KADİR HAS UNIVERSITY
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THE EFFECT OF COGNITIVE PROCESSES ON LOW AND HIGH-CALORIE FOOD SELECTION

EMRE GÜRBÜZ

MASTER'S THESIS

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Submitted to the School of Graduate Studies of Kadir Has University in partial fulfillment of the requirements for the degree of Master’s in the Program of Psychology

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I, EMRE GÜRBÜZ; hereby declare that;

this Master's Thesis is my own original work and that due references have been appropriately provided on all supporting literature and resources.

NAME AND SURNAME OF THE STUDENT

Emre GÜRBÜZ

DATE AND SIGNATURE

06.01.2020

KADIR HAS UNIVERSITY

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ACCEPTANCE AND APPROVAL

This work entitled **THE EFFECT OF COGNITIVE PROCESSES ON LOW AND HIGH-CALORIE FOOD SELECTION** prepared by **EMRE GÜRBÜZ** has been judged to be successful at the defense exam held on **06 JANUARY 2020** and accepted by our jury as **MASTER'S THESIS.**

APPROVED BY:

Asst. Prof. Dr. Ahu Gökçe (Advisor)	Kadir Has University	
Assoc. Prof. Dr. Aslı Çarkoğlu	Kadir Has University	
Prof. Dr. Ayşecan Boduroğlu	Boğaziçi University	

I certify that the signatures belong to the faculty members named above.

Prof. Dr. Sinem Akgül Açıkmeşe

Dean of School of Graduate Studies

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ABSTRACT

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In the present thesis, the effect of cognitive processes on food selection was investigated in two studies. The first study had three experiments and investigated whether low and high-calorie food stimuli are represented by left and right sides respectively, so-called calorie-SNARC. Food pairs that have low (high) calorie on the left (right) were considered as congruent (incongruent) to the spatial representation of magnitudes. It was hypothesized that congruent food pairs would increase task performance in terms of reaction times (RT) and accuracy rate. The results revealed that calorie-SNARC was not observable for congruent pairs (Experiment 1), even in the presence of endogenous cues (Experiment 2) and when the target defining attributes were controlled (Experiment 3). Study 2 focused on the relationship between the restrained eating style of individuals and working memory task performance measured by the n-Back task. It was expected that food stimuli would decrease task performance for sensitivity (*d'*) and RT, especially for high restrained eaters in the presence of high-calorie stimuli. This hypothesis was investigated by block-wise and in randomized orders of low-calorie, high-calorie and object stimuli presentation in two experiments. Results showed that as working memory load increases, food stimuli impair n-back task performance. However, the restrained eating style did not affect participants' task performance. Black-white versions of food stimuli resulted in slower RT for both experiments compared to colorful versions. The findings of this thesis can be applied for mobile applications for obesity and eating disorders interventions; and in menu and flyer preparations.

Keywords: Calorie, SNARC effect, spatial cues, N-back task, working memory, black-white stimuli, food cues, food selection.

ÖZET

GÜRBÜZ, EMRE, *DÜŞÜK VE YÜKSEK KALORİLİ YİYECEK SEÇİMİNDE BİLİŞSEL SÜREÇLERİN ETKİSİ*, YÜKSEK LİSANS TEZİ, İstanbul, 2019

Bu tez çalışmasında bilişsel süreçlerin yiyecek seçimi üzerindeki etkisi iki farklı çalışmada incelenmiştir. Birinci çalışmada, üç deney ile düşük ve yüksek kalorili yiyecek uyaranlarının kalori-SNARC olarak adlandırdığımız etki sayesinde sırasıyla sol ve sağ görsel alanda temsil edilip edilmediği araştırıldı. Düşük (yüksek) kalorili yiyecek uyaranını sol (sağ) görsel alanda içeren yiyecek çiftleri mekânsal büyüklük temsiline uyumlu (uyumsuz) olarak kabul edildi. Uyumlu yiyecek uyaranlarının görev performansını reaksiyon süreleri ve doğruluk oranları bakımından arttıracağı hipotez edildi. Sonuçlar, kalori-SNARC etkisinin uyumlu yiyecek çiftlerinde (Deney 1), uzamsal ipuçlarının varlığında (Deney 2) ve hedef uyaran belirleme stratejisi kontrol edildiğinde (Deney 3) gözlemlenmediğini gösterdi. İkinci çalışmada bireylerin kısıtlayıcı yeme skorları ile n-geri görevi ile ölçülen çalışma belleği görev performansı arasındaki ilişkiye odaklanıldı. Özellikle yüksek kalorili yiyecek uyaranlarının kısıtlayıcı yeme skoru yüksek bireylerde duyarlılığı (*d'*) azaltıp reaksiyon sürelerini arttırarak görev performansını düşüreceği hipotez edildi. Hipotez, yüksek kalori, düşük kalori ve nesne uyaranlarının katılımcılara farklı bloklarda (Deney 4) ve aynı blok içinde randomize edilmiş şekilde (Deney 5) gösterilmesiyle test edildi. Sonuçlar, çalışan bellek yükü arttıkça, yiyecek uyaranlarının görev performansını olumsuz etkilediğini ancak kısıtlayıcı yeme davranışının görev performansı üzerinde herhangi bir etkiye sahip olmadığını gösterdi. İki deneyde de uyaranların siyah-beyaz gösterilmesi renkli gösterilmesine kıyasla reaksiyon sürelerini arttırdı. Bu tezden çıkarılan bulgular obezite ve yeme bozuklukları müdahaleleri için mobil uygulamalar geliştirmede, menü ve afiş hazırlamada yarar sağlamaktadır.

Anahtar Sözcükler: Düşük ve yüksek kalori, SNARC etkisi, uzamsal ipuçları, n-geri görevi, çalışan bellek, siyah-beyaz uyaran, yiyecek ipuçları, yiyecek seçimi.

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CHAPTER 1

1. INTRODUCTION

Obesity and overweight are health problems that are caused by excessive fat accumulation that worsen the quality of life. Increased BMI (Body Mass Index) is a great risk factor for cardiovascular diseases such as heart disease and stroke, diabetes, musculoskeletal disorders and some cancers (Costa-Font & Gil, 2005). According to WHO, cardiovascular diseases were the leading cause of death in 2012. Although obesity and overweight are very serious health problems, their prevalence has increased sharply during the last few decades (Erem, 2015; Rennie & Jebb, 2005) in both developing and developed countries (Belanger-Ducharme & Tremblay, 2005; Erem, 2015; Yumuk, 2005). The difference between developed and developing countries is that the prevalence of obesity is unevenly distributed among sexes. Whereas the developed countries have a similar prevalence of obesity among both sexes, women in developing countries have higher obesity rates than men (Erem, 2015; Rennie & Jebb, 2005). Besides obesity in adulthood, obesity in childhood is important and has become a critical issue (Bereket & Atay, 2012). According to WHO, obese children more often experience difficulty in breathing, higher risk of fractures, hypertension, early marks of cardiovascular diseases, insulin resistance and negative psychological effects of obesity. Moreover, childhood obesity increases the likelihood of adulthood obesity regardless of whether the parents are obese (Whitaker, Wright, Pepe, Seidel, & Dietz, 1997).

The cause of obesity is the imbalance between calories consumed and calories expended. If the calories consumed are higher than expended, body fat increases and thus results in weight gain in the long term (Jéquier & Tappy, 1999). Since the prevalence of obesity has increased rapidly in a short period of time, genetic factors cannot be the main reason for this increment (Bleich, Cutler, Murray, & Adams, 2008). Advanced technological improvements in the last few decades have provided decreased prices and increased production of palatable, high in fat and calorie foods. This obesigenic environment that contains easily accessible and heavily marketed foods can promote weight gain (Blundell et al., 2005). Besides the availability and accessibility of unhealthy and palatable foods, technological improvements have increased the reliance on cars (James, 2008) and have promoted a sedentary lifestyle. The sedentary lifestyle has increased people's screen time during the day. Activities such as watching television, playing computer games and using mobile phones are usually performed when one is physically inactive. Besides such activities are sedentary and decrease one's calorie expansion in a day, they promote overeating. Sedentary activities that were mentioned before market unhealthy and high in fat food aggressively. Foods that are suggested for children such as fruits, vegetables, low-fat dairy products, and whole grains do not share the same amount of screen time during advertisements as non-suggested high in fat, sugars, or sodium, or low in nutrients foods. The latter food group is promoted more aggressively (Batada, Seitz, Wootan, & Story, 2008). Also, 49% of the Saturday morning advertisements were food advertisements and 91% of the food advertisements were high-fat, added sugar or low nutritious foods (Batada et al., 2008).

High-fat and sweetened foods are dangerous for eating habits because previous researches revealed that diets that are rich in sweet tastes such as sugar-sweetened soft drinks stimulate taste receptors located on the tongue (Chandrashekar, Hoon, Ryba & Zuker, 2006) and generates great sensation that most human and mammalians find rewarding (Steiner, 1979). Moreover, it was proposed that consuming food that is high-in-fat and sugar may cause changes in the brain that increases responsiveness to food-related cues, that promotes overeating and weight gain. (Davidson, Tracy, Schier & Swithers, 2014). Also, it is suggested that in the presence of food stimuli, brain areas that are associated with food taste are activated as well, indicating that food cues and the food itself activate the same brain areas (Chen, Lin, Zimmerman, Essner & Knight, 2016). Therefore, the process of food selection is highly automatic and there is no need for the food itself to understand food selection behavior. Because food cues (e.g. a sight or smell) also play an important role in the selection process.

Therefore, this thesis focused on how do cognitive processes affect low and high-calorie food stimuli selection. In the context of menu planning and food selection, spatial positions of food stimuli can play an important role. For example, when the food is harder to reach, even for 10 inches, people choose that option less (Rozin et al., 2011). On the touchscreen kiosk that had number one item on the left, changing the order of Coca-Cola icon from first to the last and Coke Zero icon from the third to the first resulted in decreased consumption of Coca-Cola and increased consumption of Coke Zero

(Schmidtke, Watson, Roberts & Vlaev, 2019). Romero and Biswas (2016) proposed that presentation of healthy food on the left and unhealthy on the right represents congruent to natural presentation and increase healthy food choices because congruent presentation increases self-control that results in healthier choices. The first goal was to investigate whether food stimuli with different calorie values (e.g. low and high-calorie) are represented by different sides of the display. Specifically, it was proposed that food stimuli with low (high) calorie would be associated with left (right) sides of the display, therefore, individuals would make faster and more accurate food choices when low (high) calorie food stimuli presented on the left (right). Another cognitive mechanism that can be important for low and high-calorie food selection can be task difficulty. For instance, unhealthy food stimuli (e.g. savory or salty snacks) are found to decrease working memory performance compared to non-food stimuli (e.g. daily objects) in a working memory task that demands high cognitive sources (e.g. n-2 back task). Also, it was observed that individuals with different eating styles such as high restrained eaters allocate their attention to food cues faster than low restrained eaters (Hollitt, Kemps, Tiggemann, Smeets, & Mills, 2010). Therefore, the second goal of the thesis was to investigate the working memory performance of individuals with different eating behaviors (e.g. restrained eating style) in the presence of low-calorie, high-calorie and object stimuli that were presented in either in colorful and black and white. Specifically, it was proposed that high-calorie food stimuli impair task performance for individuals who are restrained eaters therefore, slower and more erroneous answers were expected.

1.1. LATERAL DISPLAY PATTERNS OF FOOD STIMULI

1.1.1. Spatial Numerical Association of Response Codes (SNARC) Effect

People have the tendency to associate numerical representation with the spatial layout, an effect known as the SNARC (Spatial Numerical Association of Response Codes) effect (Dehaene, Bossini, & Giraux, 1993). The SNARC effect is associated with the mental number line where the numerical magnitude of a given number determines the representation of that number on the horizontal spatial layout (Galton, 1880). In other words, numbers are represented in ascending order from left to right on the horizontal mental number line resulting in representing numbers in smaller magnitude on the left and numbers in larger magnitude the right side. Moyer and Landauer (1967) investigated horizontal numerical representation in a comparison judgment task. Participants were presented single-digit number pairs that consisted of one digit on the left and the other on the right and were asked to indicate the location of the larger digit. Participants responded faster to pairs with the larger numerical difference (e.g. 3 and 9) than the less numerical difference (e.g. 7 and 9). Therefore, it was concluded that as numbers get more distant on the mental number line, comparison judgment becomes easier (Moyer & Landauer, 1967). SNARC effect suggests that small numbers on the mental number line represented by the left responses and larger numbers by the right responses caused by association between the location of the response hand and magnitude of the number as the right side responses were faster for the larger numbers and left side responses were faster for smaller numbers as proposed (Dehaene et al., 1993). Interestingly, this tendency was also observed when the evaluation of numerical magnitude was task-irrelevant in a parity judgment task and was not affected by the handedness of the participants (Experiment 5, Dehaene, Bossini, & Giraux, 1993). Therefore, the authors (1993) concluded that smaller numbers (e.g. 1, 2) are associated with the left and larger numbers (e.g. 8, 9) are associated with the right-side responses. But this relationship is not absolute, yet it depends on the stimuli set. When stimuli set contained the numbers from 1 to 5, the numbers 4 and 5 responded faster with the right-hand side, however, when stimuli set contained the numbers from 4 to 9, the numbers 4 and 5 responded faster with the left-hand side (Experiment 3, Dehaene et al., 1993).

Even though most of the evidence of the SNARC effect comes from the horizontal mental number line, an alternative explanation for the SNARC effect was proposed based on the polarity correspondence (Proctor & Cho, 2006). According to this view, dimensions include different polarities such as "– polarity" and "+ polarity". Therefore, stimuli or responses can be assigned to a polarity. In the domain of numerical magnitude, while right responses and large numbers indicate "+" side, left responses and small numbers indicate "-" side of the polarity. When the polarity of stimulus and response match (e.g. both "-" polarities), faster processing speed can be expected. In addition to the numerical magnitude, other magnitudes can be polarized such as size, luminance, time, tone. Bigger sizes, darker colors, future times, higher pitches indicate "+" side of the polarity whereas smaller sizes, lighter colors, past times and lower pitches indicate “-” side of the polarity. However, in a recent meta-analysis, it was discussed that there is no need to eliminate one of the explanations that support the SNARC effect. The contribution of both mental number line and polarity correspondence account should be considered (Wood, Willmes, Nuerk, & Fischer, 2008).

The underlying mechanism of the SNARC effect has been questioned. The directionality of handwriting has been found as an important factor for the SNARC effect (Zebian, 2005). In Western cultures having left-to-right writing habits show also left to right SNARC effect (e.g. Dehaene, Bossini, & Giraux, 1993; Zebian, 2005). But for the cultures that have right-to-left writing habits, the same tendency is not observed. Arabic monoliterates that have the right-to-left writing habits showed a reversed-SNARC effect. In other words, Arabic monoliterates associated larger numbers with left and smaller numbers with the right response. Interestingly Arabic-English biliterates indicated a weaker reverse SNARC effect. The directionality of writing in the native language determines the direction of the SNARC effect as long as the second language is not as skilled as the native language. Also in a recent study, the right to left SNARC effect was observed in Hebrew speakers (Zohar-Shai, Tzelgov, Karni, & Rubinsten, 2017). To sum up, the SNARC effect can be influenced by the directionality of writing and the reversed SNARC effect can be examined in different cultures as a result of reversed writing directionality.

1.1.2. Multimodality of the SNARC Effect

In addition to the numerical magnitude, the SNARC effect has been studied in various domains such as time, size, letters and luminance. The smaller/earlier and larger/later magnitudes are associated with the left and right of the hemispace, respectively (see for a review and metanalysis Macnamara, Keage, & Loetscher, 2018). In the temporal domain, individuals responded faster to the first months of the year with the left hand and the last months of the year with the right hand (Gevers, Reynvoet, & Fias, 2003) and responded faster to past time with the left responses and future time with the right responses (Torralbo, Santiago, & Lupiáñez, 2006). For the musical domain, experiments revealed that lower pitch sounds were associated with the left and higher pitch sounds were associated with the right (Cho, Bae, & Proctor, 2012; Nishimura & Yokosawa, 2009). In the research of Ren et al., 2011, participants were asked to decide whether presented stimuli size was bigger or smaller; darker or lighter; conceptually bigger or conceptually smaller than the previous ones in Experiments 2, 3 and 4 respectively. Participants responded faster to large, dark and conceptually bigger targets with right hand compared to small, lighter and conceptually smaller targets.

Dural and colleagues (2018) proposed that there is compatibility between physical size – spatial position of the stimulus. It was investigated whether smaller/larger sizes would be associated with the left/right hemispace. The experiment consisted of two phases and in the first phase, participants practiced non-numerical stimulus pairs (e.g. symbols). Three different stimuli pairs were presented; small stimulus on the left and big on the right; equal-sized stimuli on the left and right; small stimulus on the right and big on the left. In the second phase, participants were presented with stimuli pairs again. These stimuli pair consisted of three different alternatives; the same pairs from the first phase; horizontally mirrored version of the pairs from the first phase or completely new stimuli pairs. Participants were asked to respond "yes" if they saw the exact stimuli pairs in the first phase of the study (same pairs) or "no" if they did not see the exact stimuli pair (mirror versions or new pairs). Participants responded "yes" to the presence of mirrored version or new stimuli pairs when they consisted of small size on the left and the large size on the right compared to opposite pattern although they did not practice symbol pairs in the first phase, therefore, these symbol pairs required "no" answer. Moreover, stimuli pairs that had small on the left and big on the right were processed faster than stimuli with opposite patterns (Dural et al., 2018). To sum up, results show that the SNARC effect is observable in multiple domains other than the numerical magnitudes (Macnamara, Keage, & Loetscher, 2018).

1.1.3. Is there a calorie-SNARC Effect?

Given that the SNARC effect has been shown for various domains other than the numerical magnitude, the present study is designed to test whether the SNARC effect can be extended to food stimuli and calories associated with them, namely the calorie-SNARC effect. Based on the polarization view, different calorie amounts can be represented at the opposite edges of the polarity. While higher-calorie foods are expected to be in the "+" side of polarization and associated with the right side, low-calorie foods are expected to be in the "-" side of the polarization and associated with the left side of the screen. Similarly, an increase in the calorie amount can be placed on a horizontal mental number line where lower calorie is represented on the left a higher calorie is represented on the right side. To the best of our knowledge, there is not any study that directly measured the SNARC effect on the calorie domain. Romero and Biswas (2016) conducted a series of experiments to understand whether the lateral presentation of healthy and unhealthy foods affects the healthy food choice. In an online survey, they provided participants two kinds of menus (Study 1A); one included low-calorie options on the left and high calorie on the right and the other menu had the opposite pattern. Participants chose healthy food options more often when healthy options presented on the left. This tendency did not change when the same experiment conducted on a computer-based task (Study 1B). Again in the Study 2A and 2B, participants placed conceptually healthier items on the left box and unhealthier items on the right box (e.g., strawberry on the left, strawberry cheesecake on the right). Finally, in a real-life context example (Study 5), participants consumed healthy beverages more when it was placed on the left side of the participant (orange juice on the left, synthetic orange soda on the right). Authors concluded that when the healthy food was placed on the left and unhealthy on the right, congruent with natural representation, placement of food pairs ease the processing and lead a higher amount of healthy food choices (Romero & Biswas, 2016). Moreover, people consider that healthy foods contain lower calories compared to unhealthier options (Chandon & Wansink, 2007) suggesting that when people believe that the food is healthier (e.g. Subway), they believe that the foods also contain fewer calories compared to unhealthier option (e.g. Mc Donald's). If people naturally place healthy food on the left and unhealthy on the right, and also consider that healthy food contain fewer calories, the same tendency should be observed in the calorie domain as well.

1.2. WORKING MEMORY AND FOOD SELECTION

1.2.1. Working Memory Mechanisms

In daily life, one needs to store and mentally work with the information; to focus on relevant information and to change perspectives, approaches or tasks in order to adjust to new rules. These concepts are part of top-down mental processes which are called executive functions and working memory is one of the three core concepts of executive function (Diamond, 2013) Working memory actively stores, maintains and manipulates the information (Cowan, 2008). Going shopping can be a good example of working memory from daily life. During shopping, one constantly needs to remember what to buy, to make comparisons amongst different options and finally to decide what to buy. The process contains more than simply remembering. Hence, storing and processing of the information co-occur. Working memory is important for high-level cognitive skills such as reasoning (Kyllonen & Christal, 1990), problem-solving skills (Swanson & Fung, 2016), mental arithmetic (DeStefano & LeFevre, 2004).

A multicomponent model of working memory was introduced by Baddeley and Hitch (1974). The proposed model consists of one central and two slave components. The central component, the central executive, acts as a supervisory component by controlling the information flow between phonological loop and visuo-spatial sketchpad. Also, it plays an important role in focusing, dividing and switching attention (Baddeley, 1996; Baddeley, 1998). The first slave component, phonological loop, holds verbal information and prevents its decay by rehearsal. Remembering one's telephone number can be an example. The second slave system, visuo-spatial sketchpad, processes visual and spatial information such as constructing visual images and for representing mental maps. Baddeley (2000) extended the model and added the third slave component which is the episodic buffer. The episodic buffer is a link between working memory and long-term memory and integrates the information between phonological loop and visuo-spatial sketchpad.

Often, the terms short term memory and working memory are used interchangeably, however, these two memory concepts are different from each other (Cowan, 2008). Short term memory indicates only the storage of information, whereas working memory includes manipulation of stored information additionally. The difference between two memory concepts can be observed in neural subsystems as well. D'Esposito and the collogues (1999) conducted a delayed-response task with two different conditions. The first condition required maintenance and the second condition required manipulation of the information. During the manipulation condition, the dorsolateral prefrontal cortex showed greater activity than the maintenance condition.

1.2.2. Working Memory Capacity

Working memory is classified as a limited cognitive system and many studies have been conducted for measurement of working memory capacity (e.g. Bathelt, Gathercole, Johnson, & Astle, 2018; Bengson & Luck, 2016). Miller, (1956) suggested, "magical number seven, plus-minus two" to explain the limitations of working memory capacity. Miller, (1956) proposed that information-processing capacity is around seven elements (e.g. digits, letters, words or other units). Individuals create an intelligent grouping of these items, which is called "chunking", in order to increase their storage capacity (Cowan, 2001). Chunks act as individual items, therefore, ease the process of remembering. However, in the absence of chunking and rehearsal, one can remember 3 to 5 individual items (Cowan, 2001). There are various tasks are used to assess working memory capacity such as counting span (Case, Kurland, & Goldberg, 1982), operation span (Turner & Engle, 1989) reading span (Daneman & Carpenter, 1980), spatial span (Conway, Kane & Engle, 2003) and n-back task (Kirchner, 1958). Working memory capacity tasks differ from short-term memory tasks. The latter measure domain-specific storage whereas the former measure attention capability under interference (Engle, Tuholski, Laughlin & Conway, 1999). Namely, working memory span tasks usually contain to be remembered target stimuli with an additional secondary task. These tasks measure working memory performance which requires actively holding task-relevant information during tasks. One of the most frequently used tasks to measure working memory performance is the n-back task (Kirchner, 1958; Kane, Conway, Miura, & Colflesh, 2007; Owen, McMillan, Laird, & Bullmore, 2005; Pesonen, Hämäläinen, & Krause, 2007). In a classical n-back task, participants are presented with a series of stimuli and asked to indicate whether each stimulus matches the one displayed *N* stimuli before.

For instance, in an n-2 task, participants have to decide if the current stimuli are the same as the stimulus 2 trials before. By changing the numerical value of *N*, the working memory load can be manipulated. Thus, accuracy rates and RTs change as the value of *N* changes. Regardless of the stimuli type increasing the value of *N* results in increased error rates and reaction time (Miller, Price, Okun, Montijo, & Bowers, 2009). Performing the n-back task involves different processes, such as encoding of the item, monitoring, maintenance, updating and matching the current item with the *N* item before in the sequence. Most studies report reaction time or accuracy rates as the dependent variables. However, it has been suggested to report indexes such as d prime (*d'*) when modified versions of n-back tasks are used (Haatveit et al., 2010; Kane et al., 2007). *d'* measures whether participants are able to discriminate target stimuli from non-target stimuli when performing a task (Haatveit et al., 2010) and derive from signal detection theory (Stanislaw & Todorov, 1999). In a signal detection analysis, there are four different accuracy outcomes; hit, miss, false alarm, correct rejection. These accuracy outcomes can be applied to n-back task as follows; if one responds accurately whether the current response matches with N^{th} previous trial or not, this would result in hit (responding the same in the presence of signal) or correct rejection (responding differently in the presence of noise trial) however, if one response inaccurately, this would result in miss (responding differently in presence of the signal) or false alarm (responding the same in the presence of noise) (Stanislaw & Todorov, 1999). The hit and false alarm rates are used in calculating the discriminability index (*d'*). The discriminability index indicates one's ability to differentiate the signals from the noise (Tanner & Swets, 1954). If one performs more than 50% accuracy on targeting both signals and noise, the value of d' will be higher than 0 and indicates better sensitivity in detecting signal and noise trials. However, if the accuracy of both trials was lower than 50%, the value of *d'* will be lower than 0 and negative scores indicate worse than chance performance on distinguishing signals from noise (Haatveit et al., 2010). Lastly, the score of zero suggests that one cannot distinguish signals from the noise trials (Stanislaw & Todorov, 1999).

1.2.3. Cognitive Load and Food Selection

Working memory has limited capacity and the amount of working memory an individual has available to apply to a task can be varying. The term cognitive load refers to this amount of available working memory to apply any task (Paas, Renkl & Sweller, 2004). Cognitive load theory suggests that during complex activities the amount of novel information and interactions that must be processed can be variant (Paas, Tuovinen, Tabbers & Van Gerven, 2003) therefore, the more information the brain has to manipulate using the executive control of an individual's working memory, the higher the cognitive load. Increased task difficulty reduces cognitive resources that are available for processing of information and, hence, increases cognitive load.

Limited cognitive resources do not only affect task performances but also may affect the daily choices of individuals such as food choices. In the food selection context, people make over 200 food decisions in a day (Wansink & Sobal, 2007) and some of the food choices that we make do not match our health goals because sometimes choices are made by cognitive shortcuts, (e.g. habitual behavior) especially when cognitive sources are limited. Byrd-Bredbenner and colleagues (2016) proposed that when one has limited cognitive sources due to stressors and distractions in life, unhealthy food choices become more frequent. They derived cognitive load scores by self-report questionnaire however there are studies that investigated food selection behavior under cognitive load manipulation. Shiv and Fedorikhin (1999) investigated whether the depletion of cognitive sources leads to greater high-calorie food selection. Participants were asked to remember either a 2-digit or 7-digit number. Then they were asked to go to another experiment room and recall the number. Participants were offered chocolate cake or fruit salad along the corridor. The option of chocolate cake was chosen more frequently by participants who needed to recall the 7-digit number. (Shiv & Fedorikhin, 1999). The authors (1999) concluded that in a binary choice task, where the alternatives were healthy and unhealthy food, choices were affected by participants' available processing resources. Participants chose an unhealthy alternative compared to healthier alternatives more frequently when they had low processing sources (recalling the 7-digit number). In addition, Zimmerman and Shimoga (2014) investigated whether food advertisements lead to higher unhealthy food consumption under high-cognitive load. Participants have watched movie segments consisted of either food or non-food advertisements and asked to perform two different tasks for cognitive load manipulation. The first task was remembering 2 or 7-digit numbers similar to the experiment of Shiv and Fedorikin (1999) as mentioned earlier. The second task involved tracking information on the screen and participants were asked a simple or complicated question after the presentation of movie segments. While recalling 2-digit and answering easy questions were low cognitive load conditions, recalling 7-digit and answering the complicated questions were high cognitive load conditions. Results revealed that participants who watched food advertisements under the high cognitive level consumed unhealthy snacks more often. In other words, exposure to food stimuli increased food consumption when the task required more cognitive resources. Two research that showed unhealthy food consumption increase under high cognitive load was conducted with samples that had healthy eating styles (Zimmerman & Shimoga, 2014; Shiv & Fedorikin, 1999). However, the eating style of an individual such as restrained eating can lead to over-eating under high-cognitive load. The restrained eating style indicates maintaining or losing weight by using cognitive suppression of hunger signals (Herman & Mack, 1975). This eating behavior tends to be maintained by individuals over time (Klesges et al., 1991) therefore it requires sustained cognitive effort because one needs to do constant control over food choices. However, when the cognitive resources are not enough (Ward & Mann, 2000) or under stressful and emotional conditions (van Strien, Cleven & Schippers, 2000; Chua, Touyz & Hill, 2004). restrained eaters can consume food excessively. Hence, tasks that require high cognitive sources can deplete cognitive control over dietary control and result in excessive eating. Concordantly, the study of Ward and Mann (2000) proposed that the restrained eating style of an individual plays an important role in eating behavior under different cognitive load conditions. In the experiment, participants with low and high restrained eating scores were performed reaction-time measure tasks which required a response to a short beep. Participants who were on low cognitive load conditions simply performed the task whereas participants who were in high cognitive condition performed additional recognition tasks. The results revealed that high restrained eaters consumed more food while performing high cognitive load task (Ward & Mann, 2000). The results suggest that individuals who diet or cognitively limit their food intake can eat excessively during an activity that requires cognitive sources such as watching television, working on a computer or simply socializing if there is an appetizing food. (Ward & Mann, 2000). In another study of Mann and Ward (2004) participants with high restrained eating styles were asked to remember 1-digit (low cognitive load) or 9 digits (high cognitive load) numbers and were asked to test a milkshake. Participants with high restrained eating style consumed more milkshake under high cognitive load condition compare to low cognitive load. These results revealed that overeating can occur when cognitive resources are limited to monitor food intake.

The studies that have been introduced until now examined food consumption after participants received different cognitive loads (e.g low cognitive load). However, food or food cues can be used in a working memory task as the target stimuli. Therefore, food stimuli would require a direct response and if food cues require a direct response they may have a stronger influence and higher external validity (Meule, Skirde, Freund, Vögele & Kübler 2012). Recently, some studies investigated working memory performance with food cues directly (e.g. food images, Meule et al., 2012; Dickson et al., 2008; Meule, Hermann & Kübler, 2014). Meule and colleagues (2012) conducted research to investigate the effect of high-calorie food and neutral objects stimuli on working memory performance. In other words, how do individuals perform in a working memory task in the presence of food and non-food stimuli. When food and non-food stimuli types were presented in separated blocks in n-back task participants showed slower reaction times and more erroneous answers for food stimuli compared to non-food stimuli. (Meule et al., 2012). Also, in another study Meule (2016) found that palatable food cues induce higher cravings when participants completed a block of experiment with food stimuli, therefore results in slower responses to food cues in an n-back task. Craving indicates an increased desire to consume substances and usually associated with substance use disorders (Tiffany and Wray, 2012). Besides substances (e.g. drugs) foods can elicit cravings as well (Hormes and Rozin, 2010; Meule, 2016). When food craving occurs individuals tend to consume craved food more often. Satiety level is not crucial for food craving, it can occur when one is satiated (Pelchat and Schaefer, 2000). Therefore, presentation of food cues in a working memory task (e.g. n-back) may impair task performance (e.g. slower responses) regardless of satiety levels of participants (e.g. Meule, 2016).

1.3. PRESENT THESIS

The main aim of this thesis was to investigate the cognitive processes of low and high-calorie food selection. Two different studies were conducted in this regard. The first study aimed to examine whether food stimuli with different calorie values (e.g. low, high-calorie) are associated with different sides of the display. Specifically, it was proposed that presenting low-calorie food stimuli on the left and high-calorie stimuli on the right result in improved task performance in turn faster and more accurate responses would be expected. Because such a presentation of food stimuli would be compatible with the spatial-magnitude association, more precisely food pairs that have low magnitude on the left (e.g. low-calorie) and greater magnitude on the left (e.g. high calorie) would match with an association of smaller (greater) magnitudes with left (right) responses and sides. In order to investigate whether this effect can be extended to the calorie domain, three experiments were conducted. In all experiments, food stimuli pairs were presented. Food stimuli pairs that consisted of low (high) calorie on the left (right) were considered as congruent (incongruent) pairs as they are compatible (incompatible) with magnitude association. In Experiment 1, it was investigated whether calorie-SNARC can be observed. Experiment 2, this effect was examined in the presence of endogenous spatial cues. Valid or invalid spatial cues, centered arrows (←, →) preceded food pairs in order to examine if the calorie-SNARC effect is present in the presence of endogenous cues. Experiment 3 investigated whether target defining attributes affect the presence of calorie-SNARC. Also, in Experiment 3, it was examined whether target defining attributes that were used in the previous experiments, green and red color, result in approach or avoidance behaviors (e.g. approaching or avoiding high-calorie stimuli).

The second study aimed to investigate the working memory performance of individuals with low and high restrained eating styles in the presence of low-calorie, high-calorie and object stimuli that were presented in either in color or black and white. In this regard, two different experiments were conducted. Varying levels of an n-back task (n-1, n-2, and n-3) were used in both experiments in order to examine the working memory performance under different working memory load conditions. Experiment 4 investigated the working memory performance when the low-calorie, high-calorie, and object stimuli were presented block-wise manner whereas in Experiment 5 working memory performance was examined when different stimuli types were presented in a randomized order. It was proposed that food stimuli would result in decreased performance under increased working memory load conditions (e.g. n-3 condition) especially for individuals who have high restrained eating style.

CHAPTER 2

2. STUDY 1

Study 1 consisted of 3 experiments and aimed to investigate whether the food stimuli with different calorie values (e.g. low, high-calorie) are associated with different sides of the display. The presence of such association would result in representing low-calorie food on the left and high-calorie food on the right side and this representation would lead to improved task performance when the food stimuli in low and high calories are presented left and right sides respectively. In three experiments the presence of the calorie-SNARC effect was tested using different parameters. Experiment 1 was designed to test of calorie-SNARC effect is present and affects the representation of food stimuli. The effects of variables of the spatial cue (Experiment 2) and target defining attributes (Experiment 3) on food stimuli were tested on the calorie-SNARC effect.

2.1. GENERAL METHOD

The general setup of Experiments 1-3 was identical with the exceptions noted in the procedure section of each experiment.

2.1.1. Apparatus and Stimuli

All experiments were built by using the PsychoPy Builder software version 1.90.3 (Peirce, 2007, 2009) Python package. Responses were recorded via a keyboard that placed in front of participants. The distance between the computer screen and the participants was approximately 60 cm and the screen resolution was set to 1920 x 1080 pixels. The experiment room was dimly lighted.

In this study, stimuli were chosen from the Food-pics database (Blechert, Lender, Polk, Busch, & Ohla, 2019; Blechert, Meule, Busch, & Ohla, 2014). In 2014, Blechert and the colleagues developed a free access database of food stimuli and associated normative data for the study of eating and appetite. Visual properties of food images such as complexity, brightness, contrast, etc. and subjective evaluations such as liking (palatability) and wanting (desire to eat) were provided for stimuli. Later, the Food-pics database was extended by the addition of a more international selection of food stimuli (Blechert et al., 2019).

Among all food images, low and high (total 286) calorie food stimuli were taken from the Food-pics database. A pilot study was conducted to determine whether the food stimuli represent similar caloric properties (e.g., low or high) for the sample of the present study. This was to make sure that there are no culture-specific factors that may influence calorie judgments and that all food stimuli are recognizable by the sample. To do so, an online platform Qualtrics© (Provo, UT, USA) was used.

Two hundred eighty-six food stimuli with various calorie values were rated based on their calorie level (low, average or high) by participants. In the online survey, after instructions participants were presented centered food stimuli and were asked to choose which calorie group represents the current food image best. The calorie groups were "0-100 cal", "100-250 cal" and "250-500 cal" respectively. Each food image remained on the screen until the response was made. Final data were collected from 53 individuals that matched our sample in terms of age. Based on the rating responses, food stimuli that had inconsistent ratings with the actual calorie levels were excluded (8.39% of total images). For example, nuts and cheese were rated as low-calorie items although these foods are labeled as high calorie in the Food-pics database. In addition, all rated stimuli were separated into three different calorie groups whether they are rated mostly "0-100 cal", "100-250 cal" and "250-500 cal". In order to use food stimuli that represent low or high-calorie edges for our sample, stimuli that were rated as a middle category "100-250 calories" were discarded (24.81%). Finally, for every remaining stimulus (total 197), the percentage of agreement of each category was calculated. If half of the participants did not rate one stimulus as one category (e.g. less than 50% of raters rated stimulus 1 as low calorie) that item was discarded from the stimuli set (18.78%). These exclusion criteria led to 80 low-calorie and 80 high-calorie food stimuli in total. In order to determine if the ratings of the stimuli were consistent across participants', inter-rater reliability analysis was performed by calculating the Fleiss Kappa (Fleiss, 1971). Kappa value for the 160 chosen stimuli was 0.59 which indicated moderate agreement, While the value of 0 indicates chance agreement (Fleiss, 1971), 0.41-0.60 range indicates moderate agreement among participants (Landis & Koch, 1977).

2.2. EXPERIMENT 1

Experiment 1 investigated whether the low-calorie food stimuli (e.g., salad) and high-calorie food stimuli (e.g., hamburger) have a natural tendency to be represented by left and right hemispace, respectively. The item (i.e. food) – space association determined the (in)congruency. While positioning the low-calorie food stimuli on the left and high-calorie stimuli on the right side was congruent, the reversed order led to incongruency with regard to item and space association. The hypothesis as follows (a) congruent presentation of food pairs (low calorie on the left and high calorie on the right) would increase the task performance in terms of reaction time and accuracy compared to the opposite pattern.

2.2.1. Participants

Fourteen participants participated in Experiment 1 (female: 14, right-handed: 13, Mage = 19.57 years, SD = 0.85 year). The study was approved by the Ethics Committee ofKadir Has University. Prior to participation, participants gave informed consent. Participants who were enrolled in the psychology undergraduate program received course credits for their participation. All participants had a normal or corrected-to-normal vision. They were naïve to the purpose of the study and debriefed after the participation.

2.2.2. Procedure

A practice session (1 block, 20 trials) was run prior to the main experiment (4 blocks, 480 trials each). The data of the practice session was not recorded. In practice sessions instead of low and high-calorie stimuli, pairs of pebble stones and flowers were used in order to avoid priming participants with thoughts foods before the main experiment. In the practice session, participants were instructed to indicate the location of the flower stimuli after the red, location of the pebble stones after the green fixation cross. The background color was set to black. In the experiment, each trial started with the presentation of the fixation cross either in green or red for 700 ms. Depending on the fixation cross color, participants were asked to localize the low-calorie (green fixation cross) or high calorie (red fixation cross) stimulus. The color of the fixation cross was randomized across trials with equal probability of occurrence. After the fixation cross, food pairs were presented for 1500 ms, the response period was 2000 ms (see Figure 2.1). The food pairs were created by having four different combinations of low/high-calorie food stimuli on left / right sides. Presenting high-calorie on the left, low-calorie on the right (HL) (e.g. hamburger-salad), low calorie on the left, high calorie on the right (LH) (e.g. salad-hamburger), both items are high-calorie (HH) (e.g. hamburger-hamburger) and both items are low-calorie (LL) (e.g. salad-salad). The proportion of each pair was as follows: 40% LH, 40% HL, 10% LL and 10% HH pairs. In the LH and HL conditions (80% of the trials) participants were asked to respond to either low or high-calorie item targets (i.e. go trials). In the remaining HH and LL (20% of the trials) conditions, no response was required as there was no target (i.e. no-go trials). In the go trials, the task was to detect the target food stimulus (low/high-calorie item) and were asked to press the button "A" or "L" if the target is located on the left or right side respectively. Each food stimulus was positioned 10 ° away from the center (10° left for the stimuli on the left, 10° right for the stimuli on the right). The size of the food stimuli was 12° x 9°. The experiment session lasted approximately 30 minutes.

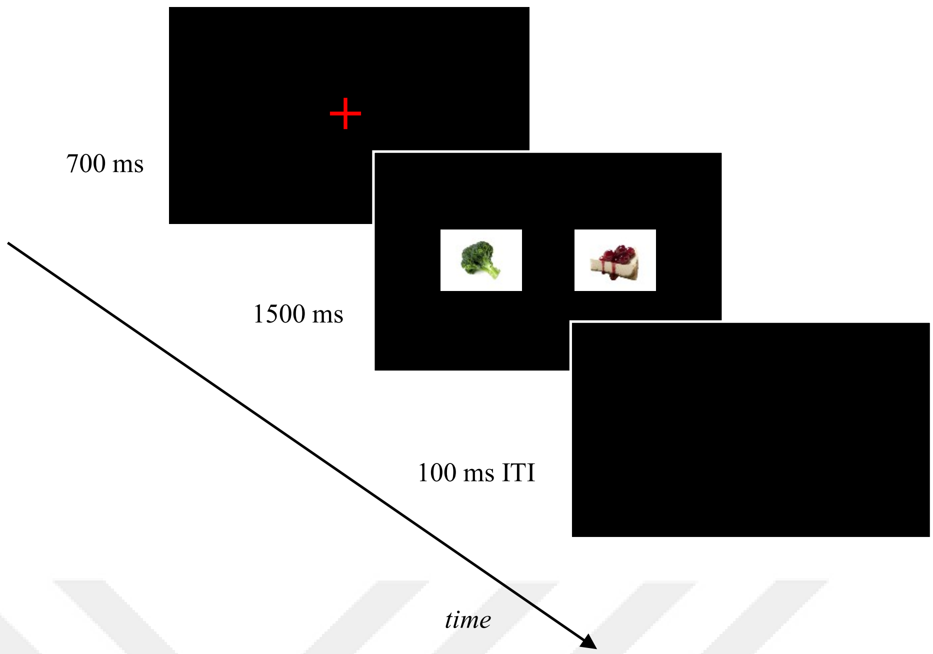

Figure 2.1. The Trial Sequence of Experiment 1.

First a green or red fixation cross was presented for 700 ms, followed by the food pairs. Each pair of food stimuli remained visible for 1500 ms. The task was to indicate the location of the low-calorie food stimulus after the green, the location of the high-calorie stimulus after the red fixation cross. In this example, the stimuli pair, LH, was preceded by a red fixation cross, therefore, localizing the high-calorie food (i.e. cherry cheesecake) was required.

2.2.3. Results

Data were analyzed by using "R" (R Development Core Team, 2017) and Jamovi (The Jamovi Project, 2019). For Bayesian statistics open-source statistical software program JASP (JASP Team, 2019) was used. Incorrect responses (20.85 %) and trials with ± 2.5 standard deviations from the reaction time mean were discarded as outliers (1.3 %). In order to test the effect of pair congruency (LH, HL) on target localization, a paired t-test was conducted for RTs and error rates separately. Reaction time for HL condition (520 ms) and LH (518 ms) were not significantly different; $t(13) = 0.23$, $p = .824$, $BF_{10} = 0{,}276$. (see Figure 2.2A). Yet, error rates (%) did not differ for HL (21.4%) and LH condition (20.3%) as well $t(13) = 0.79$, $p = 0.45$, $BF_{10} = 0{,}353$ (see Figure 2.2B).

2.2.4. Discussion

Experiment 1 investigated the presence of the calorie-SNARC effect. The presence of such an effect would lead to associating low and high-calorie items with the left and right sides respectively. Romero and Biswas (2016) proposed that presenting healthy foodson the left of unhealthy foods increase healthy food choices. Because healthy food stimuli are considered as low in calories, less filling and less heavy therefore consists of low magnitude on the left and larger magnitude on the right side that considered as congruent to the spatial representation of magnitudes (Romero & Biswas, 2016). In Experiment 1, it was investigated whether this effect can be observed in calorie domain. It was hypothesized that if individuals have an available representation of low and high-calorie food stimuli on the left and right respectively, this representation would result in faster and more accurate target detection incongruent food pairs (LH condition). However, this was not observed, the detection speed of low-calorie target, when presented in the left or right side, did not differ. Also, LH pairs did not have more accurate answers compared to HL pairs. Experiment 1, revealed the absence of a calorie-SNARC effect. In other words, the presentation of food stimuli pairs that consist of a lower magnitude on the left and greater magnitude on the right do not facilitate task performance in terms of reaction time and accuracy rate. This was further investigated by examining the role of spatial attention biases. Top-down factors influence attentional orienting by biasing attention to certain

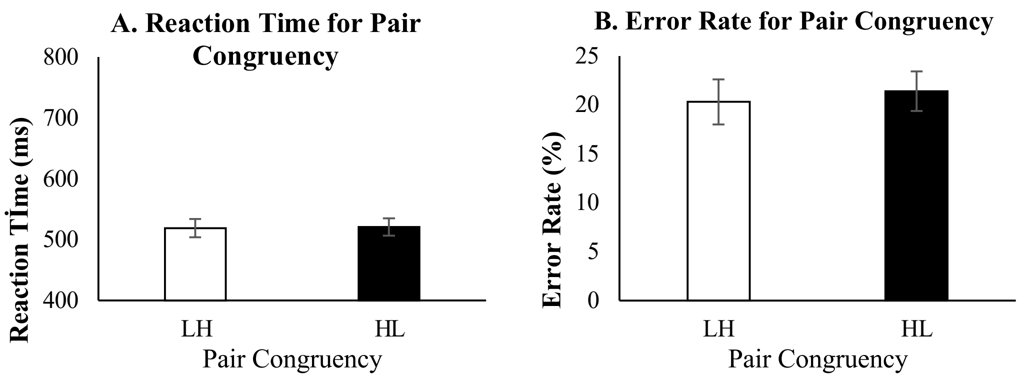

Figure 2.2. Mean Reaction Time and Error Rate Values of Pair Congruency Condition in Experiment 1.

The graph (A) shows the mean RT and (B) shows the mean error rate for the congruent and incongruent food pairs conditions. Error bars represent standard error of the means.

stimuli or space (Posner, 1980a). On the basis of this, Experiment 2 was designed to test if the calorie-SNARC effect can be obtained by biasing participants' attention to a certain region and facilitate the processing of stimulus within that region. In other words, the aim of Experiment 2 is to investigate whether external factors (spatial cues) can be used to form an association between the left/right space and the stimuli occupying that space.

2.3. EXPERIMENT 2

Exogenous and endogenous orienting mechanisms enable the allocation of attention (Johnson & Proctor, 2004; Ruz & Lupiáñez, 2002; Posner, 1980a). The distinction between the two mechanisms is based on whether the allocation of attention occurs (in)voluntarily or not. In the case of involuntary (exogenous) allocation of attention, stimulus-driven bottom-up factors are involved. These cues are called peripheral cues because they are usually presented in the periphery of the display (Johnson & Proctor, 2004). The effect of exogenous cues is even observed when the cue does not provide reliable information about the target location. In the case of voluntary (endogenous) allocation, goal-driven top-down attentional factors are involved. These cues need to be processed by individuals in order to have an effect. Endogenous cues are called central cues because they are usually presented in the middle of the display, where the fixation cross located. For instance, an arrow in the middle of the display indicates where to look however, attention should be allocated by an individual. On the other hand, exogenous cues attract attention by sudden appear in the periphery of the display (Johnson & Proctor, 2004). Posner's spatial cueing paradigm is one of the most commonly used methods to investigate the allocation of attention in space (Posner, 1980a; Posner, Snyder, & Davidson, 1980b). Posner (1980a) presented an (in)valid spatial cue is prior to the target. If the target appears on the cued location, the cue is considered valid, on the contrary, if the target appears on the opposite side of the cued location, the cue is considered invalid. Findings indicate that invalid cues lead to slower responses and more erroneous answers than valid cues (Posner, 1980a). Because valid cues provide correct information about the location of target stimuli whereas invalid cues provide wrong information about the location of the target. On the invalid cue trials, one should allocate his attention to another part of the display to target' location that usually requires more time and causes more erroneous answers. If invalid trials are slower and more erroneous compared to valid trials, cueing effect can be mentioned. By comparing invalid and valid cues cueing benefits (or costs) can be computed. (Johnson & Proctor, 2004).

In Experiment 2, the calorie-SNARC effect was examined in the presence of endogenous spatial cues. If the low (high) calorie food stimuli are associated with left (right) side and response, one should be faster when low/high-calorie food stimuli were on the left/right side of the display and cued validly. The hypothesis was as follows (a) invalid cues would lead to slower and more erroneous responses than valid cues. (b) congruent pairs would have faster responses on valid cues because biasing attention should be erased when the food pairs are congruent (c) congruent pairs would have faster responses on invalid cues than incongruent pairs on invalid cues because shifting attention from invalidly cued locations to target stimuli should be eased by the congruent presentation.

2.3.1. Participants

Sixteen participants participated in Experiment 2 (female: 11, right-handed: 13, Mage = 20.19 years, SD = 1.38 year). The study was approved by the Ethics Committee of Kadir Has University. Prior to participation, participants gave informed consent. Participants who were enrolled in the psychology undergraduate program received course credits for their participation. All participants had a normal or corrected-to-normal vision. They were naïve to the purpose of the study and debriefed after the participation.

2.3.2. Materials

In Experiment 2, apparatus and stimuli were identical as in Experiment 1 with the exception of the spatial cues (← or →; white, size: 3.75° x 3°).

2.3.3. Procedure

The identical practice session as in Experiment 1 was run. The trial sequence differed from Experiment 1 by the presentation of the spatial cues prior to the presentation of the food stimuli. Congruency of food stimuli pairs was LH and HL as in Experiment 1. Valid and invalid spatial cues were presented. Valid cue pointed out the location of the upcoming target stimulus (e.g. right-pointing cue and right-side target) and invalid cue pointed out the opposite location of the target stimulus (e.g. left-pointing cue and right-side target).

Each trial started with the presentation of a green or red fixation cross for 500 ms. After the fixation cross, (in)valid spatial cue (← or→) was presented for 500 ms. Fixation cross color and spatial cue validity were randomized across trials. After the presentation of the spatial cue, food pairs were presented for 1500 ms and the response duration was 2000 ms. (see Figure 2.3). The experiment consisted of four blocks with 120 trials each. Each block had 96 go trials (LH and HL conditions 50-50 %) and 24 no-go (LL and HH conditions 50-50 %). In the go trials, the proportion of valid and invalid spatial cues was 75% and 25% respectively.

2.3.4. Design and Data Analysis

The design was a within-subject design with two factors: “pair congruency” (LH or HL) and “cue validity” (valid or invalid). Reaction times (ms) and error rate (%) were the dependent variables. Repeated measures analysis of variance (ANOVA) was run for each hypothesis. No-go trials were not included in data analysis.

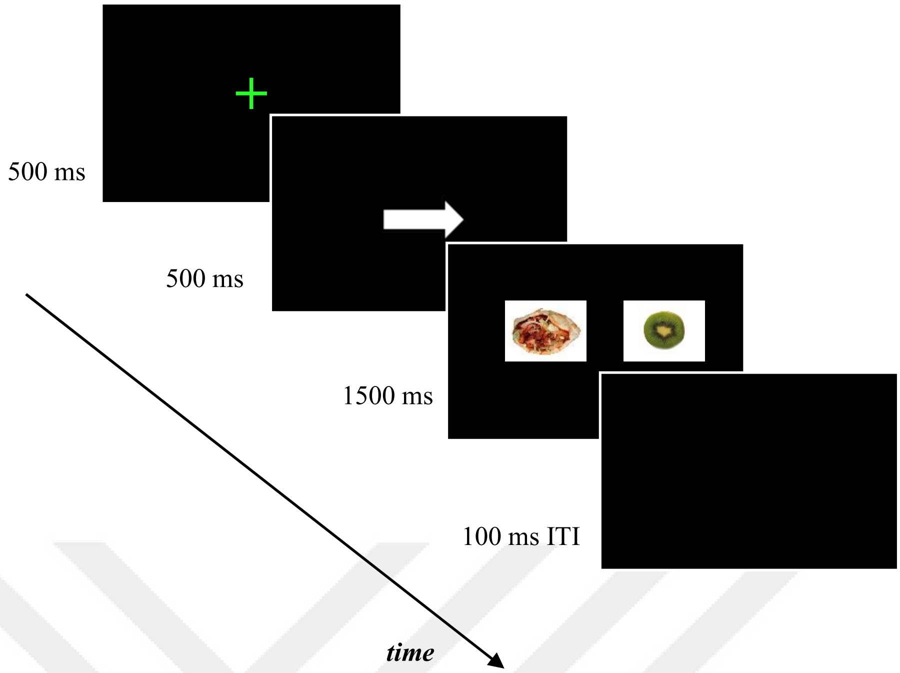

Figure 2.3. The Trial Sequence of Experiment 2.

First a green or red fixation cross was presented for 500ms, followed by a left or right spatial cue which was presented for 500 ms. Food stimuli pairs were presented and remained visible for 1500 ms. The task was to indicate the location of low-calorie food stimulus after the green, the location of high-calorie stimulus after the red fixation cross. In this example, incongruent stimuli pair, HL, was preceded by a green fixation cross and valid spatial cue, therefore localizing the low-calorie food (i.e. kiwi) was required. For this trial, pair congruency was incongruent due to HL pair presentation and cue-target validity was valid because the cue signaled the location of target stimuli.

2.3.5. Results

Data were analyzed using R (R Development Core Team, 2017) and Jamovi (The Jamovi Project, 2019). For Bayesian statistics, the open-source statistical software program JASP (JASP Team, 2019) was used. Incorrect responses (13.17%) and RTs outside of the range of ± 2.5 standard deviations from the mean were discarded as outliers (2.51%). Repeated-measures analyses of variance with the factors of pair congruency (LH, HL) and cue validity (valid, invalid) were run separately for reaction time and error rate measurements. Further examination of post-hoc comparisons (Tukey) was run for significant main and interaction effects.

For the RT, cue validity had a significant main effect on reaction times $F(1,15) = 5.82$, $p = 0.029$, $\eta_p^2 = 0.28$, $BF_{10} = 1.16$. The processing speed was faster for trials with valid cues (703 ms) than trials with invalid cues (717 ms). There was no significant main effect of pair congruency $F(1,15) = 1.49$, $p = 0.24$ $\eta_p^2 = 0.09$, $BF_{10} = 0{,}505$ suggesting that congruent LH pairs were not processed faster than incongruent HL pairs. The pair congruency and cue validity interaction was not significant $F(1,15) = 0.002$, $p = 0.96$ $\eta_p^2 = 0.001$, $BF_{10} = 0.319$ (see Figure 2.4A). Cue validity had a significant main effect on error rate $F(1,15) = 27.4$, $p < .001$ $\eta_p^2 = 0.65$, $BF_{10} = 134.504$ invalid cues led to higher error rates (17.4 %) compared to valid cues (11.8%). The main effect of pair congruency was also significant $F(1,15) = 13.2$, $p = 0.002$, $\eta_p^2 = 47$, $BF_{10} = 8.938$ indicating that participants had higher error rates for LH pair condition (M= 16.8%) than HL pairs (M= 12.4%). Pair congruency and cue validity interaction was significant $F(1,15) = 12.2$, $p = 0.003$, $\eta_p^2 = 45$, $BF_{10} = 18.4$. In order to test this further, Tukey's post-hoc test was run and it was found that $F(1,15) = 12.2$, $p = 0.003$, $\eta_p^2 = 45$, $BF_{10} = 18.4$ participants' performance was more erroneous for the LH pairs only when the cue was invalid (see Figure 2.4B).

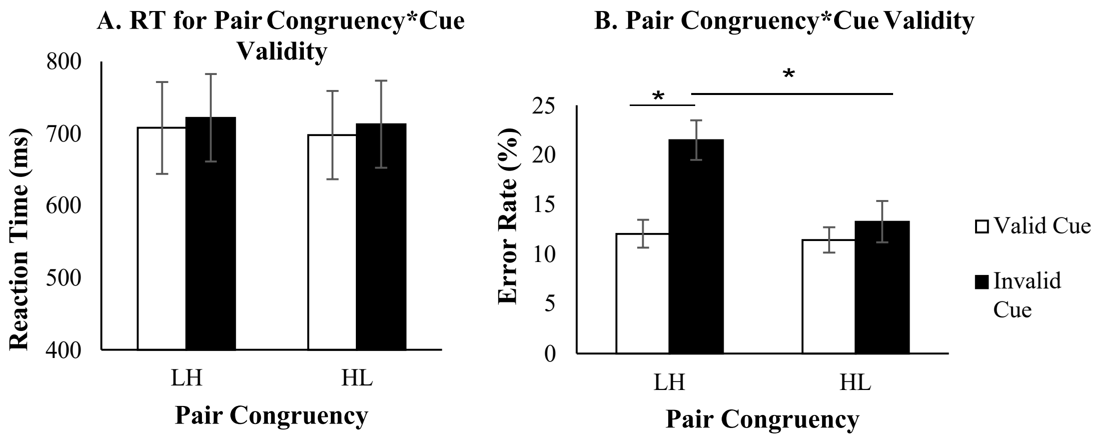

Figure 2.4. Mean Reaction Time and Error Rate Values of the Interaction Between Pair Congruency and Cue Validity Conditions in Experiment 2.

The graph (A) shows the mean RT and (B) shows the mean error rate on the valid and invalid trials for the congruent and incongruent food pair conditions. Error bars represent standard error of the means.

2.3.6. Discussion

Experiment 2 investigated whether the calorie-SNARC effect can be observed in the presence of endogenous spatial cues biasing attention to certain space. It was hypothesized that valid spatial cues would improve task performance, especially in the congruent condition by speeding the target selection process as attention would be biased to the target item. Hence, LH pairs were expected to have the fastest responses in the valid cue condition. Also, LH pairs were expected to have faster responses on invalid cue trials resulting in calorie-SNARC. Because on invalid cue trials, the opposite side of the target stimuli were cued and if LH pairs were the congruent representation, shifting attention from invalidly cued location to target location which was congruent representation should have been faster than shifting attention from invalidly cued location to target's location when the pairs were incongruent (e.g. HL). The results revealed that valid cues had faster and more accurate responses than invalid cues which are in accordance with previous findings (Berger, Dori, & Henik, 1999; Brignani, Guzzon, Marzi, & Miniussi, 2009; Posner, 1980a; Blair, Capozzi & Ristic, 2017). If the food pairs had readily available representation with low-calorie on the left and high-calorie on the right such presentation of stimuli pairs should enhance task performance in terms of both RT and error rate. Because, as earlier mentioned in the study of Romero and Biswas (2016), people have a natural representation of food stimuli and this association leads to facilitation on target selection. However, the results revealed that LH pairs led to a higher number of erroneous responses compared to HL pairs. Further investigation revealed that LH pairs were answered more erroneously only when the cue was invalid. In other words, when LH pairs were invalidly cued, participants shifted their attention from invalidly cued location to target stimuli's location with lower accuracy rate compared to HL pairs on invalid cue trials contrary to expectations. This result suggests that LH pairs do not represent congruent representation that facilitates task performance in the presence of endogenous cues moreover, this study suggested that the task performance in terms of accuracy was impaired in the presence of invalid cues for congruent (LH) trials.

In Experiments 1 and 2, the color of the fixation cross varied between red and green to signal the target stimulus. Red fixation cross indicated that the target would be the high-calorie item and the green fixation cross indicated that the target would be the low-calorie item in the display. This target defining feature could have activated approach and avoidance mechanisms towards the food stimuli. In other words, the red fixation cross color might have created a stop signal, whereas the green fixation cross color might have created a go signal for the food stimuli. While approach behaviors are demonstrated as behaviors toward the positive stimulus, avoidance behaviors are considered as behaviors away from the negative stimulus (Elliot, Maier, Binser, Friedman & Pekrun, 2009). Approach-avoidance behaviors towards food stimuli under different color conditions were investigated in the food context as well. Bruno, Martani, Corsini, and Oleari (2013) investigated the effects of colors on food choice behavior. They served popcorn (Experiment 1) and chocolate chips (Experiment 2) to a different group of participants on a red, blue and white plate. Participants were asked to try and then to evaluate their sensory qualities with a given mock questionnaire. Participants also were told that there were no correct answers and they could sample how much food they want. Participants consumed fewer popcorns and chocolate chips when they were served on a red plate than the blue or white plates. Authors interpreted this as the color red states danger and prohibition that is culturally learned or biologically embedded association as also Genschow and colleagues (2012) suggest. Therefore, red evokes avoidance motivation that results in decreased food intake in the food domain. Genschow, Reutner & Wänke, (2012) conducted two studies to examine the effect of the color red on beverage and food consumption. In Study 1, participants were served three different drinks that labeled A, B and C with the background colors red in one condition, blue in the other condition. Participants were instructed to sample and then evaluate the drinks. As a result, the participant consumed fewer beverages when the label of the cup was red. In Study 2, participants were given questionnaires with the irrelevant purposes of the study and 10 pieces of pretzels on a red, blue or white plate. Participants could eat while filling the questionnaire. It was found that participants ate fewer pretzels when the color of the plate was red in comparison to blue or white. To sum up, the current literature indicates that the color of red evokes avoidance behavior for food and beverages. This avoidance behavior that the color red creates toward food stimuli was the motivation of Experiment 3 which was designed to investigate whether the color red evokes avoidance motivation towards food stimuli.

2.4. EXPERIMENT 3

In Experiment 3, the focus was on whether the fixation cross color activates approach and avoidance mechanisms for the low and high-calorie food stimuli respectively. Since the color red is often associated with danger and prohibition (Elliot et al., 2009; Genschow, Reutner, & Wänke, 2012) it was thought that red fixation cross could elicit avoidance behavior toward food stimuli by acting as a stop signal thus resulting in slower RT and more erroneous answers. The tasks that measure approach and avoidance mechanisms are called approach-avoidance tasks (e.g. Solarz, 1960; Eder & Rothermund, 2008). Approach tendency indicates approaching toward positively evaluated and avoidance tendency indicates avoiding negatively evaluated stimuli and incidents (e.g. Watson, Wiese, Vaidya & Tellegen, 1999). Therefore, in approach-avoidance tasks, when the stimuli-response pairing is congruent (e.g. approach toward positive and avoid from negative stimuli) task performance in terms of RT gets faster (Krieglmeyer, De Houwer & Deutsch, 2013). During the tasks, approach and avoidance behaviors are usually measured by pulling (approach) or pushing (avoidance) a lever according to the instructions (e.g. pull for positive word, push away for negative word vice versa). Rohr and colleagues (2015) examined the approach-avoidance task in the food domain with green and red color. Participants were presented black and white line drawings of healthy and unhealthy foods surrounded by task irreverent circle in green or red. They were instructed to move the mouse towards themselves (approach behavior) whenever they saw heathy food drawing or away (avoidance) whenever they saw unhealthy food drawing regardless of the surrounding circle's color. Then, participants were instructed for the opposite patterns, moving the mouse away for healthy food and towards the unhealthy food. When participants were asked to move the mouse away in the presence of unhealthy food stimuli, responses were faster on the trials that consisted of a red circle compared to green. Therefore, the authors concluded that red color increased the avoidance behavior towards unhealthy food stimuli while the color green did not lead to approach behavior towards healthy food items (Rohr et al., 2015).

In Experiments 1 and 2, the target was high-calorie food stimuli after the red fixation cross and low-calorie food stimuli after the green fixation cross. According to recent studies, this target defining strategy could have activated an automatic behavior pattern.

Activation of automatic pattern might have resulted in avoidance behavior for high-calorie food stimuli on trials with the red fixation cross. However, avoidance behavior in the tasks that Experiment 1 and 2 could result in slower responses for high-calorie food in the presence of the color red. In order to examine whether the red color activates such a behavior pattern, Experiment 3 was conducted. In this experiment, the fixation cross color was task-irrelevant and randomized across trials. In other words, the green and red fixation cross did not define target stimuli as in previous experiments. Therefore, in the current experiment, we expected that if the color red (green) evoke avoidance (approach) behavior participants would respond slower (faster) to high-calorie food stimuli.

2.4.1. Participants

Eighteen participants participated in Experiment 3 (female: 17, right-handed: 17, Mage = 20.72 years, SD = 3.82 years). The study was approved by the Ethics Committee of Kadir Has University. Prior to participation, participants gave informed consent. Participants who were enrolled in the psychology undergraduate program received course credits for their participation. All participants had a normal or corrected-to-normal vision. They were naïve to the purpose of the study and debriefed after the participation.

2.4.2. Materials

Materials used in Experiment 3 were identical with Experiment 1 with the exception of the selection criteria of the food stimuli. In Experiment 1, the visual properties such as complexity and object size of the food stimuli were not controlled which may be confounding. In Experiment 3, in order to create low and high-calorie food stimuli sets, object size and the complexity scores of the food stimuli were matched. Scores for object size and complexity of food stimuli were obtained from normative ratings of the Food-pics database (Blechert et al., 2014, 2019). Stimuli with the scores above or below 1 standard deviation from the mean score of complexity and object size were discarded from the stimuli set, leading 16 stimuli of low and high calorie each.

2.4.3. Procedure

The procedure of Experiment 3 was identical with Experiment 1 except the following differences; fixation cross color was task-irrelevant and did not define the target stimuli. The target was high-calorie food stimuli in the half of the blocks and the low-calorie food stimuli in the other half of the blocks. The order of the blocks was counterbalanced. In addition, no-go trials were not included in Experiment 3, as they do not require any response and response was required to measure the approach and avoidance behaviors. Experiment 3 consisted of two food pairs LH (e.g. salad-hamburger) and HL (e.g hamburger-salad). Practice block was identical with Experiment 1 except, participants were instructed to indicate pebble stones location since the target stimuli do not change within the blocks as Experiments 1 and 2. In the experiment, each trial started with a red or green fixation cross for 500 ms. After the fixation cross food pairs were presented for 1500 ms (see Figure 2.5). Participants were asked to press the button "A" if the target was on the left and to press the button "L" if the target was on the right side. The response duration was 2000 ms. The background color was white. The experiment consisted of 4 blocks with 120 trials each and 16 different stimuli for each stimuli type.

2.4.4. Design and Data Analysis

The design was a within-subject design with three factors: "fixation color" (green or red), "pair congruency" (LH or HL) and "target calorie" (high or low). Reaction times (ms) and error rate (%) were the dependent variables. Repeated measures analysis of variance (ANOVA) was run for each hypothesis. The detection of low/high-calorie target followed by the red or green fixation cross was of particular interest to investigate the approach/avoidance mechanisms.

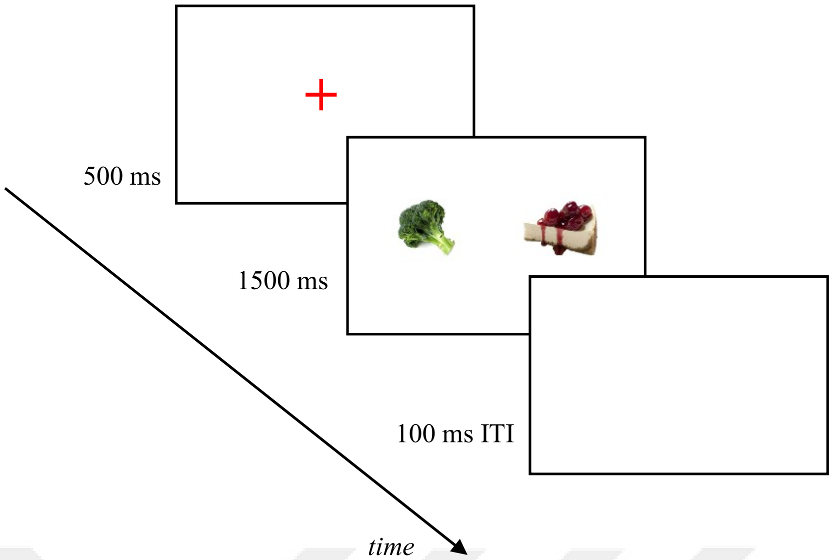

Figure 2.5. The Trial Sequence of Experiment 3.

First a green or red fixation cross was presented for 500 ms, the following food, pairs were presented. Food pairs consisted of low-calorie on the left and high-calorie on the right were considered congruent, and pairs that consisted of low-calorie on the right and high-calorie on the left was considered as incongruent. Each pair of food stimuli remained visible for 1500 ms. The task was to indicate the location of low or high-calorie food stimuli. The target was high-calorie food stimuli in the half of the blocks and the low-calorie food stimuli in the other half of the blocks. In this example, congruent stimuli pair, LH, was preceded by a red fixation cross. Participants needed to indicate the location of the low-calorie stimulus (e.g. left-broccoli) or the high-calorie stimulus (e.g. cherry cheesecake-right) according to instruction which was given at the beginning of each trial.

2.4.5. Results

Data were analyzed using R (R Development Core Team, 2017) and Jamovi (The Jamovi Project, 2019). For Bayesian statistics, the open-source statistical software program JASP (JASP Team, 2019) was used. Differences in RT and error rate were analyzed by two-way repeated-measure ANOVA. Further examination of post-hoc comparisons (Tukey) was run for significant main and interaction effects. Incorrect responses (5.14%) and RTs outside of the range of ± 2.5 standard deviations from the mean were discarded as outliers (2.68%).

The analyses on RT variable did not reveal any effect ofthe fixation cross color ($F(1,17) = 2.16$, $p = 0.16$, $\eta_p^2 = 0.11$, $BF_{10} = 0.27$), pair congruency ($F(1,17) = 2.76$, $p = 0.11$, $\eta_p^2 = 0.14$, $BF_{10} = 0.21$) nor the target's calorie type ($F(1,17) = 0.15$, $p = 0.69$, $\eta_p^2 = 0.009$, $BF_{10} = 0.23$). Two-way ($F_{fixcolor*paircongruency}$ $(1,17) = 0.31$, $p = 0.58$, $\eta_p^2 = 0.018$, $BF_{10} = 0.25$; $F_{fixcolor*targetcalorie}$ $(1,17) = 0.42$, $p = 0.52$, $\eta_p^2 = 0.024$, $BF_{10} = 0.26$; $F_{paircongruency*targetcalorie}$ $(1,17) = 1.01$, $p = 0.32$, $\eta_p^2 = 0.56$, $BF_{10} = 0.52$) and three-way ($F_{fixcolor*paircongruency*targetcalorie}$ $(1,17) = 1.01$, $p = 0.32$, $\eta_p^2 = 0.056$, $BF_{10} = 0.32$) interactions were not significant.

Similar pattern was observed for the error rates. No significant effect of pair congruency $F(1,17) = 0.28$, $p = 0.60$, $\eta_p^2 = 0.01$, $BF_{10} = 0.22$), fixation cross color ($F(1,17) = 0.38$, $p = 0.54$, $\eta_p^2 = 0.02$, $BF_{10} = 0.19$) and target calorie type ($F(1,17) = 0.43$, $p = 0.51$, $\eta_p^2 = 0.02$, $BF_{10} = 0.26$) was observed on error rates. In addition, two-way ($F_{fixcolor*paircongruency}$ $(1,17) = 0.07$, $p = 0.78$, $\eta_p^2 = 0.005$, $BF_{10} = 0.25$; $F_{fixcolor*targetcalorie}$ $(1,17) = 3.30$, $p = 0.87$, $\eta_p^2 = 0.16$, $BF_{10} = 0.49$; $F_{paircongruency*targetcalorie}$ $(1,17) = 0.58$, $p = 0.45$, $\eta_p^2 = 0.033$, $BF_{10} = 0.25$) and three-way interaction ($F_{fixcolor*paircongruency*targetcalorie}$ $(1,17) = 0.122$, $p = 0.73$, $\eta_p^2 = 0.007$ $BF_{10} = 0.37$) were not significant (see Figure 2.6A and Figure 2.7A for RT; Figure 2.6B and Figure 2.7B for error rate results).

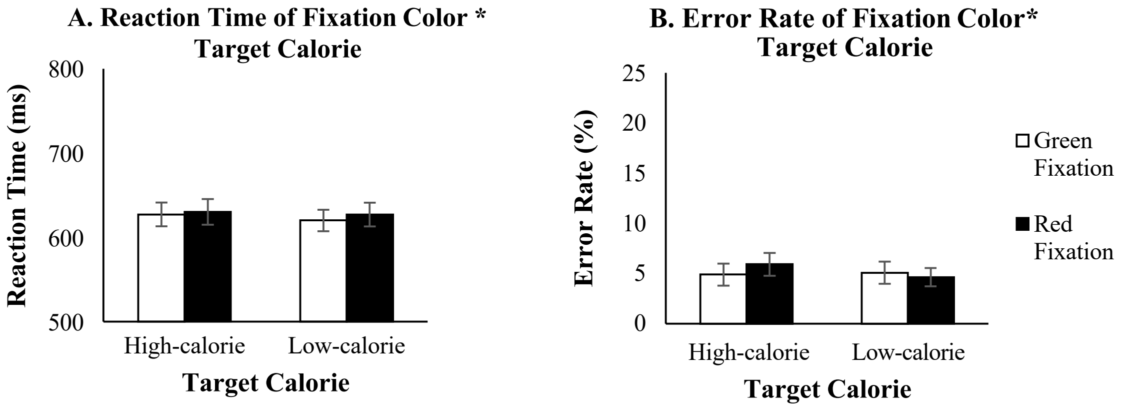

Figure 2.6. Mean Reaction Time and Error Rate Values of the Interaction Between Fixation Cross and Target Calorie Conditions in Experiment 3

The graph (A) shows the mean RT and (B) shows the mean error rate on the green and red fixation cross trials for the high and low-calorie target calorie conditions in Experiment 3. Error bars represent standard error of the means.

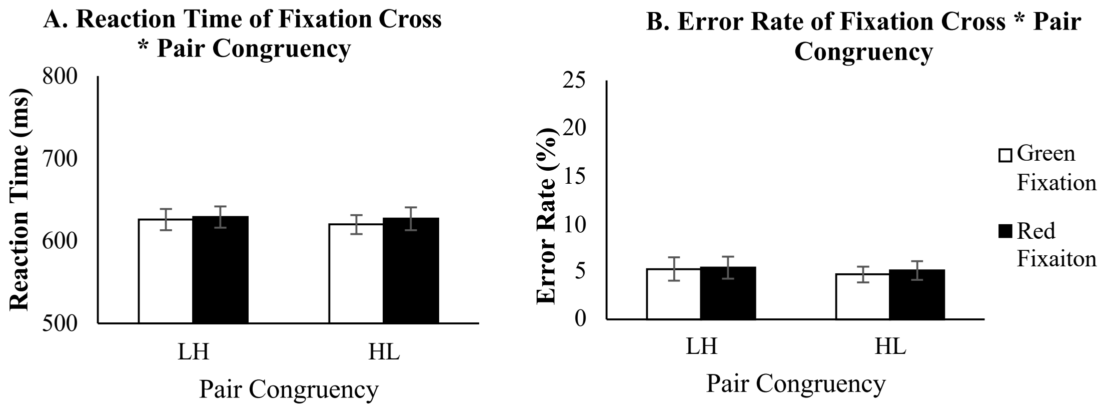

Figure 2.7. Mean Reaction Time and Error Rates Values of the Interaction Between Fixation Cross and Pair Congruency Conditions in Experiment 3.

The graph (A) shows the mean RT and (B) shows the mean error rate on the green and red fixation cross trials for the congruent and incongruent food pair conditions of Experiment 3. Error bars represent standard error of the means.

2.4.6. Discussion

Experiment 3 was designed to test whether the lack of calorie-SNARC effect is due to the target defining attributes, namely red and green fixation crosses activating the avoidance and approach mechanisms respectively that could potentially prevent the calorie-SNARC effect by not creating the food stimulus and location representation needed for the calorie-SNARC effect to occur. The randomization of red and green fixation cross colors in the current experiment did not change the pattern observed in Experiments 1 and 2. This finding did not support the findings of Rohr and colleagues (2015) who suggested that the color red evokes avoidance behavior towards unhealthy food. In Experiment 3 the use of the red fixation cross did not cause avoiding the high-calorie food stimuli. In other words, when the participants did not have a bias towards the low or high-calorie target, the target detection performance did not change compared to when the target was known in advance.

CHAPTER 3

3. STUDY 2

Study 2 consisted of 2 experiments and aimed to investigate working memory performances of individuals with low and high restrained eating style in the presence of low-calorie, high-calorie and object stimuli. Varying levels of N-back task difficulty (n-1, n-2, and n-3) was used in order to examine task performance under different working memory load conditions. Experiment 4 investigated working memory performance when the low-calorie, high-calorie and object stimuli were presented block-wise manner whereas in Experiment 5 working memory performance was examined when different stimuli type presented within a block in a randomized order. Thus the effect of stimuli presentation style on task performance will be examined. Moreover, presenting all stimuli type within the block in a randomized order enabled to investigate how do stimuli type transition affect the working memory performance (e.g. task performance in terms of RT and *d'* when one sees high-calorie food followed by an object, vice versa).

Half of the participants were performed the experiment with colorful stimuli, and the other half performed in B&W stimuli. Stimuli in colorful and B&W conditions were identical. Researchers suggest that colors attract more attention (Lohse 1997) and naming the B&W object takes a longer time (Biederman & Ju, 1988). Therefore, food stimuli, also object stimuli, would be recognized later when they are presented in B&W resulting in slower RT compared to colorful versions. In the current study, it was investigated whether the presentation of the food and object stimuli either in color or B&W affects working memory task performance differently in different working memory load conditions. The hypothesis of the present study is as follows: (a) Food stimuli (low and high-calorie) compared to object stimuli were expected to decrease task performance e.g. slower reaction times and decreased *d'* in both experiments. (b) In the high working memory load condition (e.g. n-3), high-calorie food stimuli would decrease high restrained participants' working memory performance in both experiments. (c) Moreover, it was hypothesized that this decrement in working memory performance and prolonged RT for stimuli type transitions are expected to be more dramatic for individuals who have high restrained eating scores in Experiment 5. (d) Colorful version of food stimuli was expected to be processed faster than the black and white versions in both experiments.

3.1. GENERAL METHOD

The general setup of both studies was identical with the exceptions noted in the procedure section of each experiment.

3.1.1. Stimuli and Materials

Study 2 consisted of three different stimuli types: low-calorie, high-calorie, and non-food object stimuli. Low and high-calorie stimuli were obtained from the pilot study that was conducted to choose stimuli set for Study 1. 30 low and 30 high-calorie food pictures that have been voted as low and high-calorie by majority were chosen for Study 2. In addition, 30 object stimuli (e.g. pen, scissor) were randomly chosen from the Food-pics database (Blechert et al., 2014; 2019). B&W versions of each stimulus were created by paint.net™. Restrained eating styles of participants were assessed by a subscale of the Dutch Eating Behavior Questionnaire (DEBQ; van Strien, Frijters, Bergers, & Defares, 1986). DEBQ found as a reliable and valid index that could be used in a Turkish sample (Bozan, 2009). The DEBQ questionnaire was developed to assess the eating style of individuals and it consists of three different subscales: restrained eating subscale (10 items), emotional eating subscale (13 items) and external eating subscale (10 items). In the scale participants rated each item from 1 (seldom) to 5 (very often) on a 5-point Likert scale. Item scores were added to obtain an overall score and then the overall score was divided by the number of subscale items (e.g. divided by 10 for restrained eating subscale). Thus, each participant had one eating score per category. Greater scores suggested an increased tendency to have that specific eating behavior (e.g. restrained eating behavior). In addition to DEBQ, height, and weight were collected from each participant to calculate the body-mass index (BMI).

3.2. EXPERIMENT 4

Experiment 4 was designed to investigate working memory performances of individuals with low and high restrained eating style in the presence of low-calorie, high-calorie and object stimuli that were presented in colorful or B&W condition. Varying levels of n-back task difficulty (n-1, n-2, and n-3) were used and the stimuli type was presented in a block-wise manner.

3.2.1. Participants

Eighty-two participants participated in Experiment 4 (female: 57; right-handed: 76; mean of age: 20.6 years, SD: 1.39). The study was approved by the Ethics Committee ofKadir Has University. Prior to participation, participants gave informed consent. Participants who were enrolled in the psychology undergraduate program received course credits for their participation. All participants had a normal or corrected-to-normal vision. They were naïve to the purpose of the study and debriefed after the participation.

3.2.2. Procedure

Half of the participants were tested in colorful and the other half were tested in B&W stimuli color condition. Participants were randomly chosen as one of the conditions. The practice session (3 blocks, 15 trials each) was run for n-1, n-2, and n-3 tasks separately prior to the experiment (9 blocks, 80 trials each). The data of the practice session was not recorded. In the practice sessions instead of low and high-calorie stimuli, neutral stimuli (e.g. scenes) were used in order to avoid priming participants with thoughts of foodprior to the main experiment. The background color was set to black and all stimuli were presented in the center of the computer screen (size: 15° x 11.25°). Each trial started with a centered white fixation cross (size: 3°) for 1000 ms. Following the fixation cross, food stimuli were presented for 1500 ms. Participants were instructed to respond whether the current stimuli are the same stimuli or not as in one trial before (n-1), two trials before (n-2) or three trials before (n-3). If the item was the same, participants were instructed to press the button "A" and if not, to press the button "L". While 25% of the total trials consisted of target stimuli, therefore, required the "same" response, 75% of the trials did not consist of target stimuli, therefore, required "different" responses. The response period was 1500 ms and if the response was not made within 1500 ms, trial considered as an error, Inter-trial interval was set to 100 ms (see Figure 3.1). Stimuli type conditions (low-calorie, high-calorie, and object) were presented block-wise, therefore each block consisted of one of three stimuli type only. In order to increase the working memory load of the task gradually, each n-back condition was presented in ascending order (n-1 → n-3). This stimuli presentation strategy resulted in nine different blocks (n-1 low, n-1 high, n-1 object, n-2 low, n-2 high, n-2 object, n-3 low, n-3 high, n-3 object). For example, if the participant started the experiment with n-1 condition with low-calorie food stimuli, he would randomly get high-calorie or object n-1 condition as the second block and third block would be the one that was not presented as a second block. This sequence continued for n-2 and n-3 conditions as well. The presentation of the stimuli (food/object) was counterbalanced across participants. After each block, participants could take a small break before continuing. Participants filled the Dutch Eating Behavior Questionnaire (DEBQ) when the experiment was over. The questionnaire was given to the participants after the experiment in order to avoid priming them with thoughts of eating and dieting behavior.

3.2.3. Design and Data Analysis

The experimental design was 3x3x2x2 with n-back condition (n-1, n-2, n-3) and stimuli type (low-calorie, high-calorie, object) as within; restrained eating style (low, high) and stimuli color condition (colorful, B&W) as between-subjects factors. The dependent variables were RT and discriminability index (*d'*).

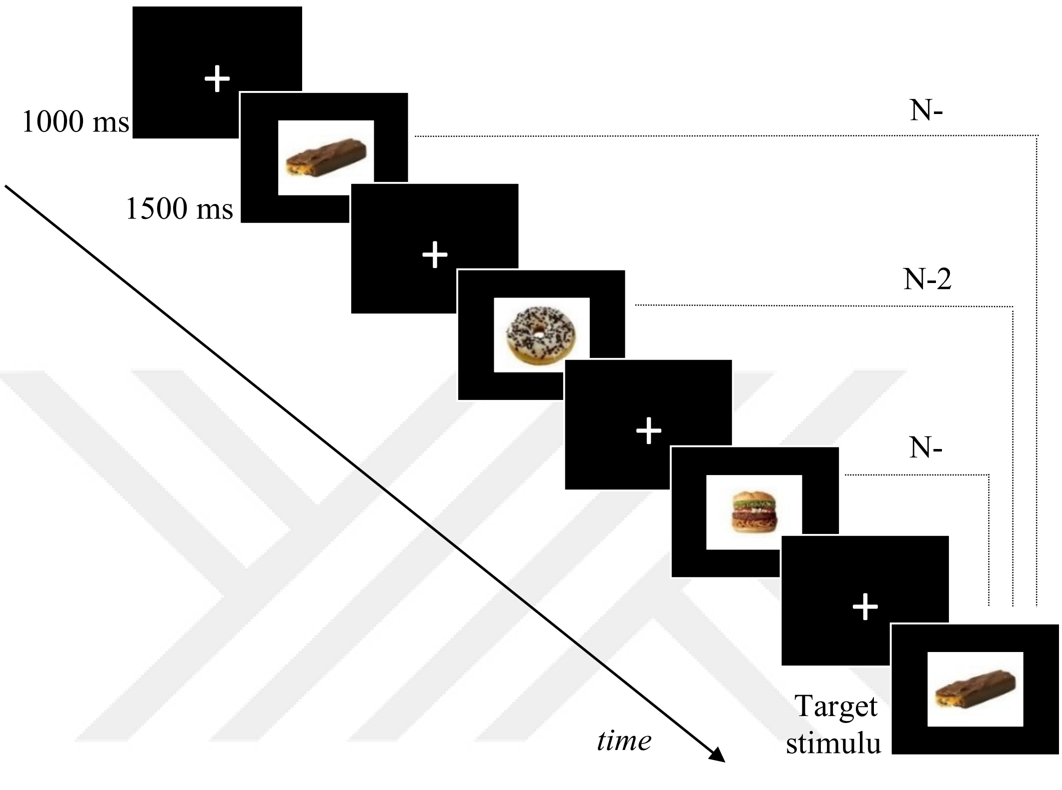

Figure 3.1. The Trial Sequence of Experiment 4.

Each pair of food stimuli preceded by a central fixation cross for 500 ms and remained visible for 1500 ms. The task was to indicate if present stimuli were the same with n^{th} stimuli before (n-1, n-2, n-3). In this example, participants were asked to give the same/different responses for the chocolate bar (e.g. target stimulus) if it matches three stimuli before.

3.2.4. Results

Data were analyzed using R (R Development Core Team, 2017) and Jamovi (The Jamovi Project, 2019). Differences in RT and *d'* (discriminability index) were analyzed by 4 way mixed repeated-measure ANOVA. Further examination of post-hoc comparisons (Tukey) was run for significant main and interaction effects. When sphericity was violated according to Mauchly's test, degrees of freedom were corrected by using Greenhouse-Geisser estimates of sphericity.

Prior to analysis for each stimuli color condition participants were divided into two different eating style category by using median split method: high restrained eaters (in colorful stimuli condition: n: 21, mean score: 2.91, SD: 0.49; in B&W stimuli condition: n: 21, mean score: 3.32, SD: 0.48) and low restrained eaters (in colorful stimuli condition: n: 20, mean score: 1.67, SD: 0.39; black and white condition; n: 20, mean score: 1.77, SD:0.5). Cut off point of the median split was 2.4 and 2.5 for colorful and B&W conditions, respectively.

Incorrect responses (9.87 %) and trials with ± 2.5 standard deviations from the reaction time mean were discarded as outliers (2.38 %). N-back level revealed a significant main effect on reaction time $F(1.61,125.4) = 17.08$, $p < 0.001$, $\eta_p^2 = 0.18$, $BF_{10} = 2.923 \times 10^{14}$. Participants were faster in n-1 (595 ms) than n-2 (644 ms) condition ($p < 0.001$). Also, faster in n-3 (586 ms) than n-2 (644 ms) condition ($p < 0.001$). However, n-1 and n-3 condition did not differ in terms of RT. Stimuli type revealed a main $F(2,156)= 16.31$, $p < 0.001$, $\eta_p^2= 0.17$, $BF_{10} = 54.006$; object stimuli (592 ms) were processed faster than both low-calorie (612 ms) and high-calorie (621 ms) stimuli (p < 0.001 for both comparison). However, the difference between low-calorie and high-calorie stimuli was not significant. There was a main effect of stimuli color $F(1,78)= 20.54$, $p < 0.001$, $\eta_p^2 = 0.21$, $BF_{10} = 1036.906$; colorful stimuli (567 ms) were processed faster than black and white (650 ms) versions (p < 0.001) (see Figure 3.2A). There was no main effect of retrained eating style ($p = .37$, $BF_{10} = .341$). Moreover, all 2-way and 3-way interaction effects between restrained eating style and other variables were not significant.

For *d'* values similar pattern was observed. There was a main effect of n-back condition $F(1.69,132.06) = 200.18$, $p < 0.001$, $\eta_p^2 = 0.72$, $BF_{10} = 9.095 \times 10^{91}$; n-1 (3.30) had the highest, n-2 (2.51) had intermediate and n-3 (1.84) condition had the lowest *d'* values (all $p < 0.001$). Moreover, there was a main effect of stimuli type $F(2.156)= 17.36$, $p < 0.001$, $\eta_p^2 = 0.18$, $BF_{10} = 11.910$; high-calorie food stimuli (2.38) had lower *d'* values than both low-calorie (2.61) and object (2.66) stimuli (p < 0.001 for both comparison). However, *d'* values for low-calorie and object stimuli were not significantly different (see Figure 3.2B). There was no main effect of retrained eating style ($p = 0.93$, $BF_{10} = .133$). In addition, 2-way and 3-way interaction effects between restrained eating style and other variables were not significant.

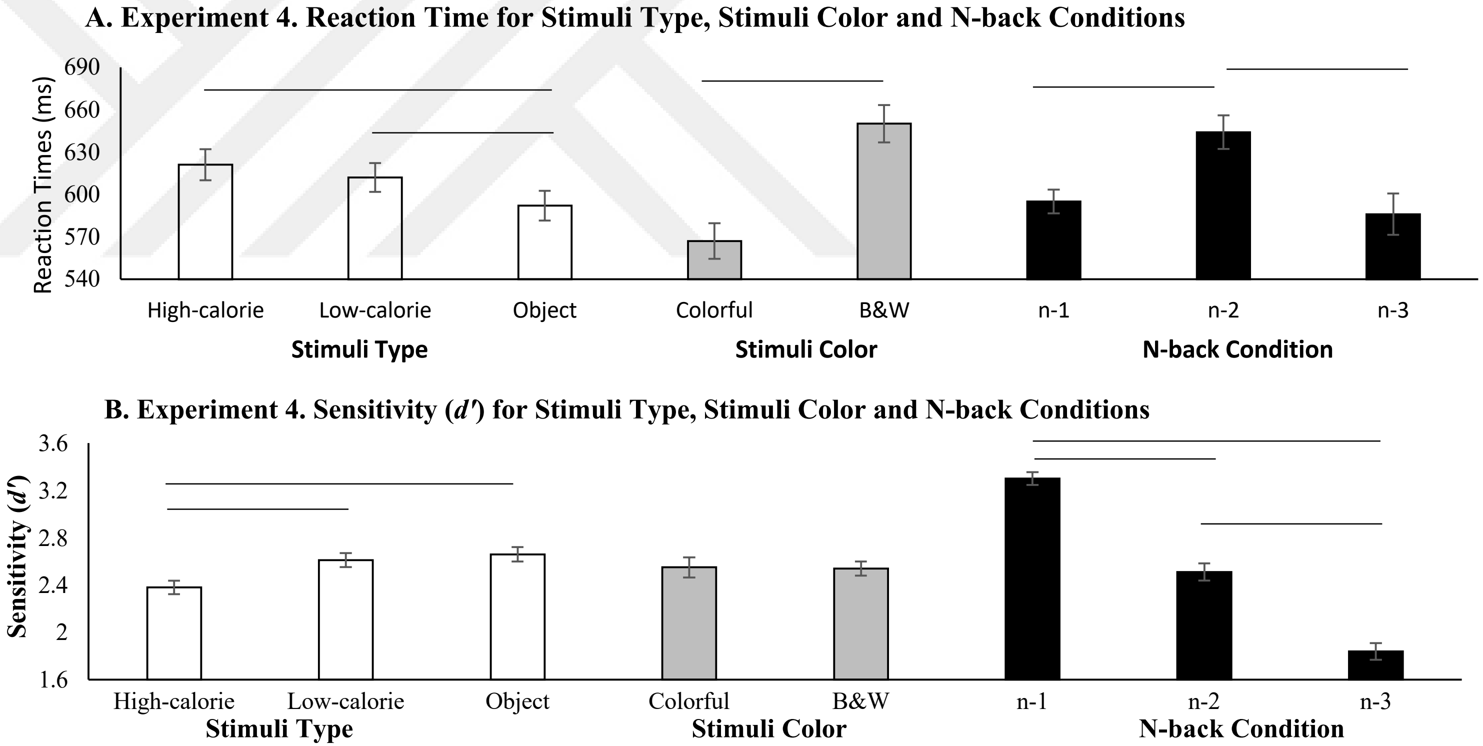

Figure 3.2. Mean Reaction Time and d' Values of Stimuli Type, Stimuli Color and N-back Conditions in Experiment 4.

Reaction Time (A) and *d'* (B) values of stimuli type (high-calorie, low-calorie, and object), stimuli color (colorful, B&W) and n-back conditions (n-1, n-2, and n-3) were presented in the present chart. Stimuli type was represented by white, stimuli color by grey and n-back condition by black bars from left to right respectively. Error bars represent standard error of the means.

3.2.5. Discussion

Experiment 4 was designed to investigate the working memory performance with an n-back task consisted of three different stimuli types (low-calorie, high-calorie and object stimuli) in two different color conditions (B&W and colorful). It was hypothesized that processing high-calorie food stimuli would decrease the task performance under high cognitive load especially for high restrained eaters.

Results revealed gradual decrement in n-back task performance as working memory load increased (n-1 → n-3). This pattern is frequently observed in studies that use n-back task (e.g. Verhaeghen, & Basak 2005; Pesonen, Hämäläinen & Krause, 2007, Gokce & Harma, 2018). There was only one exception in this pattern; although working memory load increased from n-2 to n-3 condition, responses in the n-3 condition were faster than the n-2 condition which was not expected. The reason for this unexpected pattern could be due to the difficulty of the n-3 condition. Since participants had difficulties in target detection during the n-3 condition, they may have responded faster without giving importance to accuracy. As it was hypothesized food stimuli decreased task performance (e.g. slower reaction times and less target detection sensitivity) compared to object stimuli. This result supported previous findings (both slower responses and more errors: Meule et al., 2012; Meule, 2016). Self-reported food craving was not measured after each block in the current experiment whether the presentation of food stimuli resulted in increased desire to eat however behavioral results show that participants needed a longer time to decide whether current stimuli matched with the n^{th} trial(s) before when the stimuli were food stimuli. Moreover, high-calorie food stimuli resulted in less detection sensitivity that may indicate low and high-calorie foods may impair task performance on different levels. When participants performed stimuli type blocks-wise, they were presented high-calorie food stimuli continuously. This presentation strategy might have created more desire to eat or thoughts about eating in the presence of high-calorie food stimuli compared to low-calorie food stimuli, therefore, results in decreased target detection sensitivity.

The restrained eating style did not affect task performance (see for a similar result, Meule, 2016). In other words, high restrained eaters did not show decreased task performance compared to low-restrained eaters. Food stimuli, especially high-calorie, decreased task performance for all participants compared to object stimuli (Werthmann et al. 2013; Ahern, Field, Yokum, Bohon & Stice, 2010). B&W versions of stimuli decreased processing speed for all low-calorie, high-calorie and object stimuli conditions while they did not affect sensitivity. Both low and high restrained eaters were slower to detect stimuli when they were in B&W. This result was expected since color information increase the object naming process (Biederman & Ju, 1988; Davidoff & Ostergaard, 1988; Joseph & Proffitt, 1996; Ostergaard & Davidoff, 1985). In other words, pictures are named faster when they are in color compared to when they are presented in B&W (e.g. Ostergaard & Davidoff, 1985). Concordantly in the present study, presenting food pictures in B&W resulted in slower recognition namely slower response. Therefore, using food stimuli in B&W instead of their original usual color might reduce the recognition of food stimuli, therefore, reduce food consumption.

In the present experiment, low-calorie, high-calorie and object stimuli were presented block-wise. Therefore, participants did not perform the n-back task that contains all stimuli types within a given block. This stimuli presentation strategy can cause target prediction and affect task performance. For example, the block that contained high-calorie food stimuli required to tune the system for only high-calorie food during the task. Thus, participants knew that all upcoming target stimuli would be high-calorie. In contrast, when the low-calorie, high-calorie and object stimuli are presented randomly in a flow, participants cannot predict the upcoming target's stimuli type. Moreover, this approach enables us to investigate the performance among stimuli type transitions. For instance, we can investigate whether seeing high-calorie food stimulus as the first and the object stimulus the second or vice versa affects task performance differently. With these motivations, Experiment 5 was conducted.

3.3. EXPERIMENT 5

The aim of Experiment 5 was identical with Experiment 4 with a difference in stimuli presentation strategy. In the current experiment stimuli type was presented in randomized order not block-wise as in Experiment 4.

3.3.1. Participants

Forty-three participants participated in Experiment 5 (female:31; right-handed: 41; mean of age: 21.77 years, SD: 2.58). The study was approved by the Ethics Committee of Kadir Has University. Prior to participation, participants gave informed consent. Participants who were enrolled in the psychology undergraduate program received course credits for their participation. All participants had a normal or corrected-to-normal vision. They were naïve to the purpose of the study and debriefed after the participation.

3.3.2. Materials

In Experiment 4, the visual properties such as complexity and object size of the food stimuli were not controlled which may be confounding. In Experiment 5, in order to create low-calorie food, high-calorie food and object stimuli sets, object size and the complexity scores of the stimuli were matched by excluding the pictures with the scores above or below 1 standard deviation from the mean score of complexity and object size. This stimuli selection strategy resulted in 18 stimuli of low-calorie, high-calorie and object stimuli each.

3.3.3. Procedure

The identical practice session as in Experiment 4 was run. The trial sequence differed from Experiment 4 by the presentation strategy of the stimuli type. In Experiment 5, low-calorie, high-calorie and object stimuli were presented in randomized order within each block. As in Experiment 4, in order to increase the working memory load of the task gradually, each n-back condition was presented in ascending order (n-1 → n-3). This stimuli presentation strategy resulted in six different blocks of 117 trials each.

After each block, participants could take a small break before continuing. Participants were given the Dutch Eating Behavior Questionnaire (DEBQ) when the experiment was over. The questionnaire was given to the participants after the experiment in order to avoid priming them with thoughts of eating and dieting behavior.

3.3.4. Design and Data Analysis

The design was a mixed design with four factors: “n-back condition” (n-1, n-2, n-3) and “stimuli type” (low-calorie, high-calorie, object) as within; “restrained eating style” (low, high) and “stimuli color” (colorful, B&W) as between-subjects factors. The dependent variables were RT and discriminability index (*d’*). A 3 (n-back condition) x 3 (stimuli type) x 2 (restrained eating style) x 2 (stimuli color condition) mixed ANOVA was run for analysis.

On a given trial, participants were presented with one of three different stimuli types: “high-calorie,” “low-calorie,” and “object,” (each on 33% of trials). For the next trial, one of three stimuli were presented randomly. Therefore, there were nine different possible transitions: high-calorie followed by high-calorie (HH), low-calorie followed by low-calorie (LL), object followed by object (OO), low-calorie followed by high-calorie (LH), high-calorie followed by low-calorie (HL), object followed by high-calorie (OH), high-calorie followed by object (HO), object followed by low-calorie (OL) and low-calorie followed by object (LO). For example, for n-1 condition HH transition was “**burger-burger**”, for n-2 condition “**burger**-kiwi-**burger**” and for n-3 condition “**burger**-kiwi-pen-**burger**”. Therefore, HH, LL and OO transitions consisted of target stimuli and required “same” response; HO, OH, LH, HL, LO and OL transitions consisted of no target stimuli and required “different” response.

Additionally, two separate mixed ANOVAs were run to test if participants perform differently in different stimuli type transition (target transitions: HH, LL, OO; non-target transitions: HO, OH, LO, OL, LH, HL). The design for follow-up analysis had two within: “n-back condition” (n-1, n-2, n-3) and “transition type” (HO, OH, LO, OL, LH, HL or HH, LL, OO) and with two between factors: “restrained eating style” (low, high) and stimuli color (colorful, black & white). The transition that has target stimuli (HH, LL, and OO) and transition that do not have target stimuli (HO, OH, LH, HL, LO, and OL) were analyzed separately. Dependent variables were RTs and discriminability index (*d’*).

3.3.5. Results

Data were analyzed using R (R Development Core Team, 2017) and Jamovi (The Jamovi Project, 2019). Differences in RT and *d'* (discriminability index) were analyzed by 4 way mixed repeated-measure ANOVA. Further examination of post-hoc comparisons (Tukey) was run for significant main and interaction effects. When sphericity was violated according to Mauchly's test, degrees of freedom were corrected by using Greenhouse-Geisser estimates of sphericity.

Prior to analysis for each stimuli color condition participants were divided into two different eating style category by using median split method: high restrained eaters (in colorful stimuli condition: n: 11, mean score: 3.25, SD: 0.38; in B&W stimuli condition: n: 10, mean score: 2.89, SD: 0.52) and low restrained eaters (in colorful stimuli condition: n: 11, mean score: 1.62, SD: 0.49; in B&W condition; n: 11, mean score: 1.56, SD: 0.36). Cut off point of the median split was 2.55 and 2.2 for colorful and B&W conditions, respectively.

Incorrect responses (10.5 %) and trials with ± 2.5 standard deviations from the reaction time mean were discarded as outliers (2.75 %) for RT analysis. N-back condition revealed a main effect $F(2,78)= 21.9$, $p < 0.001$, $\eta_p^2 = 0.36$, $BF_{10} = 2018\text{x}10^{24}$; n-1 level (585ms) was processed faster than both n-2 (654 ms) and n-3 (641 ms) level (both $p < 0.001$). However, there was no difference between n-2 and n-3 conditions. Also, stimuli type yielded a main effect $F(2,78) = 26.09$, $p < 0.001$, $\eta_p^2 = 0.40$, $BF_{10} = .487$; suggesting that processing speed was fastest for the object stimuli (618 ms), intermediate for low-calorie (625 ms) stimuli and slowest for the high-calorie (637 ms) stimuli ($p < 0.001$ for high-low and high-object and p = 0.032 for low-object comparisons). Lastly, color yielded a main effect $F(1,39) = 4.6$, $p = 0.038$, $\eta_p^2 = 0.11$, $BF_{10} = 1.989$; colorful (601 ms) stimuli were processed faster than black and white (653 ms) versions ($p = 0.038$) (see Figure 3.3A). There was no main effect of retrained eating style ($p = 0.51$, $BF_{10} = .414$). In addition, 2-way and 3-way interactions effects between restrained eating style and n-back condition were not significant.

d' analysis also revealed a main effect of n-back level $F(1.62,63.23)= 120.62$, $p < 0.001$, $\eta_p^2 = 0.76$, $BF_{10} = 3.15\text{x}10^{62}$; n-1 condition (3.43) had highest, n-2 had intermediate (2.68) and n-3 (2.08) had lowest sensitivity at target detection (all $p < 0.001$) (see Figure

3.3B). In addition, stimuli type and color revealed an interaction effect F (2,78) = 3.61, p = 0.32, η_p^2 = 0.09, BF_{10} = 0.1. However, post-hoc comparison did not yield any significant result. Finally, n-back condition and stimuli type yielded an interaction effect $F(4,156) = 5.23$, $p < 0.001$, $\eta_p^2 = 0.12$, $BF_{10} = 5.264$. While the sensitivity for target detection was not different for none of the stimuli type in n-1 and n-2 conditions, in n-3 condition, low-calorie (1.97) and high-calorie (1.96) food stimuli were detected with less sensitivity than object (2.29) stimuli ($p = 0.006$ for high-calorie and object, $p = 0.01$ for low-calorie and object difference) (see Figure 3.4). There was no main effect of retrained eating style ($p = 0.45$, $BF_{10} = .299$). In addition, 2-way and 3-way interactions were not significant.

Additionally, two separate mix ANOVAs were run to test whether participants perform differently in different stimuli type transitions. The transition that has target stimuli (HH, LL, and OO) and transition that do not have target stimuli (HO, OH, LH, HL, LO, and OL) were analyzed separately.

The stimuli transition had a ceiling effect for error rates. Participants' performance was close to perfect especially for non-target transitions (mean error rate: 3.62%, SD: 2.83). Therefore, the analysis for the error rate was not run for the transition type.

RT analysis for target transition (HH, LL and OO) revealed a main effect of transition $F(2,78) = 4.95$, $p = 0.009$, $\eta_p^2 = 0.011$, $BF_{10} = .107$. Post Hoc analysis revealed that there was a difference between HH (629 ms) and OO (616 ms) condition ($p = 0.007$). Also n-back level had main effect $F(1.71,66.88) = 46.11$, $p < 0.001$, $\eta_p^2 = 0.54$, $BF_{10} = 1.778 \times 10^{37}$; n-1 condition (568 ms) had the fastest, n-2 condition intermediate (642 ms) and n-3 condition (674 ms) had slowest RT ($p < 0.001$ for n-1 and n-2; n-1 and n-3, $p = 0.013$ for n-2 and n-3 comparisons). Lastly, color revealed a main effect $F(1,39) = 4.7$, $p = 0.036$, $\eta_p^2 = 0.11$, $BF_{10} = 1.99$; suggesting that colorful (601 ms) stimuli were processed faster than B&W (653 ms) versions (p = 0.036) (see Figure 3.5).

For the RT analysis for non-target transitions (LH, HL, OL, LO, OH and HO), n-back condition revealed a significant main effect $F(2,78)=14.97$, $p < 0.001$, $\eta_p^2 = 0.28$, $BF_{10} = 7.669 \times 10^{32}$. Post hoc analysis yielded that that n-1 (592 ms) condition was faster than n-2 (661 ms, $p < 0.001$) and n-3 (635 ms, $p = 0.03$). However, n-2 and n-3 conditions were not processed significantly different. Also, transition type reveled a main effect $F(5,195)$=

10.03, $p < 0.001$, $\eta_p^2 = 0.21$, BF_{10}.= .188. Post hoc analysis revealed three different relevant difference. HO (622 ms) transition was processed faster than OH (641 ms) transition (p < 0.001). LO (621 ms) transition was processed faster than LH (639 ms) transition (p < 0.001). And, OL (626 ms) transition was processed faster than OH (641 ms) transition (p = 0.003). Finally, color revealed a significant main effect $F(1,39)= 4.08$, $p =0.050$, $\eta_p^2 = 0.1$, BF_{10}.= 1.621; colorful (604 ms) transitions were processed faster than black and white (656 ms) transitions ($p = 0.05$) (see also Figure 3.5).

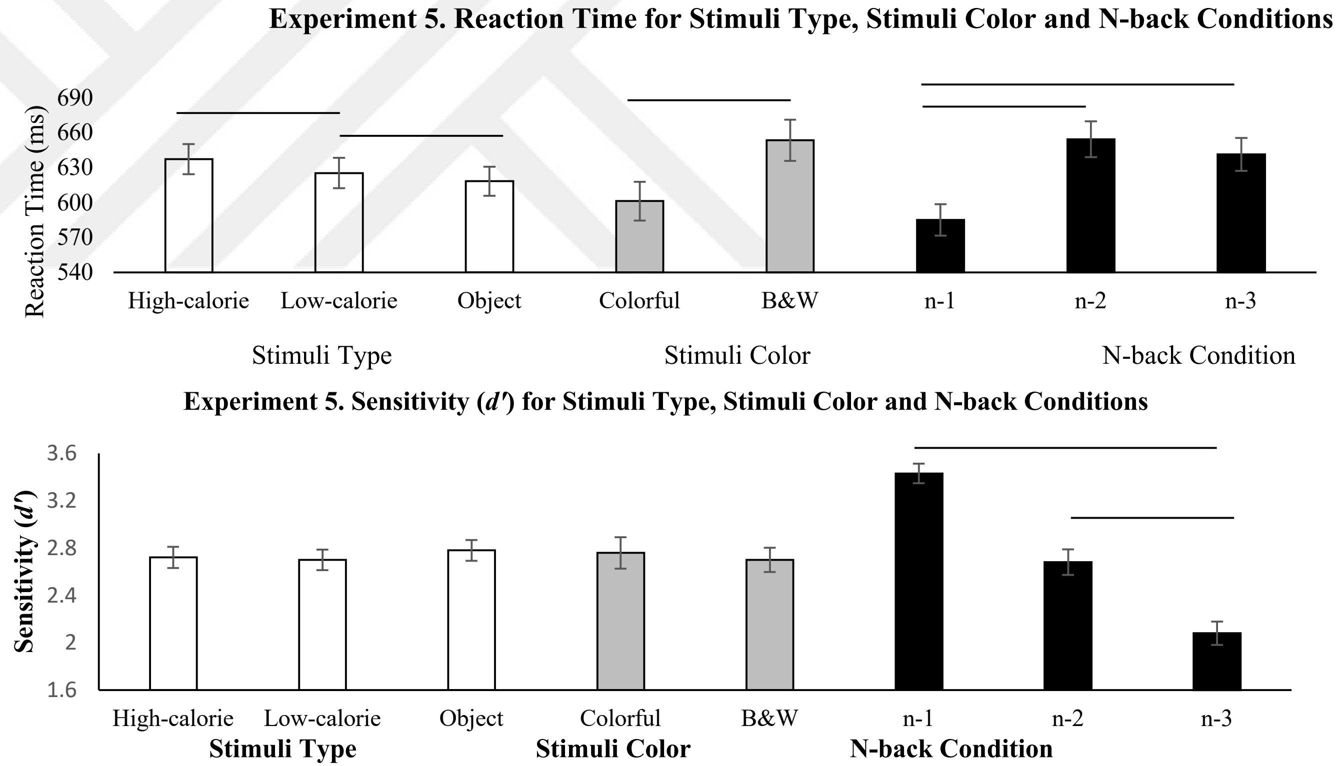

Figure 3.3. Mean Reaction Time and *d'* Values of Stimuli Type, Stimuli Color and N-back Conditions in Experiment 5.

RTs (A) and *d'* (B) values of stimuli type (high-calorie, low-calorie, and object), stimuli color (colorful, B&W) and n-back conditions (n-1, n-2, and n-3) were presented in the present chart. Stimuli type was represented by white, stimuli color by grey and n-back condition by black bars from left to right respectively. Error bars represent standard error of the means.

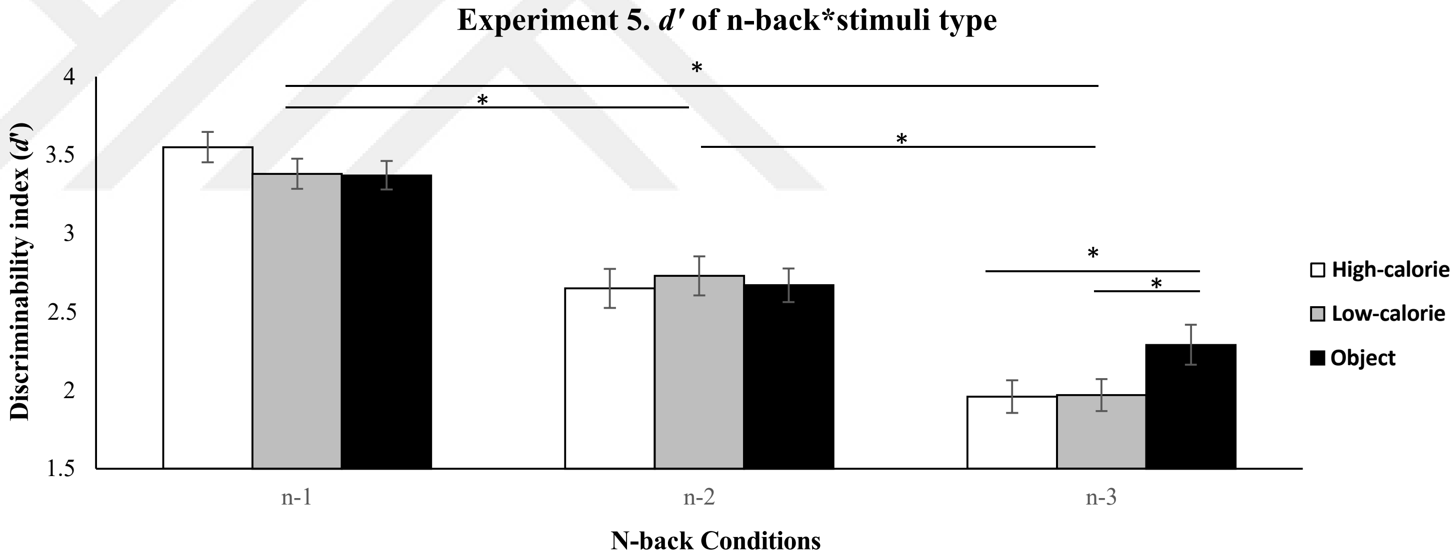

Figure 3.4. Mean *d'* Values of the Interaction Effect Between N-back and Stimuli Type Conditions in Experiment 5.

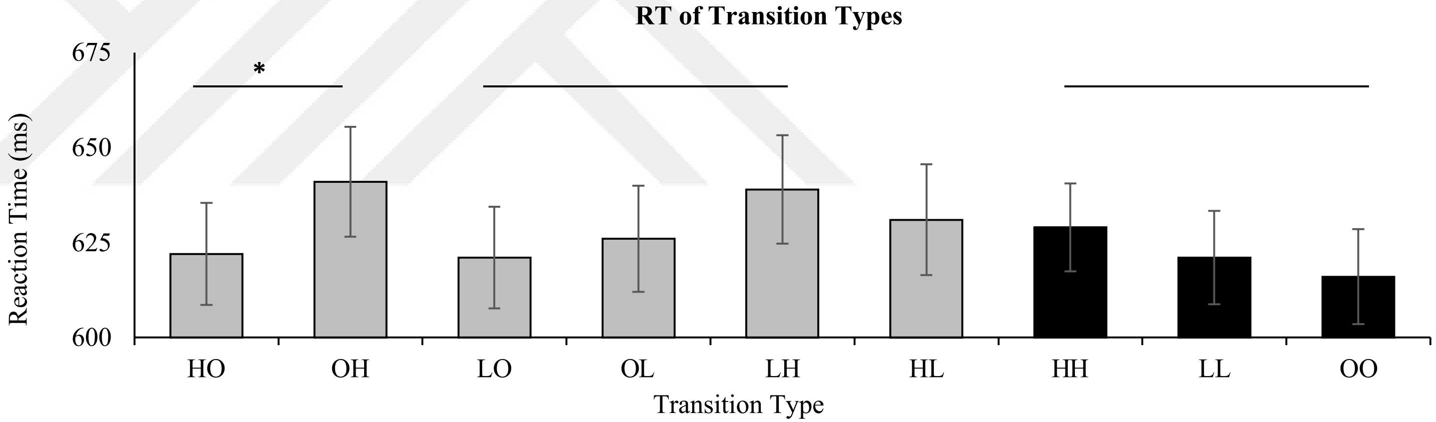

Figure 3.5. Mean Reaction Time Values of Stimuli Type Transitions in Experiment 5

Transitions that did not consist of target stimuli (HO, OH, LO, OL, LH, HL) were represented by grey bars whereas transitions that consisted of target stimuli (HH, LL, OO) were represented with black bars. Error bars represent standard error of the mean.

3.3.6. Discussion

Experiment 5 aimed to investigate the working memory performance with an n-back task consisted of three different stimuli types (low-calorie, high-calorie and object stimuli) in two different color conditions (B&W and colorful). Stimuli were not presented in a block-wise manner, yet different stimuli were presented in a randomized order.

In the current study gradual decrement in n-back task performance was observed as working memory load increased from n-1 to n-3 condition. Overall, the stimuli type did not affect task performance, however, when the working memory load was high (e.g. n-3 condition), food stimuli impaired working memory performance in terms of target detection sensitivity. Concordantly, processing speed was the fastest for object stimuli, intermediate for the low-calorie food stimuli and was the slowest for the high-calorie food stimuli. This finding supports that working memory performance is impaired when food stimuli are processed (Meule, Skirde, Freund, Vögele & Kübler, 2012; Werthmann et al., 2013). Moreover, the current experiment revealed that food stimuli did not only impair processing speed but decreased the detection sensitivity of participants under high working memory load (e.g. n-3 condition) regardless of the restrained eating style of individuals. Task performance of low and high restrained eaters did not show a difference in any condition. Stimuli transitions affected working memory performance in terms of RT. When the object stimuli were followed by high-calorie stimuli (OH transition) compared to the reversed order (HO transition) processing speed was slower that is, participants needed a longer time to respond. However, the same pattern was not present in low-calorie and object stimuli transitions (LO and OL). Moreover, interestingly, when the object stimuli were followed by low-calorie stimuli (OL) participants were faster compared to object stimuli followed by high-calorie (OH). The result indicated that the order of various calorie stimuli presentations affects working memory performance in the n-back task. Especially, seeing high-calorie stimuli after the object or low-calorie stimuli increases RT. Seeing high-calorie food stimuli during an effortful task may evoke more favorable attitudes. Therefore, seeing high-calorie food stimuli (e.g. burger) after object (e.g. pen) can be more attractive than seeing low-calorie food stimuli (e.g. broccoli) after object (e.g. pen) thus former transition may result in slower responses. To sum up, results from both transition and stimuli type analysis revealed that food stimuli impair working memory task performance in the n-back task, however, when the food stimuli are high-calorie participants gave slower responses. The restrained eating style of individuals was not important in other words, individuals who had high or low restrained eating scores did not show different task performance on transition trials. Finally, among all conditions, B&W stimuli were processed slower than colorful versions while color condition did not affect sensitivity was not affected. This pattern was identical for both low and high restrained eaters.

CHAPTER 4

4. GENERAL DISCUSSION

The dramatic improvement of technology in the last decades caused high in fat, palatable foods easily accessible. In addition to being accessible, these unhealthy palatable foods are usually aggressively marketed and can promote overeating (Blundell et al., 2005). Understanding the effect of food cues may help to decrease the consumption of high-calorie energy-dense foods. In this context, this thesis examined how cognitive processes affect low and high-calorie food selection. Two different studies were conducted in this regard. In Study 1, three experiments investigated the existence of calorie-SNARC with various variables. Experiment 1 showed that there is no calorie-SNARC effect. That is, participants, do not necessarily form an association between various calorie levels and spatial layout as they would with the mental number line (i.e. the original SNARC effect). Experiment 2 was designed to investigate whether spatial attention mechanisms may lead to the calorie-SNARC effect. Presenting (in)valid endogenous spatial cues did not lead to the calorie-SNARC effect either. Experiment 3 revealed that the target defining attributes, the green, and red color, did not create an approach or avoidance behavior towards low and high-calorie food stimuli respectively, hence did not affect task performance. Overall, the results from the Study 1 suggested that presenting low-calorie food stimuli on the left and high-calorie stimuli on the right display does not improve processing speed, in other words, participants do not associate low-calorie food stimuli with left and high-calorie food stimuli with the right display. Based on the present findings it can be stated that the establishment of the non-numerical SNARC effect cannot be generalized into the calorie domain. Horizontal representation of musical (Cho et al., 2012), temporal (Gevers et al., 2003), size (Dural et al., 2018) and luminance domains (Ren, Nicholls, Ma, & Chen, 2011) was not observed for the calorie level domain. One important factor can be taken into account is the culture-specific implicit associations that individuals have. Good and bad concepts are found to be associated with the right and left sides respectively. Such association may elicit an association between low (high) calorie food and the concept of good (bad). Because low-calorie foods usually seem as healthy and diet-friendly therefore associated with good whereas high-calorie foods usually seem as unhealthy therefore associated with bad. This association may prevent observing calorie-space association that it was proposed. Body-specificity hypothesis provides supporting evidence to this view. According to hypothesis individuals' handedness and mental representation of negative and positive concepts are related. Hence, individuals associate good or positive concepts with the hemispace of their dominant hand (Casasanto, 2009). Righ-handed individuals associate positive valence with right hemispace whereas left-handed individuals show opposite patters (e.g. association of positive valence-left hemispace). Given that the vast majority of this study's sample is right-handed, such implicit mechanism could also have a role in the failed representations of low and high calorie with space.

In Study 2, with two experiments it was investigated whether individuals with different eating styles show different working memory performance in an n-back task that consisted of three different stimuli types (low-calorie, high-calorie, and object) in two different colors conditions (B&W, colorful). Overall results revealed that the food stimuli impair task performance compared to object stimuli regardless of the individuals' restrained eating style. This result suggested that food stimuli, especially high-calorie, may create higher cravings for the individuals when their cognitive resources are limited. Therefore, seeing high-calorie food stimuli under high cognitive load can cause overeating. Interestingly, this study showed that this pattern does not show differences for low and high restrained eaters. Both low and high restrained eaters show impaired task performance when the stimuli consisted of food images. Besides the importance of stimuli type, the color of the presented stimuli also affected participants' task performance. For all stimuli type (low-calorie, high-calorie, and object) colorful versions were answered faster than B&W versions indicating that both food and object stimuli were recognized slower when the stimuli were B&W. Therefore, the food stimuli that are presented in B&W would be recognized slower therefore presentation of B&W food stimuli may result in decreased food consumption.

This thesis contributed to the existing literature by providing a better understanding of cognitive mechanisms related to food (low and high-calorie) and non-food (object) cues. Firstly, it was found that the presentation of various calorie food stimuli (e.g. low and high-calorie) in different lateral positions (e.g right and left display) do not affect processing speed. More precisely, presenting low-calorie food on the left and high-calorie food on the right does not affect the food selection process. Secondly, low and high-calorie food stimuli affect working memory task performance differently compared to non-food object stimuli. Food stimuli required more time to be processed and impaired task accuracy, especially under high working memory load. Moreover, Experiment 5 suggests that low and high-calorie food stimuli affected task performance in terms of RT differently. High-calorie stimuli resulted in slower responses than low-calorie in the n-back task suggesting that low and high-calorie food stimuli may create different levels of craving resulting in a difference in RT. Although the RT difference was small, it was significant suggesting that when low and high-calorie food stimuli are used as food cues, they may affect working memory performance at different levels. However, more researches are needed to understand the difference.

The results from the present thesis have some implications. Firstly, low and high-calorie food stimuli are not associated with the left and right sides of the display respectively. Therefore, presenting a low (high) calorie food stimuli on the left (right) side of the display do not ease the stimuli selection procedure. Therefore, such a presentation would not be beneficial when it is used in menu or flyer preparation that aims to increase healthy food choices. Secondly, mobile applications that aim to increase inhibitory motor responses to high-calorie food cues (e.g. pictures) can be developed. High-calorie food choices can be reduced when the inhibitory control of one is high. One recent study has shown that emotional eating and eating concerns in obese adults were reduced after working memory training (Houben, Dassen & Jansen, 2016). Therefore inhibiting training (e.g. avoiding responses to high-calorie foods via computerized tasks) may help for weight loss (Stice, Lawrence, Kemps & Veling, 2016). Finally, using B&W versions of food stimuli helps individuals to recognize stimuli slower than their colorful alternatives. Therefore, obesity interventions can present food stimuli (e.g image) in B&W resulting in slower recognition of high-calorie food stimuli that may decrease food consumption.

4.1.STRENGTHS & LIMITATIONS

Studies that used food stimuli measure working memory performance usually consisted of a small variety of stimuli such as only chocolates or sweet foods. However, in daily life food stimuli has tremendous variations and one type of food (such as deserts or salty snacks) may not represent one category fully (such as high-calorie). In this thesis, the food stimuli consisted of a wider range of low and high-calorie foods taken from the Food-pics database (Blechert et al., 2014; 2019). Therefore, we examined differences in working memory performance with different and more representative food stimuli category. Also, the current study examined the working memory performance with n-back tasks under different working memory load conditions instead of only one condition load (e.g. only n-2) in the presence of food and object stimuli. With this strategy, it was possible to investigate whether the various level of working memory load (e.g. n-1, n-2 and n-3 conditions) affect low and high-calorie food selection procedures differently.

The limitations of the current studies can be categorized into several aspects. First of all, prior to study sessions, participants' hunger level was not measured. The amount of hunger level may affect task performance. Because, greater selective attention for food images was observed in hungry normal-weight individuals (Piech, Pastorino & Zald, 2010). Secondly, in the current study, the median split method was used in order to classify participants' restrained eating behavior. Therefore, we created a categorical variable (e.g. low and high) from the continuous predictor. This strategy could be the reason why we could not observe any effect of eating styles on working memory performance. Because data for this thesis was collected by convenience sampling and as a result of this data collection strategy our sample can be homogenous in terms of restrained eating scores.

Future studies can investigate working memory performance in the presence of low and high- calorie stimuli different weight samples with extreme values (underweight or obese) rather than only normal ranged-weight individuals. Independent of the weight-related variables, future studies should control hunger levels by biological measures such as blood sugar level in order to investigate how different satiety levels affect working memory performance in the presence of low and high-calorie food stimuli. Finally, in the n-back task target was defined by whether the identical stimuli were presented n trial before (e.g. cheesecake-cheesecake) therefore two different stimuli (e.g. chocolate and cheesecake) did not indicate target although these two stimuli conceptually belong to the same stimuli type (e.g. high calorie). Future studies can evaluate the working memory performance when the target stimuli are defined based on conceptual similarity (e.g. both burger-french fries are high-calorie, therefore cheesecake is a target stimulus).

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CURRICULUM VITAE

Personal Information

Name Surname : Emre Gürbüz

Place and Date of Birth : Turkey, September 1995

Education

Undergraduate Education : Izmir University of Economics, Psychology

Graduate Education : Kadir Has University, Psychology

Foreign Language Skills : English, Spanish

Contact:

Telephone 0 544 234 19 01

E-mail Address : eemregurbuzz@gmail.com

APPENDIX A

A.1 Informed Consent

Kadir Has Üniversitesi bünyesinde yürütülecek bu araştırma bilişsel süreçlerin incelenmesi için tasarlanmıştır. Çalışma boyunca çeşitli resimler göreceksiniz. Sizden istenen yönergelere uygun şekilde klavye tuşuna basmanızdır. Çalışmadan istediğiniz zaman çekilme hakkına sahipsiniz.

Çalışmadan elde edilecek sonuçlar sadece eğitim, araştırma ve bilimsel yayın amaçlı olarak kullanılacaktır ve vereceğiniz bilgiler gizli tutulacaktır. Araştırmaya katılım tamamen gönüllülük esasına dayanmaktadır. Hiçbir neden göstermeksizin çalışmadan istediğiniz zaman çekilebilirsiniz.

Çalışma hakkında bilgi almak için Psikoloji Bölümü öğretim üyesi Dr. Öğr. Üy. Ahu Gökçe (ahu.gokce@khas.edu.tr; (0212) 533 6532/1663) ile iletişime geçebilirsiniz.

Yardımlarınız ve katılımınız için çok teşekkürler.

Araştırmayla ilgili bilgilendirmeyi okudum ve katılım için onayımı veriyorum.

Ad-Soyad:

Tarih:

İmza:

A.2 The Dutch Eating Behavior

Yeme Alışkanlıkları Anketi (DEBQ)

Lütfen her bir soruyu dikkatlice okuyunuz ve tüm sorulara cevap veriniz. Hiçbir sorunun doğru ve yanlış cevabı yoktur. Her bir soru için size uygun cevabın altındaki daireyi işaretleyin.

1. Eğer kilo aldıysanız, her zaman yediğinizden daha az mı yersiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
2. Yemek zamanlarında, yemek istediğinizden daha az yemeye çalışır mısınız?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
3. Kilonuzdan endişe duyduğunuz içi size sunulan yiyecek ya da içeceği ne sıklıkla reddedersiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
4. Ne yediğinize tam olarak dikkat eder misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
5. Bilinçli olarak zayıflatıcı besinler mi yersiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
6. Çok fazla yediğinizde, ertesi gün daha az yer misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
7. Kilo almamak için az yemeye dikkat eder misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
8. Kilonuza dikkat ettiğiniz için ne sıklıkla öğün aralarında yemek yememeye çalışırsınız?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık

9. Kilonuza dikkat ettiğiniz için ne sıklıkla akşamları yemek yememeye çalışırsınız?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
10. Ne yiyeceğinize karar verirken kilonuzu hesaba katar mısınız?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
11. Bir şeyden rahatsız olduğunuzda daha fazla yemek yemek ister misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
12. Yapacak bir şeyiniz olmadığında yemek yer misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
13. Depresyonda olduğunuzda ya da hayal kırıklığına uğradığınızda yemek ister misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
14. Kendinizi yalnız hissettiğinizde yemek yer misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
15. Biri sizi üzdüğünde yemek ister misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
16. Sinirleriniz bozuk olduğu zaman yemek yer misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
17. İstemediğiniz bir şey olduğu zaman yemek yer misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
18. Kaygılı, endişeli olduğunuz zaman yemek ister misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
19. Bir şeyler ters ya da yanlış gittiğinde yemek ister misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık

20. Korktuğunuz zaman yemek ister misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
21. Hayal kırıklığına uğradığınız zaman yemek ister misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
22. Duygusal olarak üzüntülü olduğunuzda yemek ister misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
23. Huzursuz olduğunuzda ya da canınız sıkkın olduğunda yemek ister misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
24. Yediğiniz şey lezzetli ise, genelde yediğinizden daha çok yer misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
25. Yediğiniz şey güzel kokuyor ve güzel görünüyorsa, genelde yediğinizden daha çok yer misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
26. Lezzetli bir şey gördüğünüzde ya da kokladığınızda onu yemek ister misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
27. Eğer yemek için lezzetli bir şey varsa doğrudan onu yer misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
28. Eğer bir fırının önünden geçerseniz, lezzetli bir şeyler satın almak ister misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
29. Eğer bir kafe ya da büfenin önünden geçerseniz, lezzetli bir	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık

şeyler satın almak ister misiniz?					
30. Başkalarını yerken görürseniz, sizde yemek	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
31. Lezzetli yiyeceklere karşı koyabilir misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
32. Başkalarını yerken gördüğünüzde, genelde yediğinizden daha fazla yer misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık
33. Yemek hazırlarken bir şeyler yemeye meyilli misiniz?	☐ Hiçbir zaman	☐ Nadiren	☐ Bazen	☐ Sık	☐ Çok sık

A.3. Study 1- Stimuli ID Numbers in Food-pics Database

Experiment 1 & 2								Experiment 3	
Low-calorie				High-Calorie				Low-calorie	High-calorie
186	243	321	389	1	46	546	289	194	9
194	246	560	391	2	48	108	290	221	16
196	247	269	396	4	49	111	293	247	18
197	249	270	398	5	52	113	295	249	22
198	250	275	401	6	57	117	296	252	30
199	251	276	407	9	59	123	302	257	46
200	252	280	413	12	61	125	313	335	61
201	253	281	429	15	68	130	363	360	79
202	255	282	438	16	75	138	375	444	87
203	256	284	453	20	79	140	400	446	127
204	257	285	454	22	81	157	421	453	138
206	258	288	528	25	83	158	484	458	174
208	259	305	558	26	97	159	485	468	290
210	260	333	566	29	101	162	488	530	328
215	263	335	567	30	104	163	492	569	400
216	264	342	761	32	105	166	510	793	510
221	265	356	797	34	113	172	565	-	-
222	266	380	832	38	188	174	669	-	-
224	267	382	833	41	302	189	810	-	-
241	283	386	868	42	387	287	825	-	-

A.4. Study 2- Stimuli ID Numbers in Food-pics Database

Experiment 4						Experiment 5		
Low-calorie		High-calorie		Object		Low-calorie	High-calorie	Object
198	266	1	97	1010	1146	194	9	1028
201	267	2	105	1013	1147	195	16	1031
208	275	6	108	1014	1149	247	18	1032
243	276	13	138	1015	1151	249	22	1035
246	333	16	159	1022	1154	252	30	1052
249	335	22	162	1023	1202	256	46	1059
250	342	32	163	1024	1213	257	49	1083
252	356	41	174	1027	1218	335	61	1089
253	398	42	290	1028	1240	360	79	1094
257	401	48	375	1029	1246	438	80	1096
258	413	61	400	1030	1247	444	87	1131
259	438	68	421	1035	1256	446	105	1147
260	761	68	485	1131	1262	453	127	1149
263	797	81	510	1140	1267	458	138	1202
265	832	83	669	1143	1274	468	290	1240
-	-	-	-	-	-	530	328	1241
-	-	-	-	-	-	569	400	1256
	-	-	-	-	-	793	510	1274