamine-deficient are fed artificially, hedonic 'liking' reactions were elicited during food consumption like normal rats (Cannon & Bseikri, 2004) and those rats still prefer water with saccharin or sucrose reward than normal water because of hedonic impact (Cannon & Palmiter, 2003). Berridge et al., (1998) destroyed dopaminergic fibers in rats by microinjection of 6-hydroxydopamine (6-OHDA). In this experiment, efforts of animals to obtain available reward was taken indicator of 'wanting' and hedonic facial expression such as rhythmic tongue protrusions and lip licking was taken as indicator of hedonic 'liking'. Results showed that 6-hydroxydopamine (6-OHDA) selectively destroy dopaminergic neurons in nucleus accumbens and neostriatum and those rats still able to express positive facial reactions to sucrose reward and negative facial reaction to quinine, whereas they were not willing to perform effort for sucrose reward.

On the other hand, another studies showed that it is possible to increase 'wanting' without 'liking' for a reward by increasing dopamine. Dopamine system manipulation boosts mesolimbic dopamine signals and this manipulation increase 'wanting' without any change of other reward components such as cognitive desires and hedonic impact. Motivational "wanting" without hedonic "liking" was shown in rats with electrical stimulation of the lateral hypothalamus (ESLH). Electrical stimulation of the lateral hypothalamus (ESLH) in rats caused aversive facial reaction such as rapid headshaking, gape, face wash etc. to different tastes even though feeding behavior increase (Berridge & Valenstein, 1991). In a different way, synaptic dopamine level in mice was increased with manipulation of dopamine transporter (DAT). Hyperdopaminergic knockdown mutant mice showed increased 'wanting' behavior to sweet reward, whereas 'liking' behavior did not increase to same reward (Peciña et al., 2003). To increase 'wanting' peaks without any change on other components of reward, Wyvell & Berridge (2000) stimulated brain mesolimbic dopamine systems by injecting amphetamine drug in the nucleus accumbens. In this study, rats trained to press lever to gain sucrose reward so

Pavlovian association between sucrose reward and light cue was learned by rats. In the test phase, amphetamine injected to the rats and light cue was presented during the session but sucrose reward was not given despite they press the lever. Results indicated that during presentation of the light cue, number of pressing the lever increased after amphetamine microinjection. On the other hand, taste reactivity measurement showed that amphetamine did not enhanced 'liking' to sucrose reward. Amphetamine leads to release extra dopamine from dopamine containing neurons to their target neuron. Amphetamine selectively increased 'wanting' for sucrose reward but failed to increase 'liking' to sucrose. Same results were also observed in human studies. Humans who have higher dopamine level by administration of methylphenidate (Ritalin) showed higher subjective 'wanting' for a reward than pleasure rating for same reward (Volkow et al., 2002).

Additionally, apart from laboratory studies, there are many examples in daily life of "wanting" without "liking". Some extremely addictive substances such as nicotine, alcohol are extremely "wanted" even though producing little or no sense of pleasure. According to incentive sensitization theory, addiction occurs because sensitization of ''wanting'' system. Neuronal changes in the mesolimbic dopamine system because of repeated drug use leads to this sensitization (Robinson & Berridge, 1993).

As mentioned previously, 'wanting' and 'liking' components of reward system are generally correlated but can be distinguished under some conditions. In humans, stress selectively increases cue-triggered wanting, independently of the hedonic properties of the reward (Pool et al., 2015). In this thesis, we aimed to differentiate 'liking' and 'wanting' components of reward system by using stress manipulation.

1.3 The Stress Response: Biological Fundamentals

First clear definition of stress comes from Hans Selye in 1936, who defined stress as non-specific response of the body to any noxious events or stimuli. He showed effects of stress in laboratory animals with some experiments, for example, some annoying stimuli (extreme cold or hot, continuous frustration, sharp light) caused same pathologic changes in animals' body. Those animals developed different diseases such as heart attack, kidney diseases as in humans. Selye (1936)

proposed that many different stressors can cause various illnesses in humans as in animals. People can experience stress as emotionally (loss of close relative, loss of job, interpersonal conflict) or physiologically (physical illness, drug deprivation stages).

Sympatho-adrenal medullary system (SAM) and hypothalamic-pituitary-adrenal (HPA) axis are physiological pathways that are activated by stressors (Torres et al., 2010; Koolhaas et al., 2011). When individual faced with a stressor, amygdala a brain region which contributes emotional processing, send direct signals to the hypothalamus where it communicates with body through autonomic nervous system (ANS). ANS consist of two components which are sympathetic and parasympathetic nervous system (McCorry, 2007). After taking these signals from amygdala, activation of sympathetic nervous system triggers a neural response that is responsible for synthesis, storage, and release of the epinephrine hormone and norepinephrine neurotransmitter. Epinephrine and norepinephrine are also known as adrenaline and noradrenaline respectively. Epinephrine and norepinephrine stimulate the α- and ß-adrenergic receptors in the heart therefore pulse rate and blood pressure increases. This leads to faster blood flow and body become ready to "fight or flight" reaction. Walter B. Cannon was first characterized this early stage of the stress response (Goldstein & Kopin, 2007). This response is rapid and reaches peak level within approximately 10-15 minutes. Contrary to sympathetic, parasympathetic nervous system help to modulate sympathetic reaction of the body during stressful events (Ulrich-Lai & Herman, 2009).

The second major component of stress response is HPA axis that is activated by hypothalamus. Paraventricular nucleus (PVN) located in the hypothalamus and includes corticotropin-releasing factor (CRF) synthesizing neurons. When organism exposed to stress, hypothalamus releases corticotropin-releasing hormone (CRH) and arginine-vassopressin (AVP). When CRH access the anterior pituitary gland, triggers the adrenocorticotropic hormone (ACTH). When ACTH triggered, glucocorticoids are synthesized and released by adrenal cortex. Cortisol is major glucocorticoid that synthesized in humans. This response is slower than adrenaline and noradrenaline, also reaches peak level within approximately 20-60 minutes (Turner et al., 2006). Cortisol activates the energy stores of the body to in order to fight with effects of stress (Torres et al., 2010). These two types of psychological responses to stress are

shown in the Figure 4. These two systems can be activated by powerful stressors such as public speaking or being judged by people. These situations can perceived as a threat for social self in humans (Dickerson & Kemeny, 2004).

1.3.1 Stress and Food Choice

Human studies showed that eating behavior effected from stress bi-directionally. During or after stressful event, most of people increased their food intake, whereas remaining people decreased their food intake (Epel & Adam, 2007). Epel et al. (2004) measured stress level of medical students during baseline and during two exam periods for one year. The majority of students who participated in the study reported changes in their eating behavior in the stressful situations. Under stress, 36 % of the students reported eating more than normal and 26 % of the students reported eating less than normal. Students who have reported more eating during stressful period, showed increase cortisol level and body mass index than students who have reported less eating during stressful period. Similarly, a survey study about perceived effect of stress on food preference showed that 42% of the participants reported that they have more food consumption under stress and 38% of the participants reported that they have less food consumption under stress, remaining participants did not report any change of their eating behavior. From the stressful group, 72 % of the participants reported more snack food eating more than usual. Study also investigated differences in types of food chosen under stress. Sweets and chocolates were more preferred under stress, whereas meal type foods such as fruits, vegetable, fish and meats less preferred under stress (Oliver & Wardle, 1998). In contrast, the other study that investigate stress and eating relationship indicated that food intake of individuals was low in the stressful period. In this study, stress was measured by using participants' reports about their difficult daily hassles and their subjective reactions to these hassles (Stone & Brownell, 1994).

In the Westernized countries, it is easy to reach palatable and calorie dense food and it makes sense that people may show more food consumption under stress (Epel & Adam, 2007). Zellner et al. (2006) suggested that stress generally increases preference of high calorie snack foods that are normally avoided. They demonstrated that stress group participants who have exposed to stress with unsolvable anagram

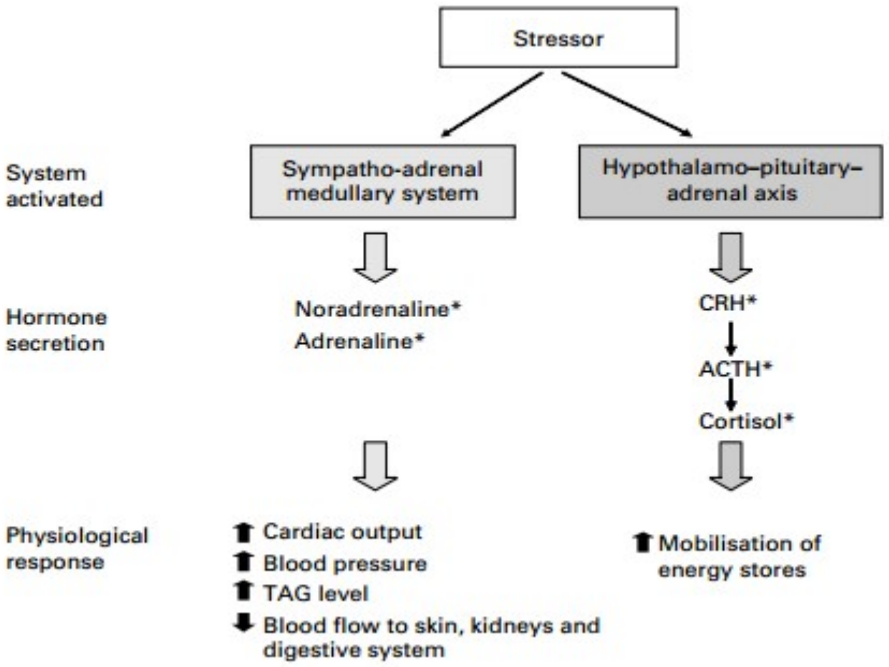

Figure 4. Sympatho-adrenal medullary system (SAM) and hypothalamic-pituitary-adrenal (HPA) axis are physiological pathways that are activated by stressors (Adapted from Torres et al., 2010).

test preferred sweet high calorie foods like chocolate more than healthy foods such as fruits. Epel et al. (2001), in a study that involves different stress manipulation technique, showed that food consumption of female increased after acute stress manipulation. They applied adapted version of the Trier Social Stress Test (Kirschbaum et al., 1993) which includes puzzle solving, mathematical operation and making a videotaped speech during the first three day of menstrual period. Fourth day of the period was rest session and they were not exposed any stress manipulation. After stress manipulation, participants were left alone in the experiment room with sweet and salty snacks and they instructed to eat as much as they want. After end of the experiment, total amount of snack food that consumed was assessed for each food category separately. Results indicated that female participants who have high cortisol level consumed more calories on the stress day compared to female participants who have low cortisol level. However, on the control day, they consumed similar amount of calories. In addition, participants who have high cortisol level consumed significantly more high fat sweet food than participants who have low cortisol level. In contrast, participants who have high cortisol level consumed significantly less salty food, specifically low fat salty food, than participants who have low cortisol level on the rest day.

Tomiyama et al. (2011) measured stress eating with a questionnaire. They used Trier Social Stress test which includes 5-min speak preparation phase, 5-min serial subtraction task and 5-min public speaking in front of two audience members and they measured cortisol levels of participants after stress manipulation. They reported that high stress group participants reported more emotional eating than low stress group participants. Rutters et al. (2009) showed that acute and psychological stress is associated with food intake in the absence of hunger. In this study, a mental arithmetic test with unsolvable math questions was used as stressor. Immediately and 10 minutes after stress manipulation, they measured heart rate and blood pressure to determine whether the psychological or physiological effect of stress manipulation. They found that in adults, stress increased sweet food and total amount of energy intake.

1.3.2 Gender Differences in Food Choice

Many studies have investigated differences between male and female eating behavior under stress. Grunberg & Straub (1992) investigated eating behavior of male and female participants under stress condition. A movie about industrial accidents was shown to experimental group to create stress and the other movie about pleasant travel was shown to control group participants. After stress manipulation participants instructed to eat three types of foods, sweet (colorful button-shaped chocolates and wafers), savoury (salty cocktail peanuts and salted cracker) and bland foods (unsalted cocktail peanuts and low salted cracker). After that, they measured amount of food that was eaten by participants. Results revealed that stress increased food intake on female participants and decreased food intake on male participants but this effect was not statistically significant for males. In the stress condition, male participants ate less sweet, savoury and bland food than control group participants. On the other hand, stress group female participants ate nearly twice as much chocolate and bland food than control group participants. Stone and Brownell (1994) did not find gender differences on eating behavior of male and female participants under stress. According to daily record of participants, both of them decreased their food intake under stressful events. O'Connor et al. (2008) used same method to examine stress and eating relationship in males and females. Participants completed daily records about their daily hassles and eating of meal snacking, vegetable and fruit consumption. Results indicated that, in females, with increased daily hassles, high fat and high sugar snack eating was also increased significantly compared to males.

Zellner et al. (2006) conducted two studies on thirty four female participants to investigate effect of stress on food selection. In the first study, they created stress with unsolvable anagram task in the stress group participants and solvable anagram task was given to non-stress group participants. The non-stress group participants consumed more healthy foods (e.g. grapes) than did the stress group. On the other hand, the stress group participants consumed more unhealthy high calorie food (e.g. M&Ms) than did the non-stress group participants. Additionally, there was no difference of savoury food choice (e.g. potato chips and peanuts) in the stress and non-stress group. Participants in both groups consumed same amount of savoury foods. Total amount of savoury foods that consumed was significantly less than total

amount of sweet foods that consumed. Zellner et al. (2006) concluded that participants choose sweet food more than savoury because there was a limited time to consume food. They suggested that people consume high calorie food more when stressed because they need to reduce anxiety and makes them feel better in this way. In a second study, they conducted a survey study with one hundred and twenty eight females and forty one males. Result showed that, 46 % of the female reported high food consumption and only 17 % of males reported high food consumption under stress. Other participants reported no change in food consumption under stress. Zellner et al. (2007) conducted same study on thirty six male participants to investigate food preference among men. They conducted same stress manipulation (unsolvable anagram) to eighteen male participants in the stress group and other eighteen participants in the non-stress group have received solvable anagram task. Results showed that male participants in the non-stress group consumed significantly more unhealthy foods than did male participants in the stress group. These results were different from results of the female participants who consumed more healthy food in the non-stress group and more unhealthy food in the stress group (Zellner et al., 2006).

1.3.3 Effects of Stress on 'Liking' and 'Wanting'

Stress not only enhances consumption of high calorie food reward, but also increases other types of reward consumption such as sexual and monetary rewards in humans. Chumbley et al. (2014) conducted an experiment by using gender classification task and they used erotic images of females as rewarding stimuli. In this task, heterosexual male participants squeezed the force gauge with dominant hand to make clear to blurred visual stimuli (female and male pictures). In the absence of any pressure, no picture was visible on the screen. Depending on the increasing power of the participants, a clearer picture was appeared. There were a linear relationship between force and clearance of female and male pictures. Cortisol measurement from hair of participants was performed end of the experiment. Participants who have high level of cortisol exerted more effort to see female pictures than male pictures. Considering these results, they suggested that stress may affect reward related behavior in humans. Kumar et al. (2014) conducted a functional magnetic resonance imaging (fMRI) study to investigate effects of stress on reward processing. They used a monetary incentive delay (MID) task and negative

performance feedback (to create acute stress) in healthy subjects. During reward anticipation, striatal and amygdala activation increased, but during reward consumption, striatal activation decreased. Increasing striatal activation means that increasing motivation of organism to obtain more reward and avoiding punishments. They proposed that stress enhances 'wanting' behavior during anticipatory phase, whereas minimizes 'liking' behavior during consumption.

The role of motivational 'wanting' and hedonic 'liking' has been studied in concept of eating disorders with overweight and normal weight participants. Lemmens et al. (2011) used a mathematical test with unsolvable question to create stress. At the same time, irritating music and background noise was given to stress group participants. On the other hand, solvable mathematic questions were given to control group participants and there were no background noise and irritating music. During test session, heart rate of participants was measured every five seconds. Results showed that in overweight participants, 'wanting' for snack foods and desserts increased after stress manipulation than normal weight participants. However, 'liking' for the same rewards was not affected by stress manipulation and was not changed for two groups. On the other hand, normal weight participants were not affected from stress manipulation. In both conditions (stress and non-stress), they decreased their 'wanting' and energy intake in the absence of hunger. Lemmens et al. (2011) suggested that stress induced food intake is associated with weight gain, because overweight participants increased their 'wanting' under stress, whereas normal weight participants were not increased their 'wanting' for food under stress.

The stress induced eating has been widely explored in many studies on humans and animals but psychological mechanism under this process was poorly understood (Pool et al., 2016). According to aversive state reduction hypothesis which is a mechanical explanation, people prefer highly palatable food, when they feel stressed because consumption of these food decrease aversive feeling caused by stress. People can cope with stress and feel better thanks to delicious food (Robbins & Fray, 1980; as cited in Pool et al., 2015). Epel et al. (2007) proposed that repeated stimulation of hypothalamic-pituitary-adrenal (HPA) axis by stress cause over high palatable food intake because cortisol plays an important role of reward value of food. Excessive activation of HPA axis can be reduced by high palatable food

reward. According to this view, palatable foods are eaten by people for hedonic properties rather than nutritional properties.

On the other hand, there is an experiment does not support the aversive state reduction hypothesis. In this study, three phase Pavlovian Instrumental Transfer Test (PIT) paradigm was used to measure effects of stress on motivation to obtain reward (Pecina et al., 2006). This test consists of three phase which are instrumental conditioning, Pavlovian conditioning and transfer test (Lovibond, 1983). In the instrumental conditioning phase, rats trained to press lever (instrumental action) to obtain sucrose reward. In the second, Pavlovian conditioning phase, a Pavlovian cue (i.e., sounds) was associated with the presence of the food reward (CS +) or absence of the food reward (CS -). Lastly, in the transfer phase, previously learned instrumental action (pressing the pedal) was measured during absence (CS -) or presence (CS +) of the Pavlovian cue. Before the transfer test, cortico-tropin releasing factor (CRF) which is a stress inducer hormone was microinjected in the medial shell of the nucleus accumbens of the rats to increase instrumental performance to sucrose reward (or increase motivational value of reward). Transfer test was performed under extinction (Pavlovian cue was delivered but any reward was not given to rats) so rats never experienced any reduction of aversive state by hedonic properties of food reward. Researchers showed that CRF microinjected rats increased instrumental performance to sweet reward than placebo group even though they never experienced hedonic properties of reward because of extinction. They also argued that dopamine manipulation is not obligatory to show the separate components of reward. As shown in this study, motivation to obtain a reward or 'wanting' can be increased with stress manipulation without any hedonic feelings for same reward.

In humans, Pool et al. (2015), used the analogue of a human Pavlovian-Instrumental Transfer test paradigm (PIT) with an olfactory reward (chocolate odor) to measure the cue triggered 'wanting' and sensory hedonic 'liking' component of the reward by using stress-inducing or stress-free behavioral procedures. In the instrumental conditioning phase, participants needed to squeeze handgrip by applying a certain power to obtain chocolate odor. In the Analogues Pavlovian conditioning phase, US (i.e. chocolate odor) was provided to participants and associated with the CS + (i.e. a geometric image) whereas, odorless air was provided

to participants and associated with the CS – (i.e. a geometric image). When participants see CS + and CS – on the screen, they needed to press button to obtain chocolate odor. They were also informed that chocolate odor releasing was not related with key pressing, it was related with the images and this is just done to keep attention of participants on the screen. In the baseline phase, any target or any air was not provided to participants. After these procedures, cold pressure test (Schwabe et al., 2008) was applied to create stress. In this method, participants were immersed their non-dominant hand in the cold water (0-2 °C) and waited as long as possible. After stress manipulation, participants evaluated their pleasantness, stressfulness, and painfulness level on a scale from zero to ten. Additionally, cortisol level of each participant was measured. After stress manipulation, in the PIT test, a Pavlovian image was associated with instrumental action. Participants needed to squeeze to handgrip to obtain chocolate odor, when they see Pavlovian image. Also, PIT test provided under extinction. After the PIT test, participants evaluated 'liking' level for chocolate odor and odorless air. Results indicated that when reward related cue was displayed, participants in the stress-condition exerted more effort than stress-free condition to obtain reward but they did not report reward as being more pleasurable. Results of this study revealed that, in humans, stress selectively increases cue-triggered wanting, independently of the hedonic properties of the reward.

1.4 Aim of the Thesis

As it was reviewed above, previous studies showed that these two components of reward system are generally correlated but can be distinguished under certain circumstances. Based on the incentive salience theory, in this study we hypothesized that 'wanting' (incentive salience) behaviour for high calorie sweet and savoury food reward will be increased by stress manipulation, whereas 'liking' behaviour of participants in the stress and non-stress group will not change. Additionally, based on the previous studies, we expected that 'liking' and 'wanting' response of female participants for high calorie sweet and savoury food reward will be high compared male participants. We also expected that reaction time of participants for 'wanting' of sweet food will be higher than savoury food in the stress condition.

CHAPTER 2: METHOD

2.1 Participants

Sixty two healthy participants for the study were recruited from the undergraduate student population of the Izmir University of Economics. For main study, thirty six females and twenty six males aged between 19 to 25 were selected from non-vegetarians. The participants mean age was 21.60 years (*SD* = 1.30), and mean BMI (body mass index) was 22.77 kg/m^2 (*SD* = 4.16). These participants divided into two groups (stress and non-stress) and mean BMI of two groups was compared with independent sample t-test. Results showed that there was no meaningful statistically significant difference, $t_{(60)} = 1.69$, $p > .05$. Several inclusion and exclusion criteria were set in order to participate in the study. These criteria were related to eating habits, psychological and physiological health status of participants. Any potential participants were excluded, if one of the following criteria was met: The exclusion criteria are as follows: (i) having any cardiovascular disease, (ii) being vegetarian or vegan, (iii) eating something at least three hours ago, (iv) smoking at least one hour ago, (v) having a BMI over 30 or under 18.

2.2 Stimuli, Apparatus and Materials

2.2.1 Stimuli and Apparatus

A total of eighty photographic food stimuli were used in the experiment. The photographic food stimuli were selected from the Food-pics database which is consists of 568 food and 315 non-food images, (Blechert et al., 2015; also see www.food-pics.sbg.ac.at). In an online survey, all images in the dataset rated by 1988 participants according to their arousal, palatability ('liking'), desire to eat ('wanting'), recognizability and visual complexity value. Also, images differ in their calorie value, macronutrients and physical image characteristics. Visual analogue

scale from one (not at all) to hundred (extremely) was provided to participants to indicate their 'liking' level according to how they find palatable of each food, and same scale was provided to participants to indicate their 'wanting' level according to how much they want to eat of each food.

In the present study, food images which are selected from this database have different calorie, 'liking' (palatability) and 'wanting' (craving or desire to eat) values (See Appendix A, Table 1 & 2 for details). Photographic food stimuli presented on a white background with a resolution of 1600 × 900 pixels. The refresh rate was set to 60 Hz. Responses were collected with a standard computer keyboard. Presentation was designed by using the Superlab Pro software package (SuperLab^{TM}, Model: 4.5; Cedrus Corporation). A fingertip pulse oximeter (Contecmed, Model: Cms 50d +) was used to obtain heart rate measurement from participants and this oximeter paired with another computer.

2.2.2 Stimulus Selection

Before using the food stimuli in the experiment, we selected two sets of ten savoury food pictures such that the mean 'wanting' (craving) value of first set and second set of food stimuli should be similar, whereas mean calorie value of the first set and second set should be different (ten of them should be high calorie and ten of them should be low calorie). Each of the ten high calorie images were paired with a low calorie images during the stimulus presentation and these pairs remained the same for all participants except the order of presentation was randomized between subjects. A paired sample t-test was conducted to see whether there was any difference between 'wanting' values of first set (high calorie savoury food) and second set (low calorie savoury food). There was a non-significant difference between 'wanting' values of high calorie savoury and low calorie savoury food, $t_{(9)} = .03$, $p > .05$. 'Wanting' values of high calorie savoury food ($M = 29.39$, $SE = 1.68$) was similar with the 'wanting' values of low calorie savoury food ($M = 29.33$, $SE = 1.65$) (See Table 1). For the same food, a paired sample t-test was conducted to see whether there was any difference between calorie values of first set (high calorie savoury food) and second set (low calorie savoury food). There was a significant difference between calorie values of two sets of stimuli, $t_{(9)} = 4.27$, $p < .05$, $r = .71$. Calorie values of high calorie savoury food ($M = 924.42$, $SE = 95.42$) was higher

than low calorie savoury food (M = 413.77, SE = 72.34) (See Table 1, Figure 5). High and low calorie savoury food stimuli did not differ in 'wanting' value but they differ in calorie value (high calorie and low calorie). At the same time, we wanted to see mean 'liking' value of these 'wanting' stimuli, because different 'liking' value can affect our results because of this reason, for the same food image, a paired sample t-test was conducted to see whether there was any difference between 'liking' values of the first set (high calorie savoury food) and the second set (low calorie savoury food). Results indicated that there was a non-significant difference between 'liking' values of the two sets of stimuli, $t_{(9)} = .60$, $p > .05$. 'Liking' values of high calorie savoury food (M = 49.23, SE = 2.13) was similar with low calorie savoury food (M = 47.46, SE = 2.05) (See Table 1).

Similarly, we selected two sets of ten sweet food pictures such that the mean 'wanting' (craving) value of first set and second set of food stimuli should be similar, whereas mean calorie value of first set and second set of food stimuli should be different (ten of them should be high calorie and ten of them should be low calorie). A paired sample t-test was conducted to see whether there was any difference between 'wanting' of first set (high calorie sweet food) and second set (low calorie sweet food). Results showed that, there was a non-significant difference between 'wanting' value of high calorie sweet food and low calorie sweet food $t_{(9)} = .04$, $p > .05$. Mean 'wanting' value of high calorie sweet food (M = 36.18, SE = 1.24) was similar with low calorie sweet food (M = 36.11, SE = 1.22) (See Table 1). For the same food picture set, a paired sample t-test was conducted to see whether there was any difference between calorie values of high calorie sweet food and low calorie sweet food. There was a significant difference between calorie values, $t_{(9)} = 2.37$, $p < .05$, $r = .49$. Mean calorie value of high calorie sweet food (M = 856.81, SE = 257.66) was greater than low calorie sweet food (M = 239.17, SE = 39.80) (See Table 1, Figure 6). High and low calorie sweet food stimuli did not differ in 'wanting' value but they differ in calorie value (high calorie and low calorie). For the same food, mean 'liking' value of 'wanting' stimuli was controlled by conducting paired sample t-test and we aimed to see whether there was any difference between 'liking' values of first set (high calorie sweet food) and second set (low calorie sweet food). Results showed that there was a non-significant difference between 'liking' values of two sets of stimuli, $t_{(9)} = .84$, $p > .05$. 'Liking' values of high calorie sweet

food (M = 62.78, SE = .89) was similar with low calorie sweet food (M = 61.10, SE = 1.79) (See Table 1).

Before using the 'liking' stimuli in the experiment, we selected two sets of 10 food pictures such that mean 'liking' (palatability) value of first set of stimuli and second set of stimuli should be similar, whereas mean calorie value of first set and second set of stimuli should be different (ten of them should be high calorie and ten of them should be low calorie). An independent sample t-test was conducted to see whether there was any difference between 'liking' (palatability) values of first set (high calorie savoury food) and second set (low calorie savoury food) of stimuli. Results showed that, there was a non-significant difference between 'liking' values of high calorie savoury and low calorie savoury food, $t_{(18)} = .29$, $p > .05$. 'Liking' values of high calorie savoury food (M = 45.91, SE = 3.26) was similar with low calorie savoury food (M = 44.73, SE = 2.37) (See Table 1). For the same food, an independent sample t-test was conducted to see whether there was any difference between calorie values of high calorie savoury food and low calorie savoury food. According to results, there was a significant difference between calorie values, $t_{(18)} = 4.03$, $p < .05$, $r = .43$. Calorie values of high calorie savoury food (M = 621.27, SE = 81.33) was higher than low calorie savoury food (M = 251.34, SE = 42.52) (See Table 1, Figure 7). High and low calorie savoury food stimuli did not differ in 'liking' value but they differ in calorie value (high calorie and low calorie). For the same 'liking' food stimuli, an independent sample t-test was conducted to see whether there was any difference between 'wanting' values of first set (high calorie savoury food) and second set (low calorie savoury food). Results indicated that there was a non-significant difference between 'wanting' values of two sets of stimuli, $t_{(18)} = 0.74$, $p > .05$. 'Wanting' values of high calorie savoury food (M = 25.32, SE = 2.41) was similar with low calorie savoury food (M = 27.81, SE = 2.38) (See Table 1).

Similarly, we selected two sets of ten sweet food pictures such that the mean 'liking' value of first set and second set of stimuli should be similar, whereas mean calorie value of first set and second set should be different (ten of them should be high calorie and ten of them should be low calorie). An independent sample t-test was applied to see whether there was any difference between 'liking' values of high calorie sweet food and low calorie sweet food. The difference between 'liking' value

of high calorie sweet food and low calorie sweet food did not reach statistical significance, $t_{(18)} = -0.10$, $p > .05$. Mean 'liking' value of high calorie sweet food ($M = 56.23$, $SE = 2.34$) was similar with mean 'liking' value of low calorie sweet food ($M = 56.56$, $SE = 2.28$) (See Table 1). For the same food, an independent sample t-test was conducted to see whether there was any difference between calorie values of high calorie sweet food and low calorie sweet food. There was a significant difference between calorie value of high calorie sweet food and low calorie sweet food $t_{(18)} = 2.80$, $p < .05$, $r = .55$, 95. Mean calorie value of high calorie sweet food ($M = 1368.99$, $SE = 424.99$) was greater than low calorie sweet food ($M = 174.96$, $SE = 36.09$) (See Table 1, Figure 8). High and low calorie sweet food stimuli did not differ in 'liking' value but they differ in calorie value (high calorie and low calorie). For the same 'liking' food stimuli, an independent sample t-test was conducted to see whether there was any difference between 'wanting' values of first set (high calorie sweet food) and second set (low calorie sweet food). There was a non-significant difference between 'wanting' values of two sets of stimuli, $t_{(18)} = -0.10$, $p > .05$. 'Wanting' values of high calorie sweet food ($M = 34.31$, $SE = 2.37$) was similar with low calorie sweet food ($M = 34.61$, $SE = 1.63$) (See Table 1).

2.2.3 Participant Evaluation Form and Informed Consent Form

A participant evaluation form with some questions that determining whether participants will participate or not was created for study (See Appendix A). The purpose of this form was to gain general information about physical and psychological health, eating habits, level of hunger and last smoking time of participants.

Below are some examples of questions:

- How do you define yourself in terms of your food preference?

  a.Vegetarian b. Vegan c. None

- When was the last time you ate?
- When was the last time you smoked?
- Have you ever been diagnosed with heart disease?
- Have you ever been diagnosed with diabetes?

Table1. Mean 'liking', 'wanting' and calorie values for sweet (high & low) and savoury (high & low) food stimuli (with 95% confidence interval).

Savoury Wanting	*High Calorie Stimuli*		*Low Calorie Stimuli*		*T-Value*	*Sig.*
Calorie	924.42 (M)	± 95.42 (SE)	413.77 (M)	± 72.34 (SE)	4.27	<.05
Liking	49.23 (M)	± 2.13 (SE)	47.46 (M)	± 2.05 (SE)	0.60	>.05
Wanting	29.39 (M)	± 1.68 (SE)	29.33 (M)	± 1.65 (SE)	0.03	>.05
Sweet Wanting	*High Calorie Stimuli*		*Low Calorie Stimuli*		*T-Value*	*Sig.*
Calorie	856.80 (M)	± 257.66 (SE)	239.17 (M)	± 39.80 (SE)	2.37	<.05
Liking	62.78 (M)	± 0.89 (SE)	61.10 (M)	± 1.79 (SE)	0.84	>.05
Wanting	36.18 (M)	± 1.24 (SE)	36.11 (M)	± 1.22 (SE)	0.04	>.05
Savoury Liking	*High Calorie Stimuli*		*Low Calorie Stimuli*		*T-Value*	*Sig.*
Calorie	621.27 (M)	± 81.33 (SE)	251.34 (M)	± 42.52 (SE)	4.03	<.05
Liking	45.91 (M)	± 3.26 (SE)	44.73 (M)	± 2.37 (SE)	0.29	>.05
Wanting	25.32 (M)	± 2.41 (SE)	27.81 (M)	± 2.38 (SE)	- 0.74	>.05
Sweet Liking	*High Calorie Stimuli*		*Low Calorie Stimuli*		*T-Value*	*Sig.*
Calorie	1368.99 (M)	± 424.99 (SE)	174.96 (M)	± 36.09 (SE)	2.80	<.05
Liking	56.23 (M)	± 2.34 (SE)	56.56 (M)	± 2.28 (SE)	- 0.10	>.05
Wanting	34.31 (M)	± 2.37 (SE)	34.61 (M)	± 1.63 (SE)	- 0.10	>.05

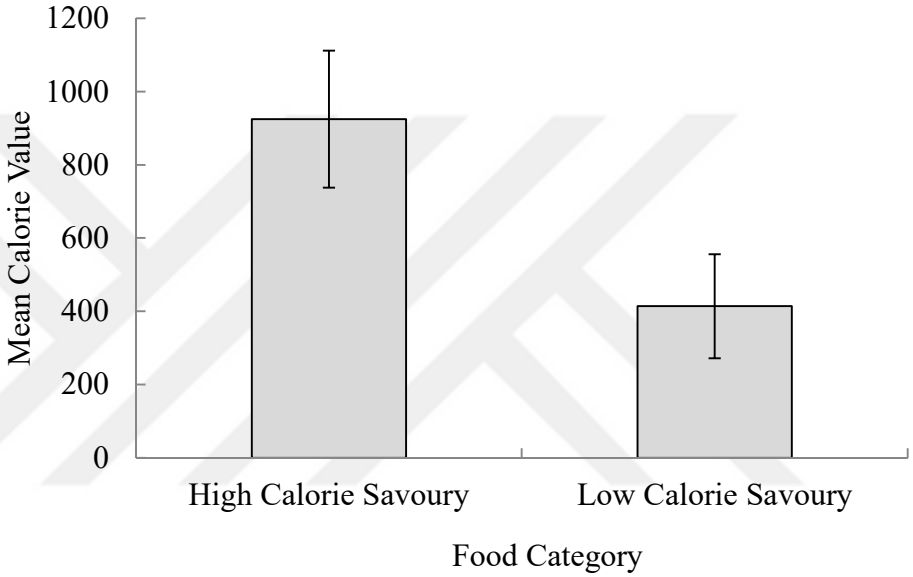

Figure 5. Mean calorie value of high calorie and low calorie savoury 'wanting' food stimuli (Error bars indicate standard error of mean with 95% confidence intervals).

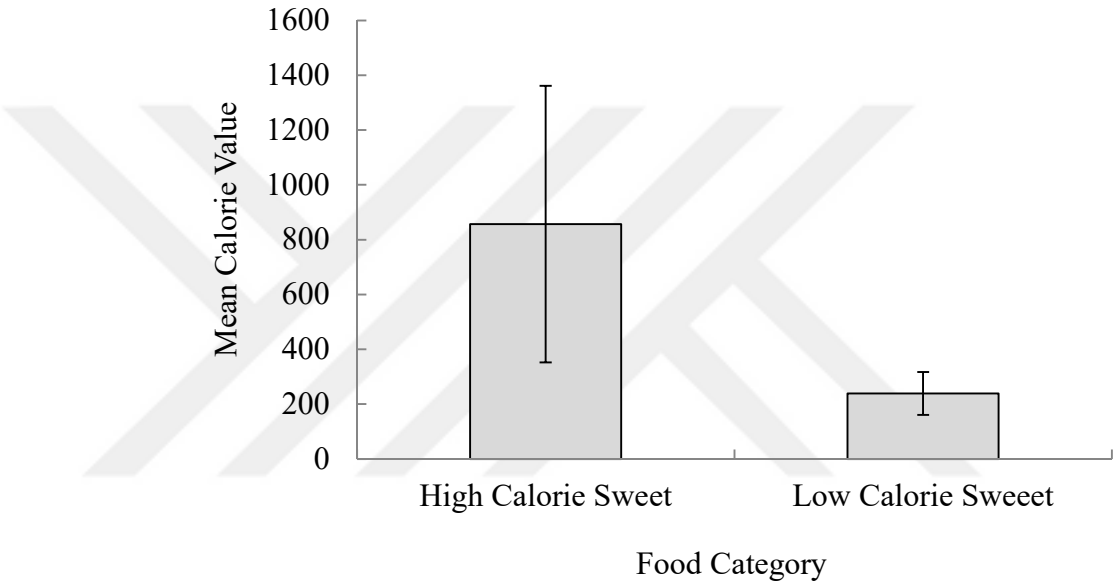

Figure 6. Mean calorie value of high calorie and low calorie sweet 'wanting' food stimuli (Error bars indicate standard error of mean with 95% confidence intervals).

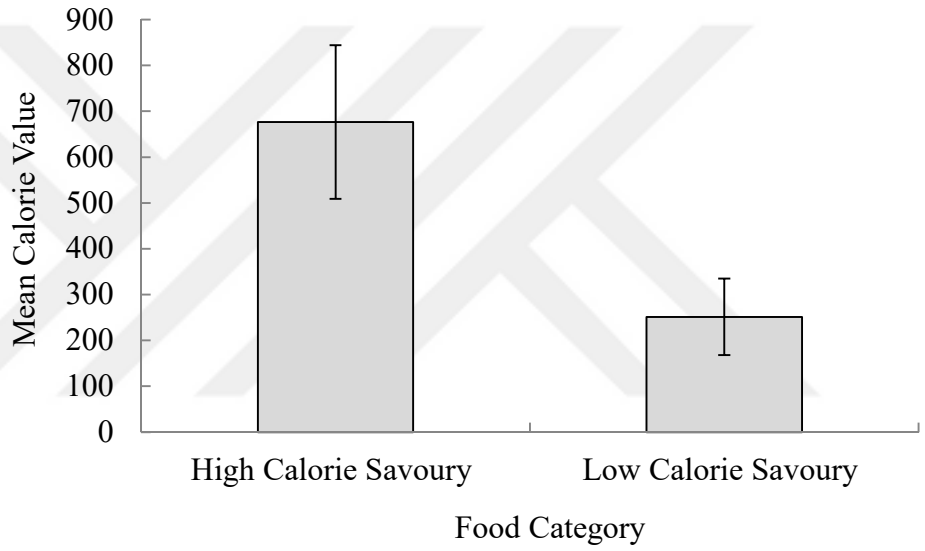

Figure 7. Mean calorie value of high calorie and low calorie savoury 'liking' food stimuli (Error bars indicate standard error of mean with 95% confidence intervals).

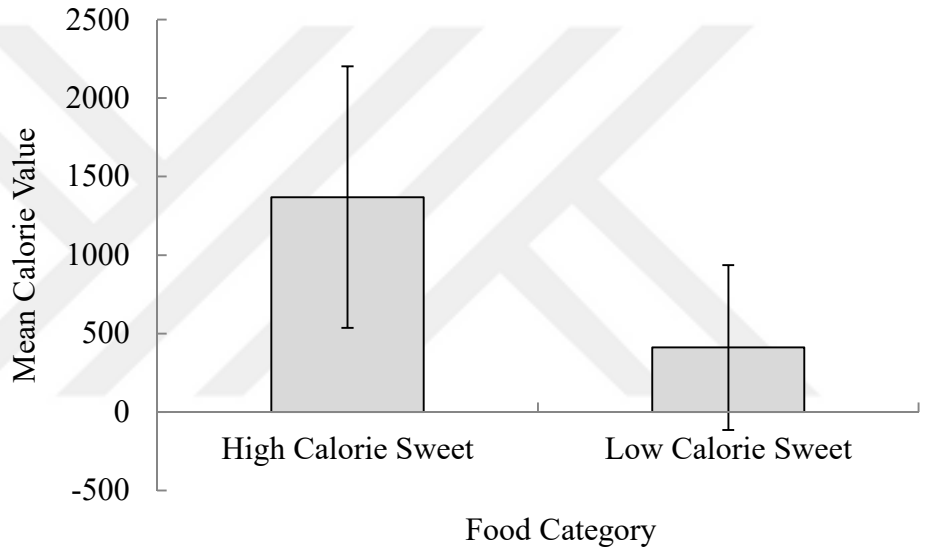

Figure 8. Mean calorie value of high calorie and low calorie sweet 'liking' food stimuli (Error bars indicate standard error of mean with 95% confidence intervals).

Two different informed consent forms were created to control (See Appendix B) and experimental group participants (See Appendix C). The form which is created for control group participants consists of information about the aim and the procedure of the actual study. However, experimental group participants did not informed about real aim of the study, they informed about presentation that needed to prepare in the study and other procedures. Both of the forms, includes explanations of the participants' rights.

2.3 Experimental Procedure

Experiment consists of two different ('wanting' and 'liking') sessions. When participants are taken to study, they were randomly assigned to either stress or non-stress condition. When participants set to their chairs facing the computer screen, their baseline heart rate measurement was taken for five minutes. Then, all the participants rated their stress level from zero (no stressful) to seven (extremely stressful). After this stage, participants filled an evaluation form and signed informed consent form. Stress manipulation was applied to stress group participants, whereas control group participants did not take any stress manipulation. After completion of these steps, participants were taken to main experiment. In the main experiment, some of the participants took 'wanting' session first and 'liking' session second. This order was counterbalanced between participants. During the experiment, heart rate measurement was taken from all the participants in both groups throughout the whole experiment. In the 'wanting' session, firstly, a general instruction about experiment was provided to the participants, and they have been thought how to choose between food images. Every trial consists of two different food images (high and low calorie) which are located on the left and right side of the screen and food images counterbalanced between participants. Every single trial lasted as long as 10.000 milliseconds and participants had to made choice within the specified time. If any response were not given by participants within the specified time, next trial was presented automatically. Each correct response (pressing 'm' or 'n' key) triggered the next trial and all trials were presented to participants in a random order. After completion of 'wanting' session, participants took another set of instruction about the 'liking' session. In the liking session, all of the trials include single food image, and all of them were given participants in a random order. A hedonic rating scale was presented beneath each food image, and participants needed to rate their 'liking'

level from one (dislike extremely) to nine (like extremely). Every single trial lasted as long as 10.000 milliseconds and participants needed to indicate their 'liking' response within the specified time. If they were not indicated their response within this time, next trial was given to the participants automatically so they did not see same trial again. Additional instructions were presented to the stress group between trials warning the participant of how much time left for their presentation. The aim of these instructions was to keep the stress levels high in the participants during the experimental session. Finally, at the end of the experimental session, a verbal stress report from zero to seven was collected from the participants. After participants completed all procedures, heart rate measurement was collected again from all participants.

2.3.1 Measurement of 'Wanting'

A forced choice methodology was used to assess incentive salience or 'wanting' for each food category. Twenty food stimulus pair that created from forty stimuli was given to the participants in a random order. Stimuli consist of sweet (*N*=20) and savoury (*N*=20) food images and also each sweet and savoury food images equally divided into high calorie and low calorie. Totally twenty trial was provided to the participants and each trial consist of one food stimulus pair, one was high calorie food stimulus and other was low calorie food stimulus but both of them has same 'wanting' value. A food stimulus from savoury high calorie food categories was paired with a stimulus from savoury low calorie food category in one trial (see Figure 9 A) and also a food stimulus from sweet high calorie food category was paired with a stimulus from sweet low calorie food category in one trial (see Figure 9 B).

All sixty two participants saw all of the forty food stimuli but randomly selected half of the participants saw high calorie food pictures on the right side while the other half saw high calorie pictures on the left side, this presentation order was counterbalanced between participants. The instruction 'would most like to eat now?' was provided before each stimulus pair to participant (See Figure 10). Inter trial interval duration between each trial was 1.500 milliseconds and a blank screen was presented to the participants between all trials. They made choice via key-press on the keyboard. They used "M" key to choose right side picture and "N" key to choose

left side picture. Each choice triggered the next food stimuli pair and all pairs stimulus pairs (*N*=20) have been presented.

2.3.2 Measurement of 'Liking'

The 9-point visual analogue scale was used to assess 'liking' (hedonic impact) of each food category. Two types of food categories that were savoury (*N*=20) and sweet food (*N*=20) which were also divided into further high and low calorie food categories as used liking stimuli (See Figure 11). Forty food stimuli were presented in a random order. The instruction 'Imagine you are eating this food, how much would you like it?' was provided to the participants before each stimulus. Inter trial interval duration between each trial was 1.500 milliseconds and a blank screen was presented to the participants between all trials. The 9-point visual analogue scale one (extreme dislike) to nine (extreme like) was given under beneath of the stimulus (See Figure 12). Participants rated each stimulus via key-press on the keyboard. Presentation order was counterbalanced between participants.

2.3.3 Physiological Measurement of Stress Response

Before stress manipulation, 62 participants were taken to experimental room and instructed to sit quietly on a chair five minutes. A pulse oximeter was attached to index finger of participants and heart rate measure was taken for five minutes as a baseline. Furthermore, heart rate measurement was taken from participants during experiment and during presentation (*Figure* 13).

Physiological data was measured by using a fingertip pulse oximeter (Contecmed, Model: Cms 50d +) and all the details about heart rate during measurement (increases and decreases in the heart rhythm) was recorded and mean heart rate was calculated by using SpO2 Review software. A representative result for a single subject outcome was shown in Appendix E.

2.3.4 Verbal Stress Report

Verbal stress report from one (no stressful) to seven (extremely stressful) was taken from all participants (See Appendix D). After participants in the control group signed informed consent form and filled participant evaluation form, an instruction,

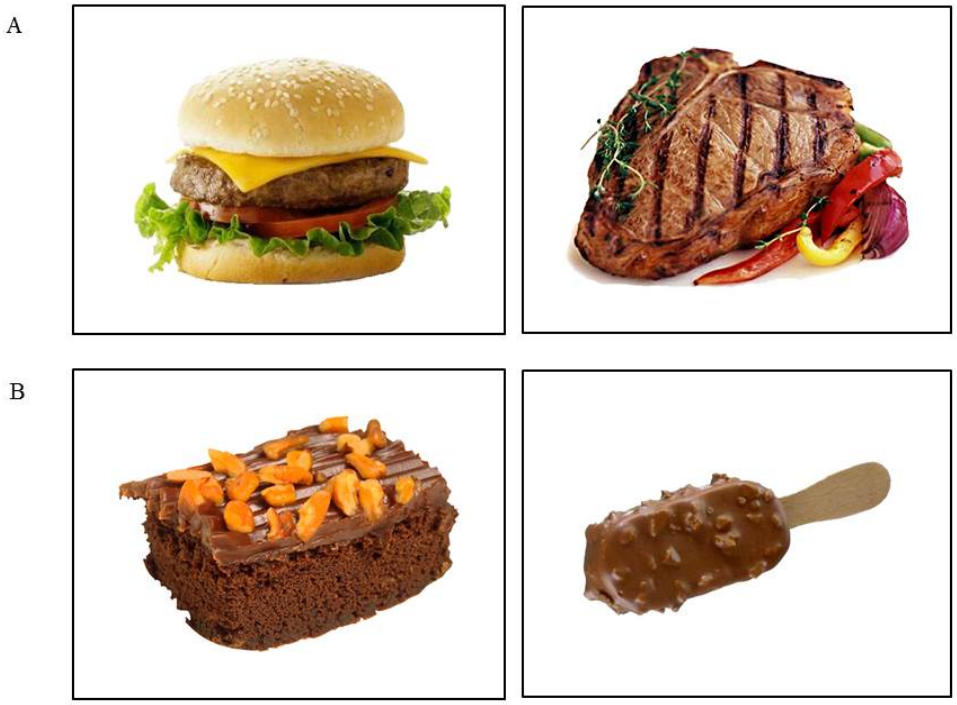

Figure 9. Examples of food pictures with same 'wanting' value. (A) savoury high and low calorie food pictures respectively from left to right (B) sweet high and low calorie food pictures respectively from left to right.

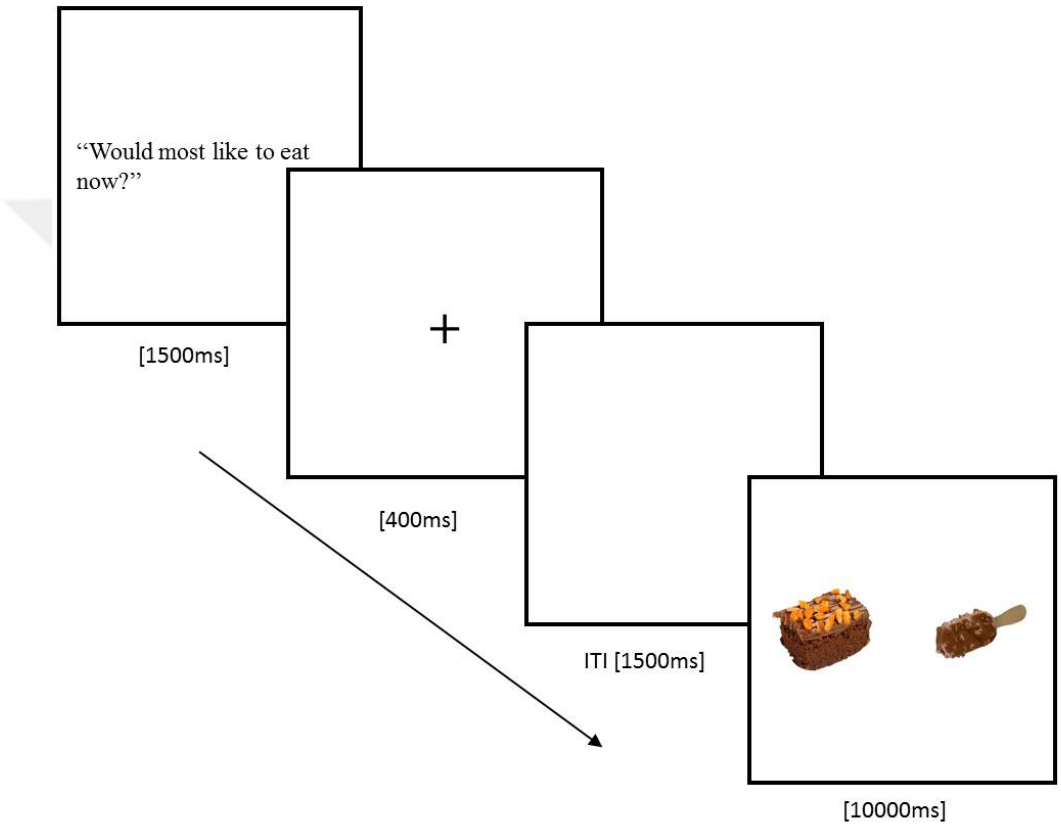

Figure 10. Representative screen displays of a single trial which participants needed to select which food they wanted. In this trial, high calorie food was shown in the right and low calorie food was shown in the left.

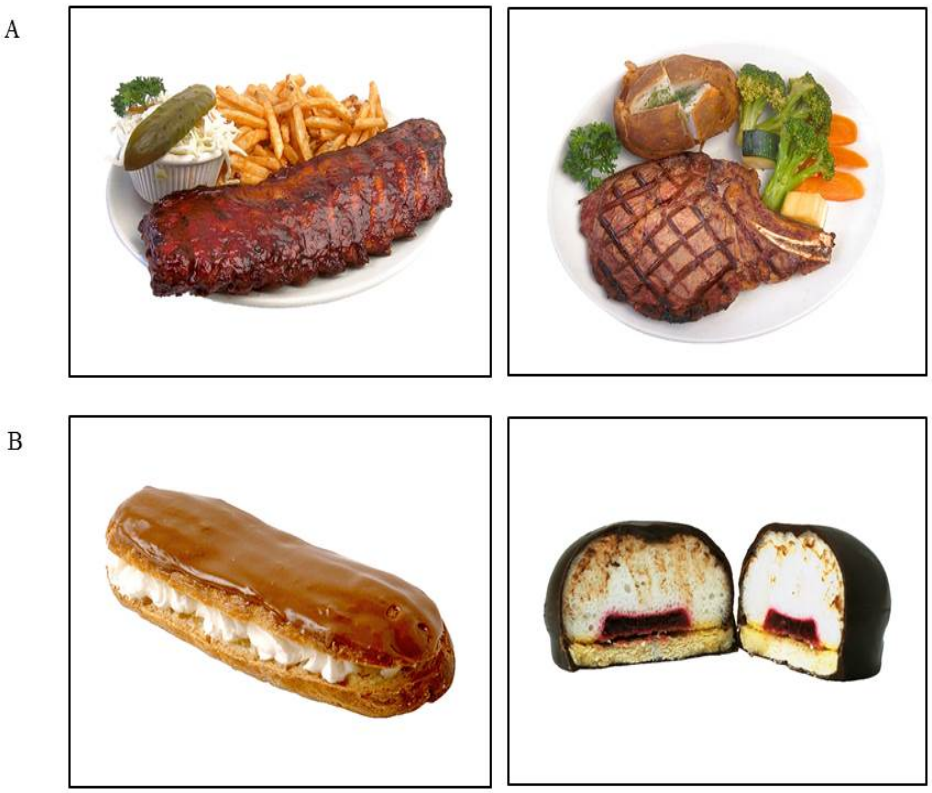

Figure 11. Examples of food pictures with similar 'liking' values. (A) savoury high and low calorie food pictures respectively from left to right (B) sweet high and low calorie food pictures respectively from left to right.

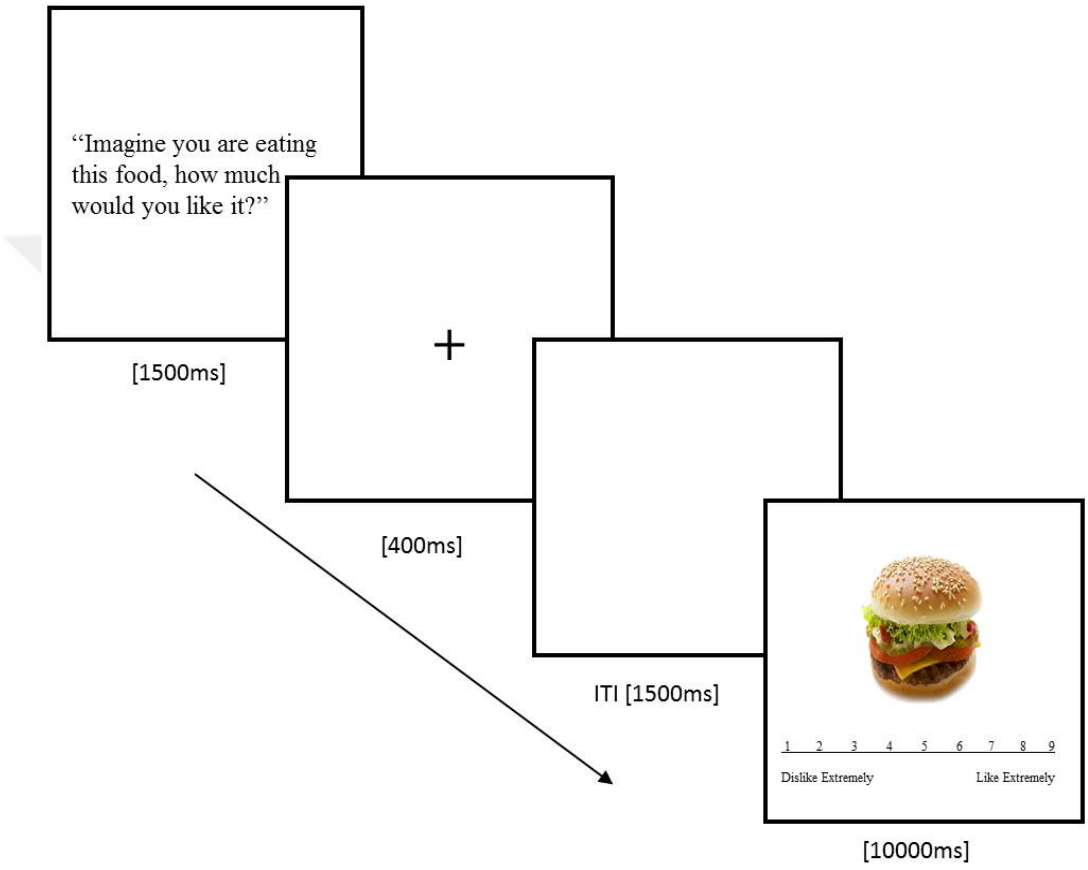

Figure 12. Representative screen displays of a single trial in which participants needed to rate of each food how much they like it on 9- point scale from zero (extremely dislike) to nine (extremely like).

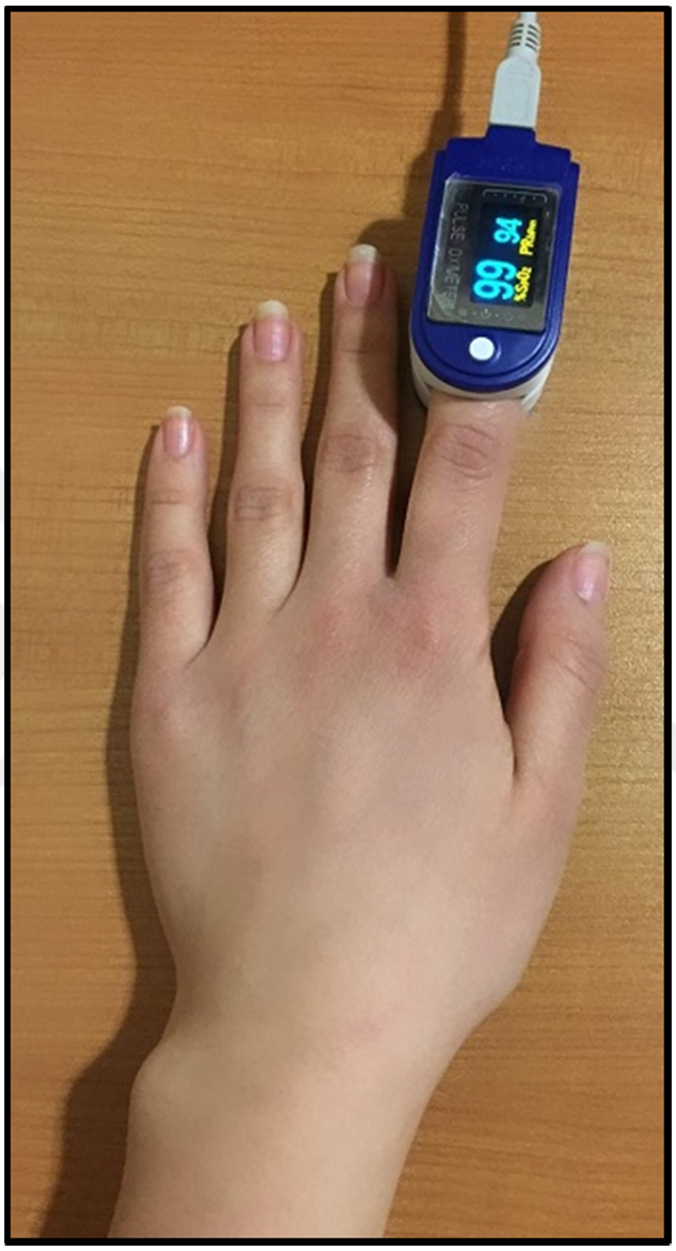

Figure 13. A pulse oximeter was attached to index finger to measure heart rate during baseline, experiment and presentation.

‘’how much do you feel stressful at the moment? Please rate yourself from zero to seven’’ was provided. However, same instruction was provided to stress group participants before given before informed consent form and after stress manipulation. The reason of taking stress report before reading informed consent form was preventing to participants any information about stress manipulation. Because any information about stress manipulation could be effect participants stress ratings’.

2.3.5 Stress Manipulation for Experiment

For the experiment, sixty two participants were randomly assigned to the stress or control condition. Thirty three of them assigned to control condition and twenty nine of them assigned to stress condition randomly. All of the participants were taken to experimental room and instructed to sit quietly and comfortably. Any information about experiment and presentation was not provided to participants before baseline manipulation. Five minute heart rate measurement was taken from all participants.

After baseline measurement, verbal stress report from one (no stressful) to seven (extremely stressful) was taken from participants and then asked to participants fill participant evaluation form and sign to informed consent form. Stress group participants were taken to room which contained a camera, monitor, and voice recorder. Stress group participants were then instructed to prepare five minutes oral presentation about a topic from psychology and given ten minute preparation period. Topic of the presentation determined from perception and pattern recognition chapter from a cognitive psychology book randomly. By using the following instruction, they warned about making a good presentation.

> ‘’The purpose of this study is to evaluate a presentation about a topic in psychology in terms of quality, content and presentation style. You will make 5 minutes presentation about this topic during the study process. The topic of the presentation will be determined by the researcher. Please try to prepare an oral presentation as organized as possible because your presentation will be recorded and your presentation style, quality and content of speech will be evaluated and scored by a panel of psychologists. You have ten minutes preparation time than i will come back for recording.’’

This method has been used and found affective, mild stressor with no deleterious effect (Morokoff et al., 1987; Rozanski et al., 1988, Scheufele et al., 2000). After ten minutes, researcher came back and instructed to participant about real experiment verbally. Before starting the experiment, pulse oximeter was attached to non-dominant hand of the participants and heart rate measurement was taken until experiment finished. Also same verbal stress report was taken from participants again. After finishing experiment, pulse oximeter was started again and participants were leaved alone in the experimental room with video camera and voice recorder. They presented their topics for five minutes and they were watched by experimenter from camera. After five minutes, experimenter turned back room to extract pulse oximeter and to close voice recorder. For each participant, mean heart rate during baseline, experiment and presentation was compared (See Appendix E)

A different instruction is provided to control group participants. After baseline measurement, these participants filled participant evaluation form and signed informed consent form. Verbal stress report from one to nine was taken from participants. Before starting of experimental session, participants of the control group rested for ten minutes reading neutral magazine (National Geographic). After the ten minutes resting period, the experimenter returned to the room and verbally informed participants about experiment process. Before starting experiment same verbal stress report was taken from participants. Later, they were invited to sit in front of the computer and the pulse oximeter was reattached. Heart rate measurement was taken during experiment and after experiment for five minutes. They did not made presentation but we wanted to see mean heart rate of the participants after experiment. These three mean heart rate (during baseline, during experiment and after experiment) was compared.

CHAPTER 3: RESULTS

In this chapter, firstly, in order to see whether there was any difference between mean heart of non-stress group participants and stress group participants during baseline, during experiment and after experiment, 2 (Condition: stress, non-stress) x 3 (Time: baseline, during experiment, after experiment) mixed design ANOVA was conducted. Additionally, in order to see whether there was any difference between mean verbal stress of control group participants and experimental group participants before and after experiment, 2 (Condition: stress, non-stress) x 2 (Time: before experiment, after experiment) mixed design ANOVA was conducted. Secondly, in order to see whether there was any effect of stress and gender on high calorie food choice or 'wanting', 2 (Condition: stress, non-stress) x 2 (Gender: male, female) x 2 (Food Category: sweet high calorie, savoury high calorie) mixed design ANOVA was conducted in order to see whether there was any effect of stress and gender on low calorie food choice, 2 (Condition: stress and non-stress) x 2 (Gender: male and female) x 2 (Food Category: sweet low calorie, savoury low calorie) mixed design ANOVA was conducted. Thirdly, in order to see whether there was any effect of stress and gender on 'liking' of sweet (high calorie and low calorie) and savoury (high calorie and low calorie) food , 2 (Condition: stress, non-stress) x 2 (Gender: male, female) x 2(Calorie: high calorie, low calorie) x 2 (Taste: sweet, savoury) mixed design ANOVA was conducted. In addition, in order to see whether there was any significant difference of participants' reaction time for different types of food, 2 (Condition: stress and non-stress) x 2 (Taste: sweet and savoury) x 2 (Calorie: high and low) x 2 (Gender: male and female) mixed design ANOVA was conducted.

3.1 Physiological Results

3.1.1 Comparison of Stress vs. Non-stress Group

In order to see whether there was any difference between mean heart rate of non-stress group participants and stress group participants during baseline, during

experiment and after experiment, 2 (Condition: stress, non-stress) x 3 (Time: baseline, during experiment, after experiment) mixed design ANOVA was conducted. Results of the analysis revealed that there was a significant main effect of condition, $F_{(1, 60)} = 11.78$, $p < .05$, $\eta_p^2 = .16$. Mean heart rate of stress group participants ($M = 93.09$, $SE = 1.89$) was higher than mean heart rate of non-stress group participants ($M = 84.21$, $SE = 1.77$) (Figure 14). Additionally, results of the analysis showed that there was a significant main effect of time, $F_{(2, 120)} = 5.44$, $p < .001$, $\eta_p^2 = .08$. Contrast revealed that mean heart rate of participants during experiment ($M = 88.63$, $SE = 1.40$) was significantly higher than during baseline measurement ($M = 86.21$, $SE = 1.62$), $F_{(1, 60)} = 4.21$, $p < .05$, $r = .26$, and mean heart rate of participants after experiment ($M = 91.10$, SE = 1.63) was significantly higher than during baseline measurement ($M = 86.21$, $SE = 1.62$), $F_{(1, 60)} = 7.39$, $p < .05$, $r = .33$ (Figure 15). Furthermore, condition and time interaction effect was significant, $F_{(2, 120)} = 10.80$, $p < .001$, partial $\eta_p^2 = .15$. The interaction graph showed that in the baseline measurement, mean heart rate of the stress group participants ($M = 87.29$, $SE = 2.36$) was not significantly different from mean heart rate of the control group participants ($M = 85.14$, $SE = 2.21$). However, during experiment, mean heart rate of the stress group participants ($M = 92.91$, $SE = 2.04$) was significantly higher than mean heart rate of the control group participants ($M = 84.34$, $SE = 1.92$). Furthermore, after experiment, mean heart rate of the stress group participants (during presentation) ($M = 99.06$, $SE = 2.38$) was significantly higher than mean heart rate of the control group participants ($M = 83.14$, $SE = 2.23$) (Figure 16). Simple effect analysis showed that in the baseline condition, there was no significant difference between mean heart rate of stress group and non-stress group participants, $F_{(1, 60)} = .44$, $p > .05$. On the other hand, during experiment, there was a significant difference between mean heart rate of stress and non-stress group participants, $F_{(1, 60)} = 9.37$, $p < .05$, $r = .37$ and after experiment, there was a significant difference between mean heart rate of stress and non-stress group participants, $F_{(1, 60)} = 23.92$, $p < .05$, $r = .53$.

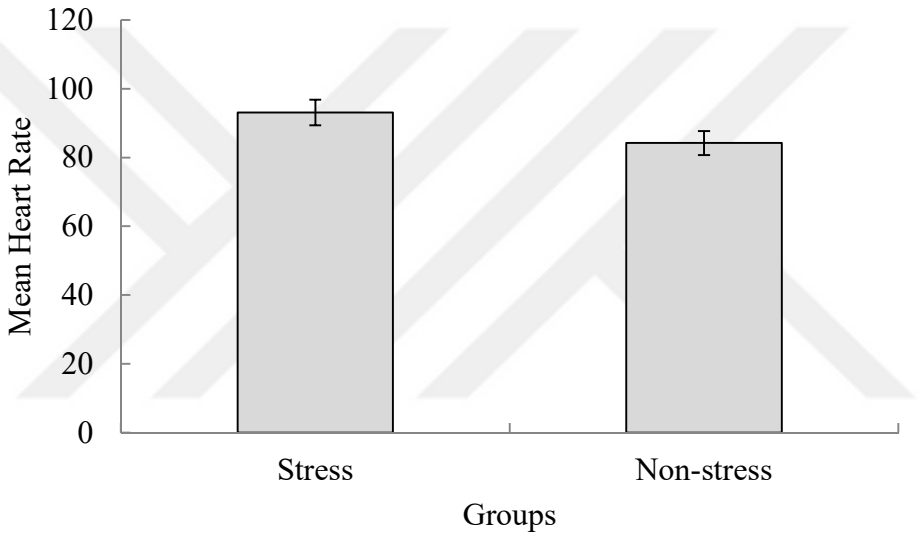

Figure 14. Mean heart rate of the stress and non-stress group participants (Error bars indicate standard error of mean with 95% confidence intervals).

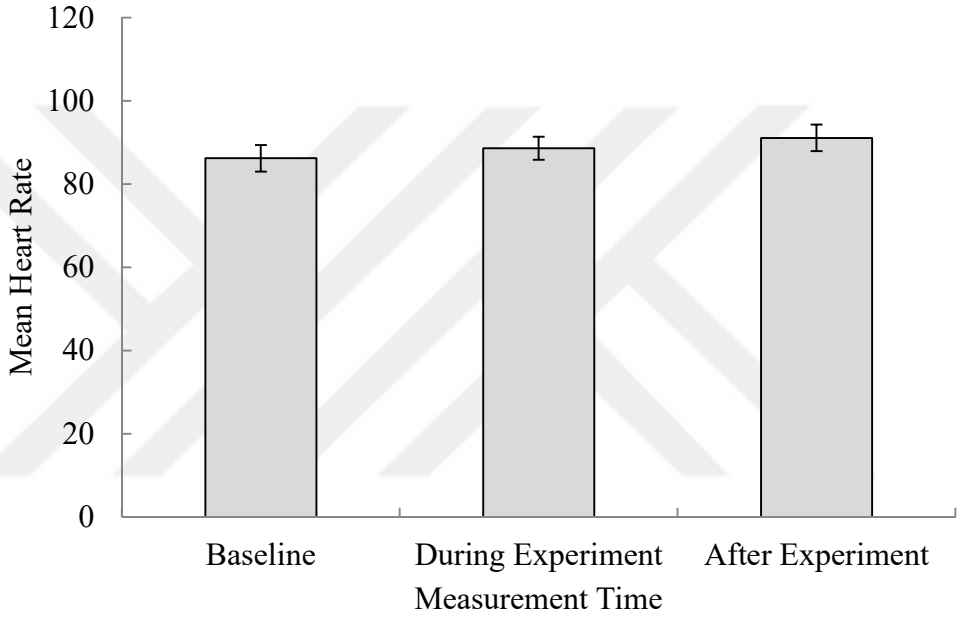

Figure 15. Mean heart rate of the participants during baseline, during experiment and after experiment (Error bars indicate standard error of mean with 95% confidence intervals).

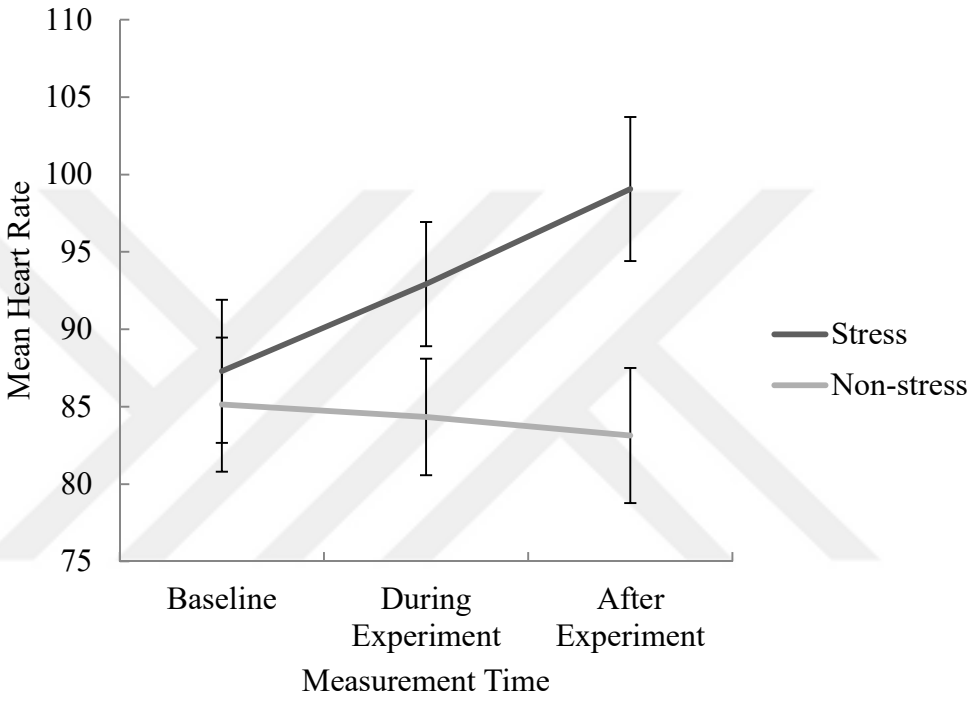

Figure 16. Mean heart rate of the participants during baseline, during experiment and after experiment in the stress and non-stress condition (Error bars indicate standard error of mean with 95% confidence intervals).

3.2. Verbal Stress Report Results

3.2.1 Comparison of Stress vs. Non-stress Group

In order to see whether there was any difference between mean verbal stress of control group participants and experimental group participants before and after experiment, 2 (Condition: stress, non-stress) x 2 (Time: before experiment, after experiment) mixed design ANOVA was conducted. Result of the analysis revealed that there was a significant main effect of condition, $F_{(1, 60)} = 469.17$, $p < .001$, $\eta_p^2 = .20$. Mean verbal stress report of the stress group participants ($M = 4.00$, $SE = .23$) was higher than mean verbal stress report of the non-stress group participants ($M = 2.77$, $SE = .21$) (Figure 17). Furthermore, there was a significant main effect of time, $F_{(1, 60)} = 32.59$, $p < .001$, $\eta_p^2 = .35$. Mean verbal stress report of the participants before experiment ($M = 2.85$, $SE = .19$) was lower than mean verbal stress report of the participants after experiment ($M = 3.93$, $SE = .18$) (Figure 18). Additionally, there was significant interaction effect between condition and time, $F_{(1, 60)} = 27.33$, $p < .001$, $\eta_p^2 = .31$. Before experiment, mean verbal stress report of the stress group participants ($M = 2.97$, $SE = .28$) was not significantly different from mean verbal stress report of the control group participants ($M = 2.73$, $SE = .26$). However, after experiment mean verbal stress report of the stress group participants ($M = 5.03$, $SE = .26$) was significantly higher than mean verbal stress report of the control group participants ($M = 2.82$, $SE = .24$) (Figure 19). Simple effect analysis indicated that there was no significant difference before the experiment between two groups, $F_{(1, 60)} = .40$, $p > .05$, but the stress group participants showed significant increase in their stress levels after the manipulation $F_{(1, 60)} = 39.26$, $p < .001$, $r = 63$.

3.3 Comparison of 'Wanting' for Sweet and Savoury Food Reward

We wanted to see the effects of stress on 'wanting' of high calorie sweet, high calorie savoury, low calorie sweet and low calorie savoury food. Actually, we wanted to compare the means with each other and tried to conduct 2 (Condition: stress and non-stress) x 2 (Taste: sweet and savoury) x 2 (Calorie Choice: high calorie and low calorie) mixed design ANOVA. Unfortunately, this design was not possible because of 'wanting' scores are consist of percent values. For example, if percent high calorie sweet food choice value is 60 for a participant, percent low

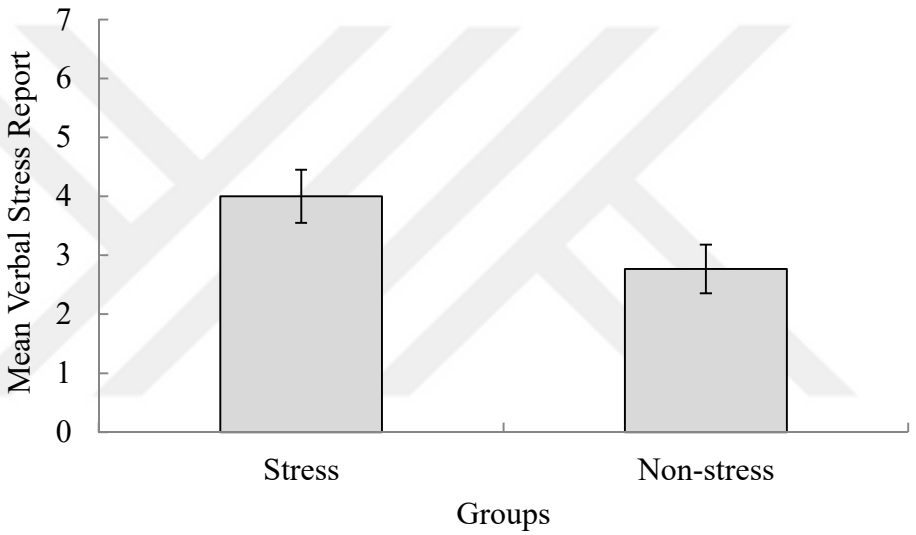

Figure 17. Mean verbal stress report of the stress and non-stress group participants (Error bars indicate standard error of mean with 95% confidence intervals).

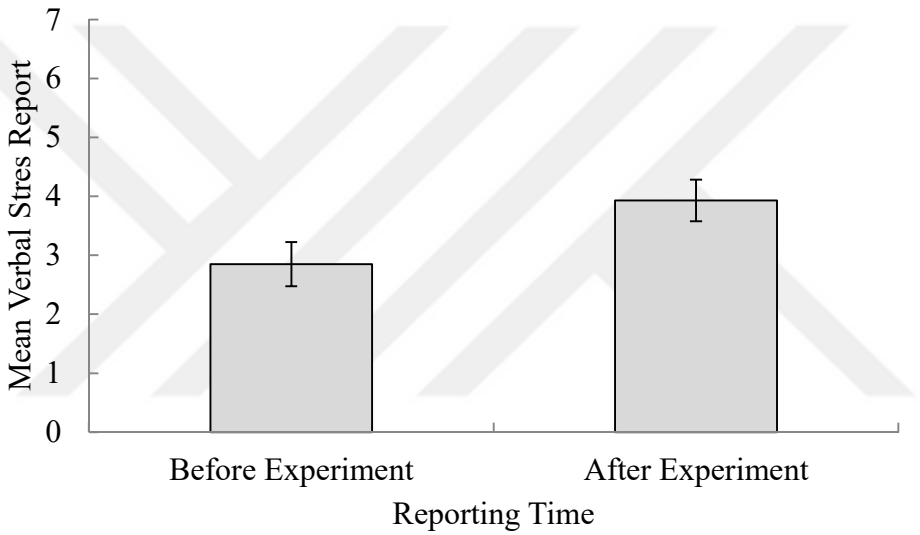

Figure 18. Mean verbal stress report of the participants before and after experiment (Error bars indicate standard error of mean with 95% confidence intervals).

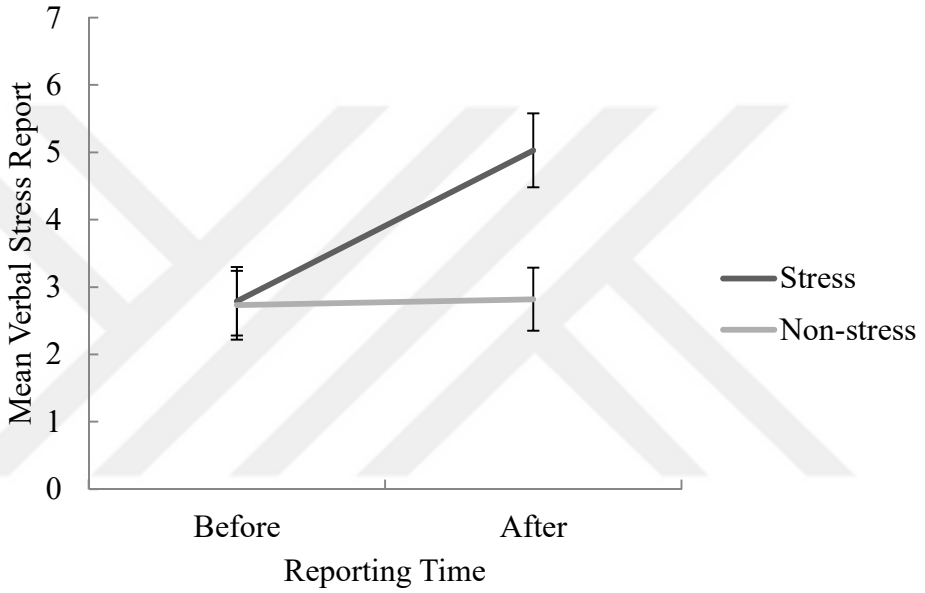

Figure 19. Mean verbal stress report of the stress and non-stress group participants before and after experiment (Error bars indicate standard error of mean with 95% confidence intervals).

calorie sweet food choice value should be 40 and sum of the two values gives 100. As shown in the Table 2, sum of the mean percent high calorie sweet food choice (M = .61) and mean low calorie sweet food choice (M = .39) gives 1. Because of this reason, independence assumption of measurement was violated and we had to analyze high calorie food choice (for sweet and savoury food category) and low calorie food choice (for sweet and savoury food category) separately.

In order to see whether there was any effect of stress and gender on high calorie food choice or 'wanting', 2 (Condition: stress, non-stress) x 2 (Gender: male, female) x 2 (Food Category: sweet high calorie, savoury high calorie) mixed design ANOVA was conducted and also in order to see whether there was any effect of stress and gender on low calorie food choice, 2 (Condition: stress and non-stress) x 2 (Gender: male and female) x 2 (Food Category: sweet low calorie, savoury low calorie) mixed design ANOVA was conducted.

Results indicated that there was a significant main effect of food category, $F_{(1, 58)} = 36.18$, $p < .001$, $\eta_p^2 = .38$. Percent high calorie sweet food choice was higher than percent high calorie savoury food choice independent from stress. In contrast, percent low calorie savoury food choice was higher than percent low calorie sweet food choice independent from stress (See Table 2 & Figure 20). However, there was a non-significant main effect of condition (stress vs. non-stress), $F_{(1, 58)} = 1.23$, $p > .05$ and there was a non-significant main effect of gender, $F_{(1, 58)} = .05$, $p > .05$. On the other hand, condition and food category interaction effect was significant, $F_{(1, 58)} = 4.59$, $p < .05$, $\eta_p^2 = .07$. Percent high calorie sweet food choice in the stress group was higher than percent high calorie sweet food choice in the non-stress group, whereas percent high calorie savoury food choice in non-stress group was not significantly different from percent high calorie savoury food choice in the stress group (See Table 2, Figure 21). Differently, percent low calorie sweet food choice in non-stress group was higher than percent low calorie sweet food choice in stress group, whereas percent low calorie savoury food choice in stress group was not significantly different from percent low calorie savoury food choice in non-stress group (See Table 2, Figure 22). Results of the simple effect analysis showed that there was a significant difference between percent high calorie sweet food choice in the stress and non-stress condition and also there was a significant difference between percent low calorie sweet food choice in the stress and non-stress condition,

$F_{(1, 60)} = 5.38$, $p < .05$, $r = .29$. On the other hand, there was no significant difference between percent high calorie savoury food choice in the stress and non-stress condition and also there was no significant difference between percent low calorie savoury food choice in the stress and non-stress condition, $F_{(1, 60)} = .28$, $p > .05$. Additionally, food category and gender interaction effect was not significant, $F_{(1, 58)} = .33$, $p > .05$ and also food category, condition and gender interaction effect was not significant, $F_{(1, 58)} = .15$, $p > .05$.

Table 2. *Mean high and low calorie 'wanting' values*

		High Calorie		Low Calorie	
Stress	Sweet	0.61 (M)	0.03 (SE)	0.39 (M)	0.03 (SE)
	Savoury	0.43 (M)	0.03 (SE)	0.57 (M)	0.03 (SE)
Non-stress	Sweet	0.53 (M)	0.02 (SE)	0.47 (M)	0.02 (SE)
	Savoury	0.45 (M)	0.02 (SE)	0.56 (M)	0.02 (SE)

3.4 Comparison of 'Liking' for Sweet and Savoury Food Reward

In order to see whether there was any effect of stress and gender on 'liking' of sweet (high calorie and low calorie) and savoury (high calorie and low calorie) food, 2 (Condition: stress, non-stress) x 2 (Gender: male, female) x 2 (Calorie: high calorie, low calorie) x 2 (Taste: sweet, savoury) mixed design ANOVA was conducted. Results of the analysis revealed that there was a significant main effect of calorie (high calorie or low calorie), $F_{(1, 58)} = 15.88$, $p < .001$, $\eta_p^2 = .22$. Mean 'liking' value of high calorie food ($M = 5.56$, $SE = .17$) was higher than low calorie food ($M = 5.18$, $SE = .14$) (Figure 23). However, main effect of taste (savoury or sweet) was not significant, $F_{(1, 58)} = .81$, $p > .05$, main effect of condition (stress or

Figure 20. Percent high and low calorie (sweet, savoury) food choice (Error bars indicate standard error of mean with 95% confidence intervals).

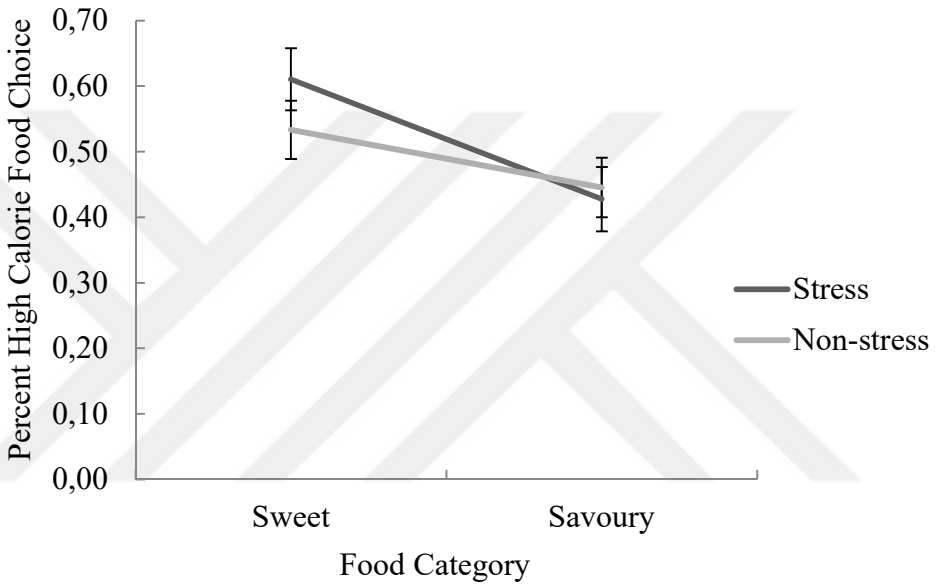

Figure 21. Percent high calorie food choice for high calorie sweet food and high calorie savoury food in stress and non-stress condition (Error bars indicate standard error of mean with 95% confidence intervals).

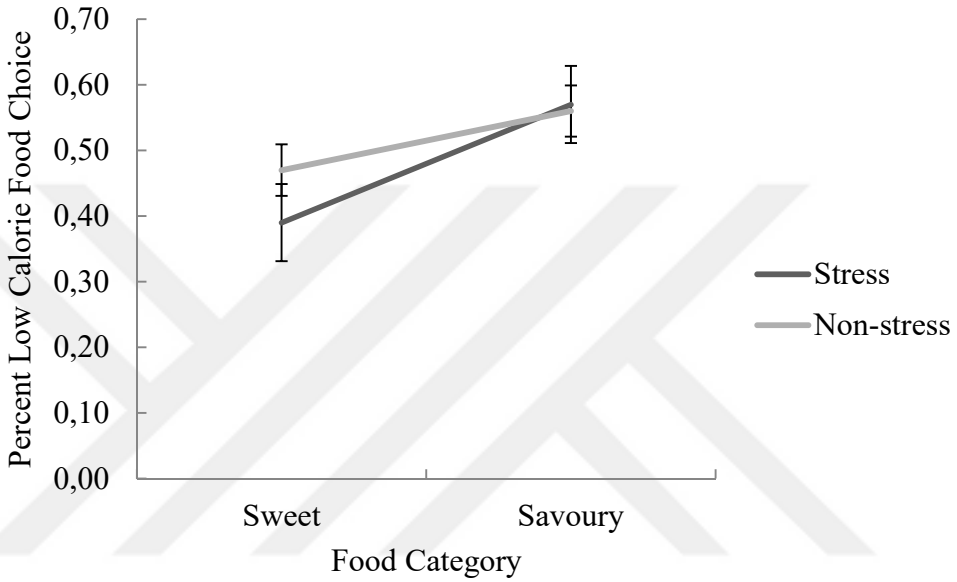

Figure 22. Percent low calorie sweet food choice and low calorie savoury food choice in stress and non-stress conditions (Error bars indicate standard error of mean with 95% confidence intervals).

non-stress) was not significant, $F_{(1, 58)} = .41$, $p > .05$ and main effect of gender was not significant, $F_{(1, 58)} = .24$, $p > .05$. On the other hand, taste and calorie interaction effect was significant, $F_{(1, 58)} = 11.26$, $p < .05$, $\eta_p^2 = .16$. Mean 'liking' value of savoury high calorie food ($M = 5.58$, $SE = .19$) was greater than savoury low calorie food ($M = 4.94$, $SE = .17$) but mean 'liking' value of sweet high calorie food ($M = 5.54$, $SE = .22$) was not significantly different from sweet low calorie food ($M = 5.42$, $SE = .21$) (Figure 24). As a follow up analysis, a paired sample t-test was conducted and p value was corrected with Bonferonni correction. Results of the analysis indicated that there was a significant difference between mean 'liking' value of high calorie savoury food and low calorie savoury food, $t_{(61)} = 5.08$, $p < .025$, $r = .28$ but there was no significant difference between mean 'liking' value of high calorie sweet food and low calorie sweet food, $t_{(61)} = 1.29$, $p > .025$. Additionally, taste and condition interaction effect was not significant $F_{(1, 58)} = .21$, $p > .05$, calorie and condition interaction effect was not significant, $F_{(1, 58)} = .02$, $p > .05$ and also calorie and gender interaction effect was not significant, $F_{(1, 58)} = 1.29$, $p > .05$. On the other hand, there was a significant interaction effect between taste and gender, $F_{(1, 58)} = 7.43$, $p < .05$, $\eta_p^2 = .11$. Mean 'liking' ratings of male participants for savoury food ($M = 5.66$, $SE = .25$) was greater than mean 'liking' ratings of female participants ($M = 4.86$, $SE = .21$). In contrast, mean 'liking' ratings of female participants for sweet food ($M = 5.73$, $SE = .27$) was not significantly different from mean 'liking' ratings of male participants, ($M = 5.22$, $SE = .32$) (Figure 25). Results of the simple effect analysis showed that there was significant difference between mean 'liking' ratings of males and females for savoury food, $F_{(1, 58)} = 5.91$, $p < .05$, $r = .30$, whereas mean 'liking' ratings of males and females for sweet food was not significantly different, $F_{(1, 58)} = 1.45$, $p > .05$. Furthermore, taste, calorie and condition interaction effect was not significant, $F_{(1, 58)} = .73$, $p > .05$ and there was a non-significant interaction effect between taste, calorie and gender, $F_{(1, 58)} = 1.10$, $p > .05$ and also there was a non-significant interaction effect between taste, condition and gender, $F_{(1, 58)} = .004$, $p > .05$. Lastly, there was a non-significant interaction effect between calorie, taste, condition and gender, $F_{(1, 58)} = .18$, $p > .05$.

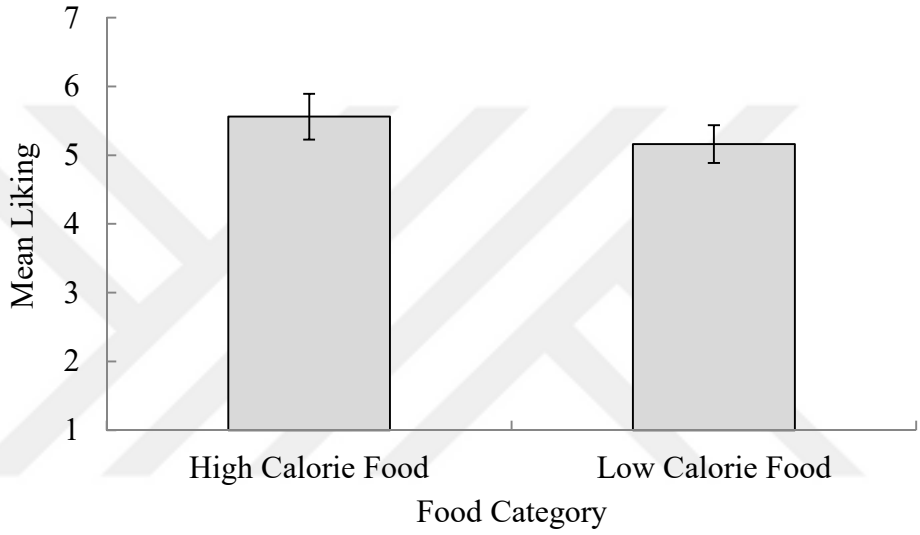

Figure 23. Mean 'liking' of high calorie food and low calorie food (Error bars indicate standard error of mean with 95% confidence intervals).

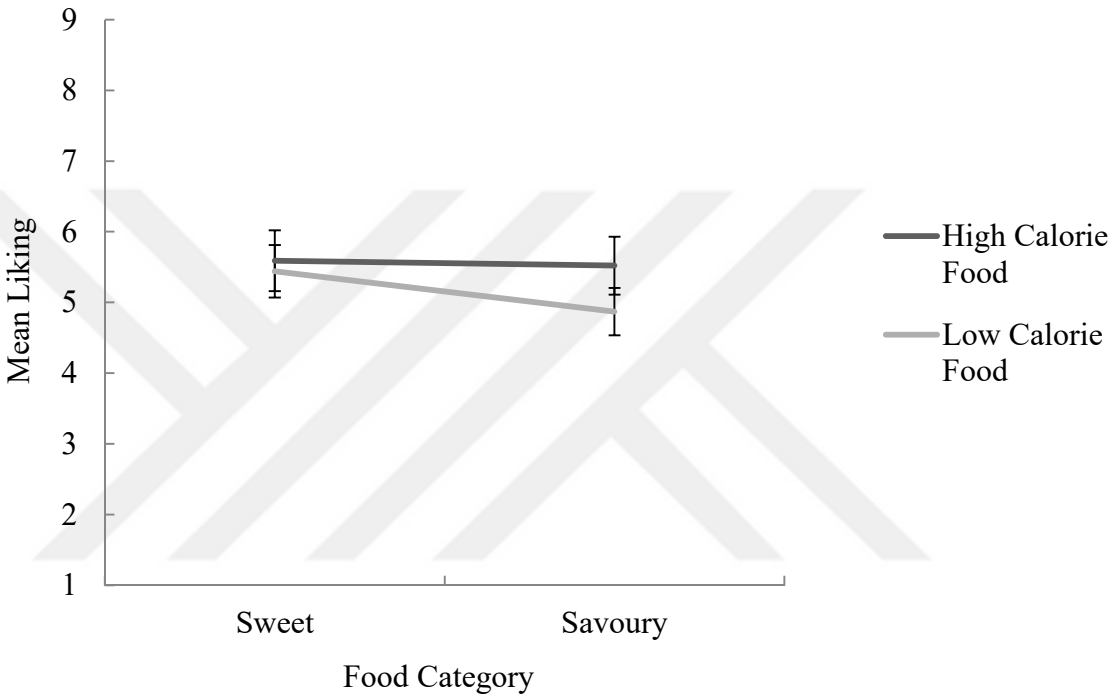

Figure 24. Mean 'liking' of high calorie sweet, low calorie sweet, high calorie savoury and low calorie savoury food (Error bars indicate standard error of mean with 95% confidence intervals).

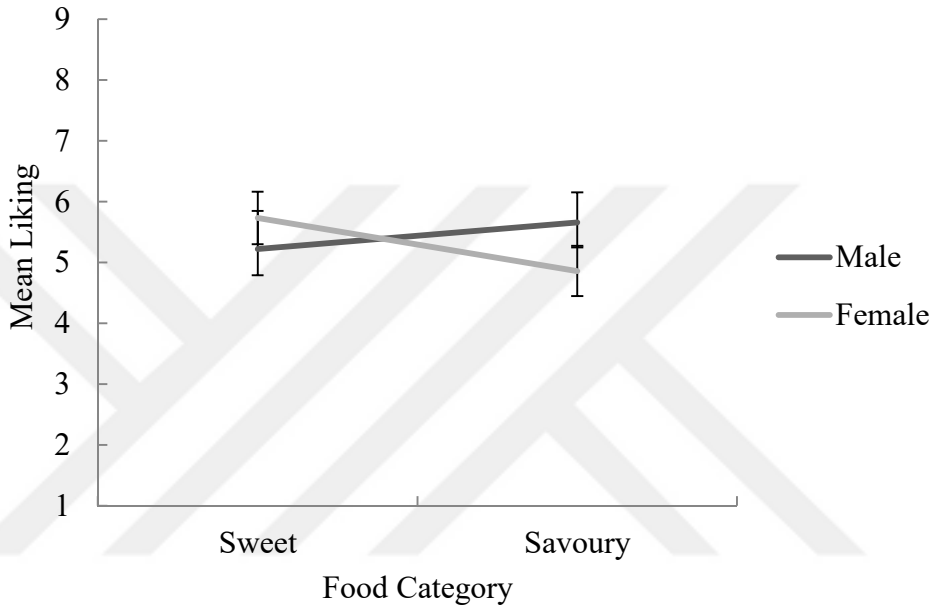

Figure 25. Mean 'liking' of sweet and savoury food for male and female participants (Error bars indicate standard error of mean with 95% confidence intervals).

3.5 Reaction Time for 'Wanting'

In order to see whether there was any significant difference of stress and non-stress group participants' reaction time for different types of food, we conducted 2 (Condition: stress and non-stress) x 2 (Taste: sweet and savoury) x 2 (Calorie: high and low) x 2 (Gender: male and female) mixed design ANOVA. Results of the analysis showed that there was a significant main effect of taste (sweet and savoury) for reaction time, $F_{(1, 58)} = 34.89$, $p < .001$, $\eta_p^2 = .38$. Reaction time of participants for sweet foods ($M = 2044.72$, $SE = 68.29$) was faster than savoury foods ($M = 2537.33$, $SE = 121.87$) (Figure 26). Moreover, main effect of calorie for reaction time was significant, $F_{(1, 58)} = 6.59$, $p < .05$, $\eta_p^2 = .10$. Reaction time of participants for low calorie food ($M = 2189.38$, $SE = 78.96$) was faster than high calorie food ($M = 2392.67$, $SE = 113.75$) (Figure 27). However, there was a non-significant main effect of condition, $F_{(1, 58)} = 1.94$, $p > .05$ and there was a non-significant main effect of gender, $F_{(1, 58)} = .11$, $p > .05$. On the other hand, interaction effect of calorie and gender for reaction time was statistically significant, $F_{(1, 58)} = 4.56$, $p < .05$, $\eta_p^2 = .07$. Reaction time of female participants for high calorie food ($M = 2279.10$, $SE = 147.20$) was faster than reaction time of male participants ($M = 2506.24$, $SE = 173.45$). However, mean reaction time of males for low calorie food ($M = 2133.82$, $SE = 120.40$) was not different from mean reaction time of female participants ($M = 2244.94$, $SE = 102.18$) (Figure 28). As a follow up analysis a paired sample t-test was conducted and p value was corrected with Bonferonni correction. Before conducting paired sample t-test, the data was split in male and female, and then mean of the reaction time of each participant for high calorie and low calorie food was calculated. Results of the analysis showed that reaction time of male participants for high and low calorie food choice was significantly different, $t_{(25)} = 2.51$, $p < .025$, $r = .30$. Mean reaction time of male participants for high calorie food choice ($M = 2522.98$, $SE = 200.91$) was slower than mean reaction time for low calorie food choice ($M = 2141.84$, $SE = 98.13$). However, mean reaction time of female participants for high ($M = 2285.79$, $SE = 127.89$) and low ($M = 2248.05$, $SE = 112.22$) calorie food choice was not significantly different, $t_{(35)} = .49$, $p > .025$.

On the other hand, there was a non-significant interaction effect between taste and condition, $F_{(1, 58)} = 1.37$, $p > .05$ and there was a non-significant interaction effect between taste and gender, $F_{(1, 58)} = 1.14$, $p > .05$ and also taste and calorie

interaction effect was not statistically significant, $F_{(1, 58)} = 3.66$, $p > .05$. Furthermore, there was a non-significant interaction effect between condition and calorie, $F_{(1, 58)} = 1.26$, $p > .05$ and taste, condition and gender interaction effect did not reach statistical significance, $F_{(1, 58)} = .42$, $p > .05$. In addition to these results, calorie, condition and gender interaction effect was not significant, $F_{(1, 58)} = .10$, $p > .05$ and taste, calorie and condition interaction effect was not significant, $F_{(1, 58)} = .74$, $p > .05$ and also taste, calorie and gender interaction effect was not significant, $F_{(1, 58)} = 1.35$, $p > .05$. Lastly, taste, calorie, condition and gender interaction effect was not statistically significant, $F_{(1, 58)} = .01$, $p > .05$.

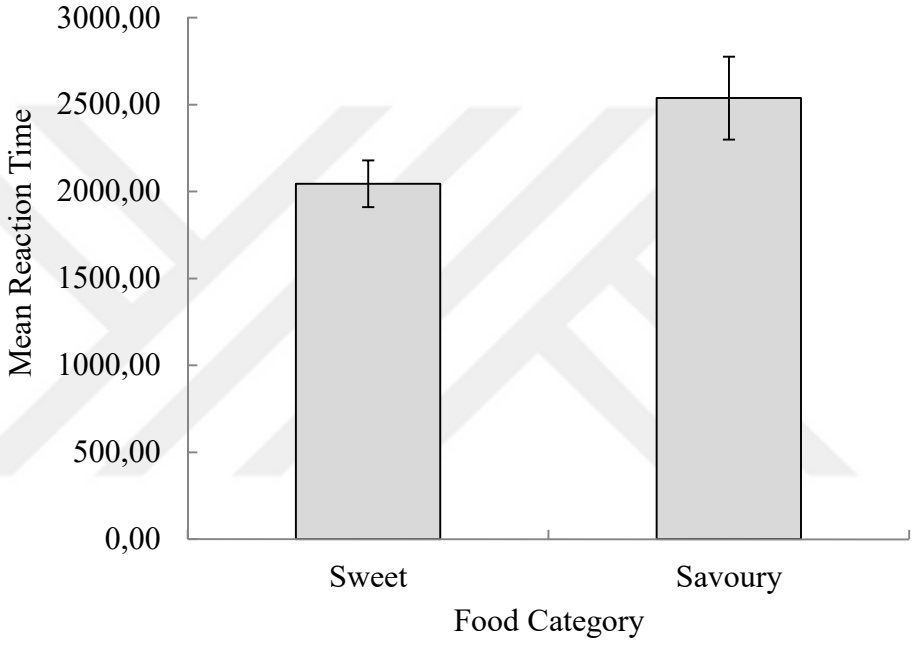

Figure 26. Mean reaction time for sweet and savoury food (Error bars indicate standard error of mean with 95% confidence intervals).

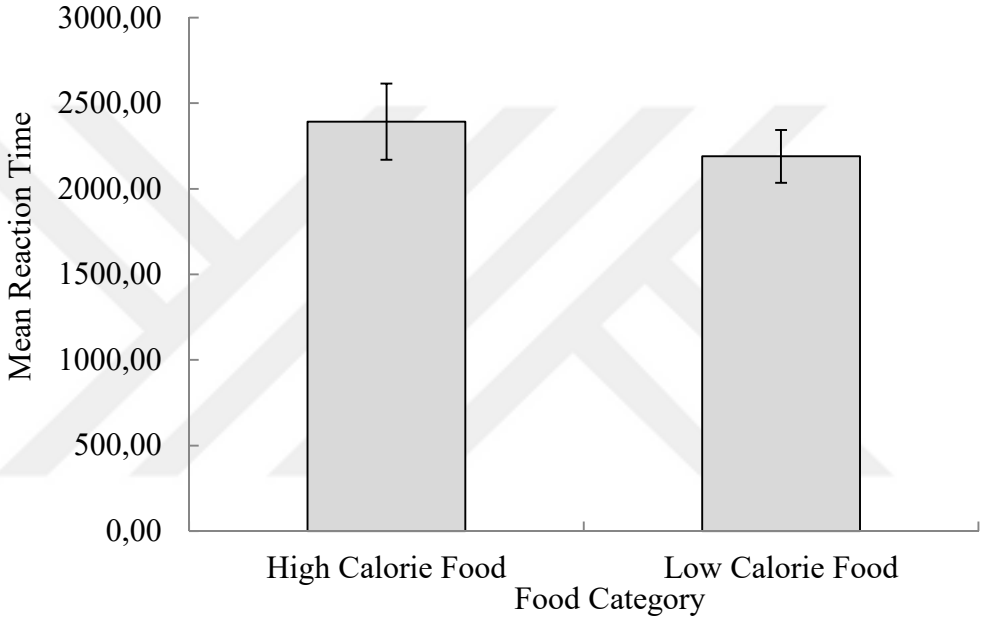

Figure 27. Mean reaction time for high and low calorie food (Error bars indicate standard error of mean with 95% confidence intervals).

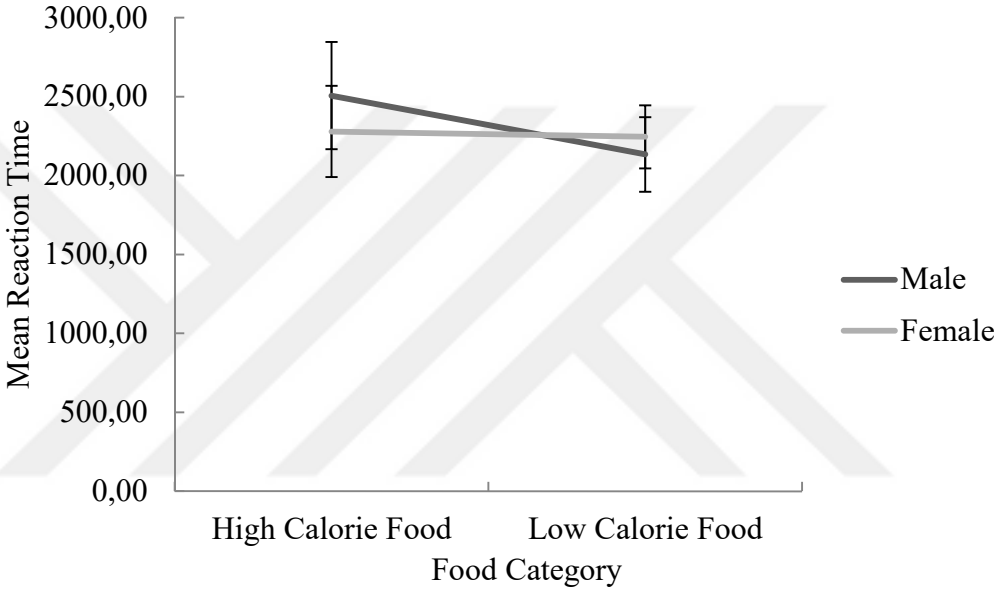

Figure 28. Mean reaction time for high and low calorie food based on gender (Error bars indicate standard error of mean with 95% confidence intervals).

CHAPTER 4: DISCUSSION

Previous studies have revealed that the reward system consist of two different components, 'liking' and 'wanting'. These two components of reward system are generally correlated but can be distinguished under certain circumstances. Based on incentive salience theory, we aimed to show that' wanting' for sweet and savoury reward can be differ under stress condition in humans. On the other hand, we expected that 'liking' ratings for sweet and savoury rewards may not change depending on stress and non-stress condition. For this purpose, we used equally liked food pictures which are differ in high vs. low calorie and equally wanted food pictures which are differ in high vs. low calorie.

In the present study, in humans, 'liking' and 'wanting' were measured by using the method which is devised by Finlayson et al. (2007). In this method, forced choice methodology was used to asses 'wanting' and visual analogue scale was used to asses 'liking'. Incentive salience theory was demonstrated that 'wanting' component of reward is a motivational process. Motivation involves pushing drive and there is an impulse directed to external target. Forced choice method is an appropriate method to measure 'wanting', because preference for choosing one stimulus or one food category over another is required to have motivational directedness toward a stimulus.

According to Zhang et al. (2009), appropriate stimulus guides behavior by integration of current physiological state (appetite or satiety state, stress state etc.) and previously learned cues. When organism encountered with a cue, incentive salience is dynamically computed based on previously learned association between a reward cue and reward, physiological state of organism. Finlayson et al. (2007) used hungry and satiety to change physiological state of organism in their experiment. In

contrast, we administered same method in the stress and stress free condition. In other words, we used stress to change physiological state of organism.

Contrary to animal studies, instead of manipulating brain activity, we used more ecological way to create stress in humans. Reward system can be activated by behavioral manipulation instead of direct manipulation of the brain (Pool et al., 2015). Pool et al. (2015) used cold pressure test (Schwabe et al., 2008) to create stress in participants and they measured cortisol level of participants after stress manipulation. In the present study, a different behavioral manipulation was used to create stress. Stress system can be activated by powerful stressors such as public speaking or being judged by people. These situations can perceived as a threat for social self in humans (Dickerson & Kemeny, 2004). This method has been used and found affective, mild stressor with no deleterious effect (Morokoff et al., 1987; Rozanski et al., 1988, Scheufele P. M., 2000). As an alternative way to measure the cortisol to show stress level of participants, we measured heart rate of the participants. Heart rate measurement is a suitable way to demonstrate the presence of stress in humans because the sympathoadrenal system (SAM) is activated during stressful event. When SAM activated, heart rate and blood pressure increase and adrenal gland release epinephrine and norepinephrine (Weiner, 1992). These methods can be used mild stressor in humans and create temporary physiological changes in human body. Future studies should examine 'wanting' and 'liking' within the scope of chronic stress in daily life.

Physiological results showed that mean heart rate of participants in baseline condition was lower than during experiment. This means that before any stress manipulation, participants did not show any physiological changes but after stress manipulation, a physiological change has occurred. Actually, we wanted to see this physiological change or increasing heart rate throughout experiment. Moreover, we expected that after experiment this physiological change should be increase because participants will have to face with stressor so significant increase of heart rate occurred during presentation. Before and after stress manipulation, we also obtained verbal stress reports from participants. Consistent with the physiological measures, mean verbal stress report of the participants after stress manipulation was higher than verbal stress report before stress manipulation. In the stress free condition, we did not find any significant changes of the physiological state and the verbal stress report of

the participants before and after the experiment. In other words, mean heart rate of the participants in the baseline condition was similar during experiment and did not change after the experiment ended. Consistent with the physiological measures, mean verbal stress report of the participants before experiment did not change after experiment ended.

Finlayson et al. (2007) showed that in the hungry state, participants wanted high fat savoury food more than high fat sweet food whereas, wanting of participants for low fat savoury and low fat sweet did not changed. In the satiated state, however participants wanted low fat sweet food more than low fat savoury food, and wanting of participants for high fat sweet higher than high fat savoury food. They showed that 'wanting' can be differ for same high and low fat food in two different condition.

In our study, we demonstrated that, participants wanted high calorie sweet food more than high calorie savoury food in two conditions. When we considered interaction effects, we can conclude that participants in the stress group wanted high calorie sweet food more than participants in the non-stress group. On the other hand, savoury food choice or 'wanting' between the stress and non-stress group participants did not change significantly.

Our findings supports the idea that sweets and chocolates are more preferred under stress, whereas meal type foods such as fruits, vegetable, fish and meats are less preferred under stress (Oliver & Wardle, 1998). These findings are consistent with the findings of Epel et al (2001). They showed that, participants who have high cortisol level consumed significantly more high fat sweet food than participants who have low cortisol level. Zellner et al. (2006) showed that the stress group female participants consumed more unhealthy sweet high calorie food than did the non-stress group participants. The interesting point in their study was that, there was no difference of savoury food choice in the stress and non-stress group. Participants in both groups consumed same amount of savoury foods. Total amount of savoury foods that consumed was significantly less than total amount of sweet foods that consumed in both group. They have concluded that participants choose sweet food more than savoury because there was a limited time to consume food and they preferred sweet foods to savoury. However, in our study, participants have equal time to for choosing sweet and savoury foods even so they prefer sweet high calorie

foods more than savoury. In another study by Epel et al. (2001), participants who have high cortisol level consumed significantly more high fat sweet food than participants who have low cortisol level.

Other finding of the current study was that percent low calorie savoury food choice was higher than percent low calorie sweet food choice in both groups. When we considered interaction effect, participants in the non-stress group wanted low calorie sweet food more than participants in the stress group. However, participants in the stress group wanted low calorie savoury food more than participants in the non-stress group. One contradictory findings to the results showed that participants who have high cortisol level (increased stress levels) consumed significantly less salty food, specifically low fat salty food, than participants who have low cortisol level (Epel et al., 2001). These results are not consistent with our results because low calorie savoury food more preferred by stress group participants. Already, Epel et al. (2001) did not expect these results and they suggested that these findings may have arisen by chance and should be interpreted carefully.

Results from hedonic ratings of food, showed that participants liked high calorie food more than low calorie food. Savoury high calorie food liked more than savoury low calorie food and sweet high calorie food liked more than sweet low calorie food. However, when stress factor taken into account, there were no significant differences of 'liking' ratings of stress group and non-stress group participants. The current study is consistent with literature; mean 'liking' values for sweet and savoury did not change in the stress or non-stress condition. These results support the incentive salience theory which suggested that 'liking' component of reward is different from 'wanting' component and 'wanting' can be increased without any change of hedonic value of reward ''liking'' depending on the organism's physiological state (Berridge & Robinson, 1998, 2003). Our findings are also consistent with the findings of Pool et al. (2015). They suggested that in humans, stress selectively increases cue-triggered wanting, independently of the hedonic properties of the reward. They showed that participants in the stress-condition mobilized more effort than stress-free condition to obtain reward but they did not report reward as being more pleasurable.

These results also disprove the aversive state reduction hypothesis (Robbins & Fray, 1980; as cited in Pool et al., 2015) which is a mechanical explanation for stress induced eating. If people prefer highly palatable food, when they feel stressed because of the consumption of these food decrease aversive feeling caused by stress, mean 'liking' value for high calorie food should have increased in the stress condition. However, hedonic 'liking' of participants did not change in two groups.

Lemmens et al. (2011) showed that in overweight participants, 'wanting' for snack foods and desserts increased after stress manipulation whereas normal weight participants did not increased their 'wanting' for food in both conditions (stress and non-stress). On the other hand, 'liking' for the same rewards was not affected from stress manipulation and was not changed for two groups. In our study, stress and non-stress group participants did not differ in their mean body mass index (BMI) scores. In other words, there was no weight difference between the groups. Therefore the difference in 'wanting' between stress and non-stress condition cannot explained by the group differences in BMI scores.

One possible reason for the difference between 'wanting' ratings of high calorie sweet and high calorie savoury food might be due to our stimulus set because mean 'wanting' value of high calorie sweet food was higher than mean 'wanting' of high calorie savoury in the database that we have taken (See Table 1). However, in the database, 'wanting' ratings for low calorie sweet food was higher than low calorie savoury food in database but our results showed that stress group participants wanted low calorie savoury food more than low calorie sweet food. Therefore this difference cannot be explained by the differences in wanting score between savoury and sweet stimulus set. One possible explanation might be related to the general effect of sweet rewards that indicate only high calorie sweets higher (Oliver & Wardle, 1998; Zellner et al., 2006; Rutters et al., 2009).

Previous studies showed that stress increased high calorie and high sugar snack food intake on female participants (Grunberg & Straub, 1992; Zellner et al. 2006; O'Connor et al. 2008). Based on the previous studies, we expected that 'liking' and 'wanting' response of female participants for high calorie sweet and savoury reward will be high compared male participants. However, we did not find any gender difference on high and low calorie sweet and savoury food choice ('wanting')

where males and females did not differ in their choice preferences. On the other hand, taste and gender interaction effect was significant; males and females differ in their 'liking' for sweet and savoury rewards. Males liked savoury food more than females, whereas female participants liked sweet food more than males. Our findings are consistent with the finding of Stone and Brownell (1994). Stress did not effect of 'liking' and 'wanting' for sweet and savoury food of males and females differently.

In the future, we are planning to conduct the same experiment with participants who have eating disorders. Based on the literature, these results might differ for example in the obese population (Lemmens et al., 2011). Also, in the current study we conducted all the experimental procedures while the participants were in a hungry state, in the future we would like to see whether these results differ in the satiated state. Furthermore, we are also planning to conduct the same experiment with erotic visual stimuli. Chumbley et al. (2014) showed that participants who have high level of cortisol exerted more effort to see female pictures than male pictures. However they did not measure 'liking' response of participants so future studies should examine that how 'liking' response change for erotic stimuli. Also, it would be nice to measure stress rates of participants with a more direct measure that is cortisol level of each individual (Epel et al., 2001, 2004, 2007; Tomiyama et al., 2011; Chumbley et al., 2014; Pool et al., 2015). It will also be interesting to see the differences between the individuals 'wanting' and 'liking' references in their brain. One study that used functional magnetic resonance imaging (fMRI) imaging showed that during reward anticipation, striatal and amygdala activation increased, but during reward consumption, striatal activation decreased (Kumar et al., 2014). This means that stress enhances motivation 'wanting' during anticipatory phase, whereas minimize reward responsiveness 'liking' (Kumar et al., 2014). It would be nice to see that how these mechanism effected by high and low calorie food reward 'wanting' and 'liking'. Additionally, in the current study we could not be able to compare the performance of those participants who are smokers and non-smokers. Previous studies suggested that smoking might influence incentive salience of rewards. In the future studies, we are planning to compare 'wanting' and 'liking' preferences between smokers and non-smokers. Finally, and probably the most important weakness of the current study is that all of the liking reactions are measure by liking scale where participants imagined how much they would have

liked it if they have actually consumed it, but in real life when there is actual consumption of food reward occurs the results might be different. Therefore, in the future rather than using visual food stimuli we are planning to replicate a similar experiment with real food stimulus where participants have chance to actually consume it.

In summary, the current study showed that motivation to obtain a reward or 'wanting' can be changed for high and low calorie sweet foods with stress manipulation, however we found no significant change in preference for the savoury food choice. Also consistent with the literature, we found no meaningful difference in 'liking' for both sweet and savoury foods.

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Appendix A

"Participant Evaluation Form" given to participants before experimental session.

KATILIMCI BİLGİ FORMU

AD-SOYAD: TELEFON NUMARASI:

CİNSİYET: e-MAIL:

YAŞ: OKUL:

MESLEK:

Aşağıdaki soruları yanıtlarken size en uygun olan numarayı yuvarlak içine alınız.

(0= hiç aç değil, 7= çok aç)

1. Şu anda kendinizi ne kadar aç hissediyorsunuz?

   0 -----1 -----2 -----3 -----4 -----5 -----6 -----7

Aşağıdaki soruları yanıtlarken size en uygun olan harfi yuvarlak içine alınız.

1. Beslenme tercihiniz bakımından kendinizi nasıl tanımlarsınız?

   a. Vejetaryen b. Vegan c. Hiçbiri

Aşağıdaki soruları yanıtlarken lütfen durumunuzu en iyi yansıtan seçeneği işaretleyiniz.

1. Yakın zamanda (son 1 sene dahil) başka bir psikoloji deneyine katıldınız mı?

   ○ Evet ○ Hayır

   Yanıtınız "Evet" ise 2.sorudan, "Hayır" ise 3. sorudan devam ediniz.

2. Hangi deneye katıldınız?

   ……
   ……

3. Herhangi ciddi bir görme bozukluğunuz var mı?

   ○ Evet ○ Hayır

4. Herhangi bir psikolojik rahatsızlık geçmişiniz var mı?

   ○ Evet ○ Hayır

   Yanıtınız "Evet" ise 5. sorudan, "Hayır" ise 7. sorudan devam ediniz.

5. Bir ruh sağlığı çalışanı tarafından rahatsızlığınıza konulan tanı nedir?

   ……
   ……

6. Rahatsızlığınız ile ilgili kullandığınız ilaç(lar) var mı?

   ○ Evet,……isimli ilaç(lar)ı kullandım/kullanmaktayım.

   ○ Hayır

7. Herhangi bir nörolojik hastalık geçmişiniz var mı?

   ○ Evet ○ Hayır

   Yanıtınız "Evet" ise 8. sorudan, "Hayır" ise 10. sorudan devam ediniz.

8. Bir uzman tarafından hastalığınıza konulan tanı nedir?

   ……
   ……

9. Hastalığınız ile ilgili kullandığınız ilaç(lar) var mı?

   ○ Evet,……isimli

ilaç(lar)ı kullandım/kullanmaktayım.

○ Hayır

10. Daha önce kafa travması geçirdiniz mi?

○ Evet ○ Hayır

11. Düzenli olarak kullandığınız ilaç(lar) var mı?

○ Evet ○ Hayır

Yanıtınız "Evet" ise 12. sorudan, "Hayır" ise 13. sorudan devam ediniz.

12. Lütfen kullandığınız ilaç(lar)ı ve ilaç(lar)ın kullanım amaçlarını belirtiniz.

İlaç(lar):……..……..…….…

Kullanım amacı:…….……..……

13. Herhangi bir kalp rahatsızlığı tanısı aldınız mı?

○ Evet ○ Hayır

Yanıtınız "Evet" ise 14. sorudan, "Hayır" ise 15. sorudan devam ediniz.

14. Size konulan tanıyı belirtiniz.

15. ……

… Hiç yemediğiniz bir yemek türü var mı?

○ Evet ○ Hayır

Yanıtınız "Evet" ise 16.sorudan, "Hayır" ise 17. sorudan devam ediniz.

16. Bu yemek türünü belirtiniz?

……

17. Çok sevdiğiniz bir yemek türü var mı?

○ Evet ○ Hayır

Yanıtınız "Evet" ise 18.sorudan, "Hayır" ise 19. sorudan devam ediniz.

18. Bu yemek türünü belirtiniz?

……

19. En son ne zaman yemek yediniz?

…… saat önce.

20. Dün akşam kaç saat uyudunuz?

○5 saatten az ○6-8 saat ○8 saatten fazla

21. Şeker hastalığınız (Diyabetiniz) var mı?

○ Evet ○ Hayır

22. Sigara kullanıyor musunuz?

○ Evet ○ Hayır ○ Bazen

Yanıtınız “Evet” ise 23.sorudan devam ediniz.

23. En son ne zaman sigara içtiniz?

…….saat / dakika / gün önce (size uygun zaman dilimini yuvarlak içine alınız).

Appendix B

"Participant Information Form" given to control (non-stress) group participants before experimental session.

KATILIMCI BİLGİLENDİRME FORMU

Bu çalışmanın amacı, farklı kategorilerde sunulacak olan yiyeceklerin tüketilmesine olan isteğin ve tüketildikten sonra hissedilen beğenme durumunun değerlendirilmesidir. Çalışma süresince ekranda bir takım yiyecek resimleri sunulacaktır. Bunlar tatlı ve iştah açıcı yiyeceklerden oluşmaktadır.

Çalışma kapsamında katılımcılardan elde edilen veriler isim kullanılmaksızın analizlere dahil edilecektir. Katılımınız araştırma hipotezinin test edilmesi ve yukarıda açıklanan amaçlar doğrultusunda literatüre sağlayacağı katkılar bakımından oldukça önemlidir. Ayrıca katılımınızın psikoloji alanın gelişmesi açısından da bir takım faydaları bulunmaktadır.

Çalışmaya katılmanız tamamen kendi isteğinize bağlıdır. Katılımı reddetme ya da çalışma sürecinde herhangi bir zaman diliminde devam etmeme hakkına sahipsiniz. Eğer görüşme esnasında katılımınıza ilişkin herhangi bir sorunuz olursa, araştırmacıyla iletişime geçebilirsiniz.

Okudum, kabul ediyorum

Appendix C

"Participant Information Form" given to experimental (stress) group participants before first experimental session.

KATILIMCI BİLGİLENDİRME FORMU

Bu çalışmanın amacı, psikoloji alanındaki bir konuyla ilgili yapacağınız bir sunumun, kalite, içerik ve sunum tarzı bakımından değerlendirilmesidir. Çalışma sürecinde, sizden bu konuyla ilgili 5 dakikalık bir sunum yapmanız istenecektir. Sunum konusu araştırmacı tarafından belirlenecektir. Bu sunum kayıt altına alınacak ve konu anlatımınızın kalitesi, içeriği ve sunum tarzınız psikologların bulunduğu bir panel tarafından değerlendirilecektir. Çalışma kapsamında katılımcılardan elde edilen veriler isim kullanılmaksızın analizlere dahil edilecektir.

Katılımınız araştırma hipotezinin test edilmesi ve yukarıda açıklanan amaçlar doğrultusunda literatüre sağlayacağı katkılar bakımından oldukça önemlidir. Ayrıca katılımınızın psikoloji alanın gelişmesi açısından da bir takım faydaları bulunmaktadır.

Çalışmaya katılmanız tamamen kendi isteğinize bağlıdır. Katılımı reddetme ya da çalışma sürecinde herhangi bir zaman diliminde devam etmeme hakkına sahipsiniz. Eğer görüşme esnasında katılımınıza ilişkin herhangi bir sorunuz olursa, araştırmacıyla iletişime geçebilirsiniz.

Okudum, kabul ediyorum

"Consent Form" given to participants before experimental session (cont.).

KATILIMCI İZİN FORMU

Çalışmanın amacını ve içeriğini ..... katılımcı numarasına sahip katılımcıya açıklamış bulunmaktayım. Çalışma kapsamında yapılacak işlemler hakkında katılımcının herhangi bir sorusu olup olmadığını sordum ve katılımcı tarafından yöneltilen bütün soruları yanıtladım.

Tarih: Araştırmacının İmzası:

..... / ..... / ....

Araştırmacının Telefon Numarası

.....

Çalışmanın amacı ve içeriği hakkında açıklamaların yer aldığı "Katılımcı Bilgilendirme Formu"nu okudum. Araştırmacı çalışma kapsamındaki haklarımı ve sorumluluklarımı açıkladı ve kendisine yönelttiğim bütün soruları açık bir şekilde yanıtladı. Sonuç olarak, uygulama esnasında şahsımdan toplanan verilerin bilimsel amaçlarla kullanılmasına izin verdiğimi ve çalışmaya gönüllü olarak katıldığımı beyan ederim.

Tarih: Katılımcının İmzası:

..... / ..... / .....

.....

Appendix D

Verbal stress report of participants before and after stress manipulation was taken from participants.

		Hiç stresli değil			Orta derecede			Çok stresli
Katılımcı No		1	2	3	4	5	6	7
	Önce	O	O	O	O	O	O	O
	Sonra	O	O	O	O	O	O	O
	Önce	O	O	O	O	O	O	O
	Sonra	O	O	O	O	O	O	O
	Önce	O	O	O	O	O	O	O
	Sonra	O	O	O	O	O	O	O
	Önce	O	O	O	O	O	O	O
	Sonra	O	O	O	O	O	O	O
	Önce	O	O	O	O	O	O	O
	Sonra	O	O	O	O	O	O	O
	Önce	O	O	O	O	O	O	O
	Sonra	O	O	O	O	O	O	O
	Önce	O	O	O	O	O	O	O
	Sonra	O	O	O	O	O	O	O
	Önce	O	O	O	O	O	O	O
	Sonra	O	O	O	O	O	O	O
	Önce	O	O	O	O	O	O	O
	Sonra	O	O	O	O	O	O	O

Appendix E

Representative physiological data from the stress group participants (five minute baseline measurement). Mean BMI was calculated by using participants height and weight information from this report.

SpO2 Report ---Summary Report

User Information	**Name :** [redacted] baseline		
Age : 22	**Sex :** Female	**Height /cm :** 167.00	**Weight /kg :** 52.00
Recording Date(mm/dd/yy) : 12/19/16	**time :** 17:07:29	**Duration :** 00:05:01	**Analysed :** 00:00:40

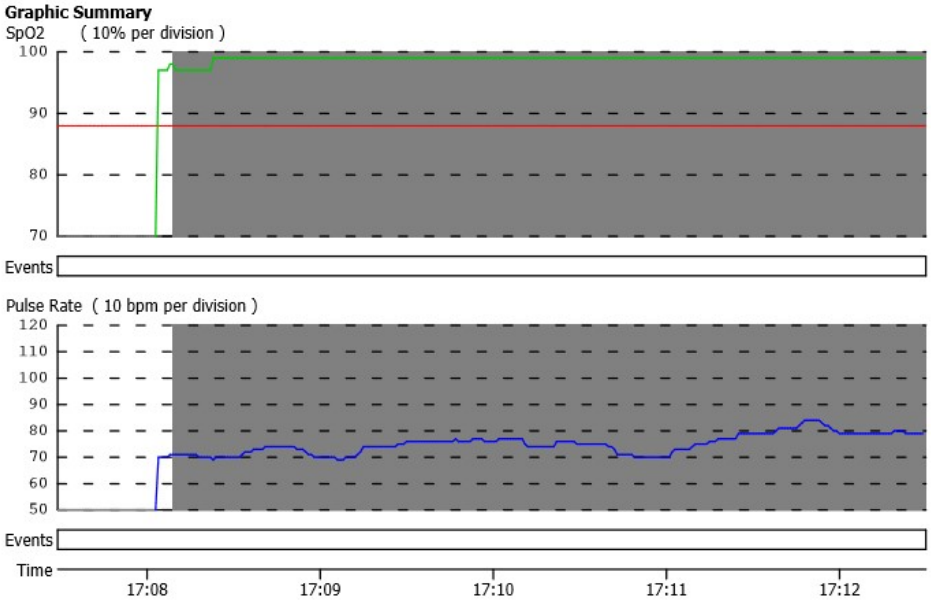
Comments

Event Data	**SpO2**	**Pulse**	**Interpretation**
Total Events	0	0	
Time In Events(min)	0.0	0.0	
Avg. Event Dur.(sec)	----	----	
Index (1/hr)	0.0	0.0	
% Artifact	98.3	98.3	
Adjusted Index (1/hr)	0.0	0.0	
%SpO2 Data			
Basal SpO2(%)	97.2		
Time(min) < 88%	0.0		
Events < 88%	0		
Minimum SpO2(%)	97		
Avg. Low SpO2(%)	----		
Avg. Low SpO2 < 88%	----		
Pulse Data			
Avg Pulse Rate(bpm)	70.2		
Low Pulse Rate(bpm)	70		

Analysis Parameters

Desaturation Event: drop in SpO2 by at least 4% for a minimum duration of 10 seconds.
Pulse Event: Change in rate by at least 6 bpm for a minimum duration of 8 seconds.

Graphic Summary



Representative physiological data from the stress group participants (heart rate measurement during experiment).

SpO2 Report ---Summary Report

User Information **Name :** [redacted] experiment
Age : 0 **Sex :** **Height /cm :** 0.00 **Weight /kg :** 0.00
Recording Date(mm/dd/yy) : 12/19/16 **time :** 17:31:53 **Duration :** 00:06:17 **Analysed :** 00:00:15

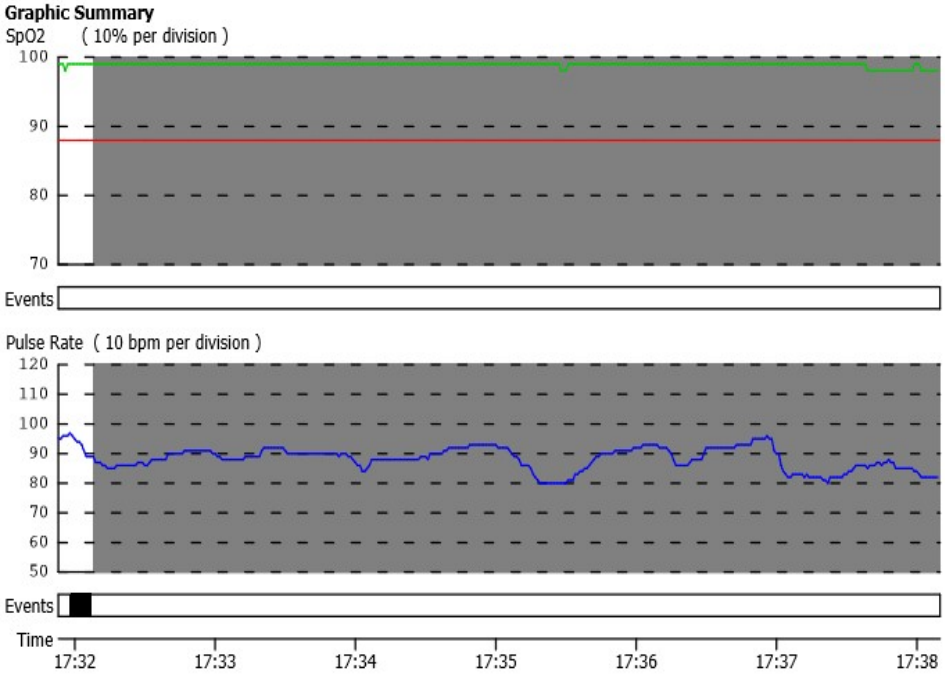
Comments

Event Data	**SpO2**	**Pulse**
Total Events	0	1
Time In Events(min)	0.0	0.1
Avg. Event Dur.(sec)	----	9.0
Index (1/hr)	0.0	9.5
% Artifact	96.0	96.0
Adjusted Index (1/hr)	0.0	240.0
%SpO2 Data		
Basal SpO2(%)	98.9	
Time(min) < 88%	0.0	
Events < 88%	0	
Minimum SpO2(%)	98	
Avg. Low SpO2(%)	----	
Avg. Low SpO2 < 88%	----	
Pulse Data		
Avg Pulse Rate(bpm)	93.7	
Low Pulse Rate(bpm)	89	

Interpretation

Analysis Parameters
Desaturation Event: drop in SpO2 by at least 4% for a minimum duration of 10 seconds.
Pulse Event: Change in rate by at least 6 bpm for a minimum duration of 8 seconds.

Graphic Summary



Representative physiological data from the stress group participants (heart rate measurement during presentation).

SpO2 Report ---Summary Report

User Information	**Name :** [redacted] presentation		
Age : 0	**Sex :**	**Height /cm :** 0.00	**Weight /kg :** 0.00
Recording Date(mm/dd/yy) : 12/19/16	**time :** 17:38:49	**Duration :** 00:05:44	**Analysed :** 00:00:06

Comments

Event Data	**SpO2**	**Pulse**	**Interpretation**
Total Events	0	0	
Time In Events(min)	0.0	0.0	
Avg. Event Dur.(sec)	----	----	
Index (1/hr)	0.0	0.0	
% Artifact	98.5	98.5	
Adjusted Index (1/hr)	0.0	0.0	
%SpO2 Data			
Basal SpO2(%)	99.0		
Time(min) < 88%	0.0		
Events < 88%	0		
Minimum SpO2(%)	99		
Avg. Low SpO2(%)	----		
Avg. Low SpO2 < 88%	----		
Pulse Data			
Avg Pulse Rate(bpm)	94.4		
Low Pulse Rate(bpm)	93		

Analysis Parameters

Desaturation Event: drop in SpO2 by at least 4% for a minimum duration of 10 seconds.
Pulse Event: Change in rate by at least 6 bpm for a minimum duration of 8 seconds.

Graphic Summary