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Choice and attention for high and low-caloric food images  
under condition of hunger and satiety

An eye-tracking study

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## Abbreviations

|        |                                      |
|--------|--------------------------------------|
| ANOVA  | Analysis of Variance                 |
| AOI    | Area of Interest                     |
| BMI    | Body Mass Index                      |
| DEBQ   | Dutch Eating Behaviour Questionnaire |
| FCQ    | Food Craving Questionnaire           |
| FRIDa  | Foodcast Research Image Database     |
| GHS    | Grand Hunger Scale                   |
| MANOVA | Multivariate Analysis of Variance    |
| PSRS   | Perceived Self-Regulatory Success    |
| VAS    | Visual Analogue Scale                |



## **1. Introduction and theoretical background**

The sight and smell of food can have a powerful effect on appetite, but not just that, also appetizing food images can control eating behaviour, for example by causing food craving and influencing food choices. Our environment is characterized by the presence of food cues, which are displayed via many forms of media such as television, internet and print. Particularly a growing amount of studies across the disciplines of medicine, psychology and neuroscience have shown the relevance of visual food cues (Blechert et al., 2014).

Research findings of Castellanos et al. (2009) concluded, that these visual food appearances could lead to overconsumption and excessive weight gain. Especially the ability of these visual stimuli to interact with the brain's reward system might trigger excessive food consumption and resultant obesity.

In this master thesis, attention and choice for food-related stimuli, more precisely for food high and low in calories, were examined by recording eye movements via Eye-Tracking Technologies in normal-weight participants. The study was based on the results of Castellanos et al. (2009) which combined a visual probe task with recording of eye movements to examine food-related attention in obese and normal-weight hungry and sated subjects. They concluded that obese participants had similar biases concerning attention for food stimuli during conditions of hunger and satiety. Whereas normal weight individuals' biases were clearly reduced in satiety, compared to the hunger state. Besides that, caloric difference between stimuli had no significant influence on attentional bias of participants.

A study of Graham et al. (2011) extended the findings from Castellanos et al. On the one hand, attentional biases for different kinds of food cues, such as high and low-caloric sweets and snacks, in individuals with different BMI status were examined. On the other hand, it was determined if gazing behaviour is systematically related to hunger and craving. The outcome was, that high-calorie savoury foods led to an extensive craving in normal-weight participants. Further there was no significant difference in attentional bias regarding the different food categories.



In the following chapter, more details about Eye-Tracking Technology as well as additional information regarding attentional bias in eating behaviours, like restraint and external eating, and food craving are described. Building on this, in chapter 2, the whole testing documentation is listed, with an extensive explanation of the study design and the used methods. Concluding, study results are presented and discussed.

## **1.1 Eye-Tracking Technology**

In this chapter a short overview regarding the current state of Eye-Tracking Technology is described, as well as information about attentional bias and eating behaviours.

Eye-Tracking has been used for more than 40 years, but in the past few years it has become more viable as a commercial research tool. Currently, there is a growing research interest regarding Eye-Tracking in combination with food-associated cues. It allows to interpret the different strategies that people use to look at things and how to utilize information. In turn this makes it possible to understand the meanings one gives to a decision making process and how to face with real world affairs. Eye-Tracking continuously measures eye movements, which provides a direct indicator for overt visual attention (Armstrong et al., 2009; Field et al., 2009).

Nevertheless, just with Eye-Tracking, it is not possible to study all the cognitive processes. For that reason, Eye-Tracking is always associated with other methods such as self-completion questionnaires (Graham et al., 2011).

In the course of this thesis, gazing behaviour was recorded while being exposed to high and low-caloric food items. Afterwards obtained information, as measured values out of the Eye-Tracking session were linked to the stimuli. Areas of interest (AOI) were manually defined to assign a specific section to each food image.

## **1.2 Attentional Bias**

Attentional bias is when people's attention gets focused on just a few out of all the presented options while ignoring the rest. But why are they paying more attention to certain stimuli while ignoring others? This trend is a form of cognitive bias, also known as attentional bias (Eysenck et al., 2010).

In recent years, attentional biases regarding food stimuli are reported multiple times and are defined as the tendency to attend personally notable information over neutral information (Mathews et al., 2005). Important aspects while monitoring eye movements are where one's attention is attracted and how long the fixation is captured within this area. This means how long one looks and is described as fixation duration (Henderson et al., 1998).

In this respect, a meta-analysis of Field et al. (2009) showed that the most meaningful measures for attention biases are eye movement recordings. Thus, it allows a clear differentiation of specific attention distribution processes.

As mentioned above attention biases of overweight and normal-weight individuals regarding food and non-food cues was studied by Castellanos et al. (2009). Their results were, that both test groups had increased gaze durations for food compared to non-food items.

## **1.3 Attentional bias in eating behaviours**

Our current food environment is characterized by an excess of high-calorie, palatable, cheap and convenient food, which is always available and promoted aggressively. It entails more stimuli than individuals are able to process. Being surrounded by such a setting represents a severe challenge for weight maintenance and not everyone is receptive in the same way to these temptations. Because of that, an attentional bias for food could be an important cognitive process concerning overeating. (Werthmann et al., 2014)

Further knowledge on attentional biases could be utilised to determine effective weight-loss actions. But regarding attention for food, it can reflect both: motivation to eat as well as restraint habits to eat, which means to worry about food and weight (Werthmann et al., 2014).

In the following section more details concerning these topics are presented.

### **1.3.1 Restrained eating**

Individuals with restrained eating behaviour usually limit their calorie intake to prevent weight gain (Lowe et al., 2013).

#### **Restraint eating and attentional bias for food cues**

There are conflicting results, if restrained eating is associated with an attentional avoidance or an attentional approach concerning food cues. Study findings concluded that exposure to palatable food cues were harmful for dieting goals of restrained eaters, because as a matter of fact it is more difficult to ignore appetizing food cues during a period of actual and/or intended dieting. Further findings from the same author showed, that people with restraint eating habits typically experience concerns about high-fat foods and once an attentional bias for these cues has been triggered, it becomes even more difficult to release from them. This leads to a continuous stimulation of hedonic thoughts about highly palatable foods, which then again maintains attention biases for those tempting foods (Papies et al., 2008).

Further study results from Werthmann et al. (2014) showed that subjects with restraint eating habits paid increased attention to high-calorie food compared to unrestrained eaters. But contrary to this, there is also evidence that restrained eating is associated with an attentional avoidance of food pictures high in calories. This could be an attempt to follow dieting rules or to show attentional attitude, which reflects high preoccupation with food (Higgs et al., 2012).

### **1.3.2 External eating**

Individuals with external eating habits have an increased tendency to eat in response to external food cues, more precisely when they were exposed to sight or smell of food (Hou et al., 2011).

#### **External eating and attentional bias**

Equal findings as for restraint eaters were found in studies with external eaters. An experimental study of Johansson et al. (2004) investigated attentional biases for food cues in normal-weight external eaters. Surprisingly, results showed that subjects with high-external eating habits, those who had a high score on the scale of the DEBQ, showed a bias away from food cues, which suggests cognitive avoidance. Whereas individuals with low-external eating habits, those who had a lower rating on the DEBQ scale, directed their attention towards food cues, which suggests attentional bias.

### **1.3.3 Food craving**

Food craving is described as an intense desire to eat a specific kind of food, of which chocolate is the most often craved one among foods high in calories. It is common and reported by the majority of adults (Meule et al., 2014).

Of course hunger and craving show many similarities and are closely related. They differ from each other, as craving tends to be much more intense for the kind of food desired. Certainly, craving plays a central role in promoting consumption and in challenging control over intake (Martin et al., 2008). Although these two forms of desire for food often occur at the same time, a low energy level is not determining for experiencing food craving, because it can also occur without being hungry (Meule et al., 2014).

#### **Craving and attentional bias for food cues**

Study results of Field et al. (2009) assumed that attention biases for food high in fat may lead to craving for those foods, while the other way round, craving can also trigger attention biases for these cues.

Since palatable foods and food cues are ubiquitous in western or westernized societies, these stimuli exert a strong influence on eating behaviour. They initiate an increased food intake in an automatic and implicit way (Cohen et al., 2012).

As well as findings of Rodriguez et al. (2005) examined that food cue exposure leads to so-called “cephalic phase responses” in the brain, which prepare the body for food intake and are further associated with increase of craving for those foods.

### **External eating and craving**

A study of Nijs et al. (2009) showed that, individuals with high-external eating habits reported significantly more food craving than those with low-external eating habits. Which indicated that high-external subjects showed stronger subjective cravings and that the tendency to eat is more balanced by the exposure to external food cues compared to low-external ones.

Concerning the above described findings, the main aim of this thesis is, to systematically examine whether attention and choice for food images is clearly related to appetite, craving, BMI and special eating behaviours, like restrained and emotional eating. A further motivation is to get a more precise look at normal-weight participants concerning this topic and how they chose their food (high or low in calories) under hunger and sated condition.

Compared to the above described studies from Castellanos et al. (2009) and Graham et al. (2011), some of the basic elements were replicated, as for example distinction between hunger and satiety state concerning attentional bias for food images with a different caloric content. As well as determination of gazing behaviour concerning craving and BMI. Most important extensions were investigations like restraint and external eating behaviour and appetite.

Now that the most important findings in this area were explained, the next section gives an overview about the methods used in this study.

## **2. Material and Methods**

### **2.1 Stimuli - Selection of appropriate food images**

#### **2.1.1 Pre-testing preparations**

Before starting with the testing procedure, an ideal test set-up had to be selected. Most important were the right stimuli, which should meet most of the participant's approvals. Special attention was given to the chosen food cues, especially to a consistent popularity rating, a good image quality as well as equal resolutions.

To pre-test the preferred pictures, an online questionnaire was implemented to find the most attractive food pictures. For that, individuals were recruited randomly via social networks and completed the pre-questionnaire online, a few weeks prior to the experiment to avoid a possible influence of reluctance on different food images. A huge advantage of that method was, that we reached people of different ages and regions. The pre-questionnaire consisted of 26 slides - on each slide 4 images (two were high in calories and two low) were shown. For the realisation an online tool was used called Lime Survey ([www.limesurvey.org](http://www.limesurvey.org)). People were asked to choose impulsively the picture, which they like best, and if the images tasted good for them. Afterwards with help of a 5 point likert scale each of the pictures was evaluated. In total 199 people were included in the questionnaire, thereof 131 completed the whole questionnaire. The pre-test was useful for a better understanding of the preferred pictures.

All food images were selected from two different food picture databases - the Foodcast Research Image Database (FRIDa) (Foroni et al., 2013) and the Food-pics Database (Blechert et al., 2014). Both databases contain several hundreds of pictures displaying food items as well as neutral objects. Moreover they include extensive information on physical features like nutrition data such as fat, carbohydrate, protein and calorie content.

The following points were important for the food picture selection, especially to avoid possible sources of error:

- All images tested were shown with a white background, in the same size and in realistic size to each other, because otherwise participants could be tempted to always choose the bigger portion. As well as the ingredients presented on the plate were approximately the same amount.
- All food items were arranged in a way that they did not cover the middle section of the slide. In order to prevent a possible bias all pictures had the same distance from the middle line, to make sure that there is no fixation of one image before the others.
- All images were presented in the same way. For example on a plate, with cutlery or not, cut in pieces or as a whole.
- Each of the four meals within one slide was compared with pictures of the same kind. For example Main Dishes were not compared with Side Dishes or Sweets.

Finally 32 relevant colour food photographs were chosen for the eye-tracking experiment. More precise 16 high and 16 low-calorie images with 4 meals on each slide, 2 items high in calories and 2 items low in calories were matched to each other (concerning size and shape) and thereof 8 stimuli pairs (Breakfast, Breakfast 2, Side Dishes, Lunch, Lunch 2, Dessert, Dessert 2 and Snacks) were built.

High-calorie food cues included both sweet and savoury food items, so most of them were palatable foods, containing large amounts of fat, sugar and/or salt such as chips, kebab and cake. For the ones low in calories foods like vegetables, fruits and crisp bread were chosen.

All pictures had the same resolution and colour depth. Important for the choice were a balanced allocation of the most attractive images as well as a perfect homogeneity of the pictures on each slide.

The following food pictures were used in the current study:

**BREAKFAST:**



**SIDE DISHES:**

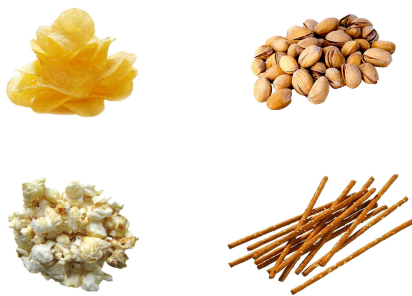


**LUNCH & DINNER:**





## SNACKS:



## DESSERTS:



**Figure 1.** Stimuli Pictures for the Eye-Tracking Experiment

### 2.1.2 Calorie-Calculation of High-Calorie and Low-Calorie Food Images

Based on the macronutrient information and the attendant calorie content from the two food databases, it was possible to divide in high and low-energy food images. The classification if the food pictures were in the category high-energy or low-energy was determined by a few factors:

First of all, the average calorie content of all four images per stimuli slide was calculated. Afterwards the variance in per cent per meal at the rate of the average calorie content of all four images was determined. Due to that variation two pictures were rated as high and two as low in calories. Generally it was considered that each meal differentiates at

least +/- 10 per cent from the average value and +/- 30 per cent between high to low-calorie images. Because of all the restrictions of the study explained before, 4 out of 32 pictures have not met the +/- 10 per cent variation.

In the following tables, the calorie content per kcal in 100 g and the average calorie content for each food image as well as the calorie differences in total and in per cent are listed. The total difference was determined by discounting the average calorie content from the kcals per 100g.

#### Breakfast

| Picture number and title        | Kcal/100g | Difference | Difference in % |
|---------------------------------|-----------|------------|-----------------|
| 184 - chocolate croissant       | 429       | 113,75     | 36,08           |
| 425 - roll & curd with chives   | 223       | -92,25     | -29,26          |
| 66 - croissant                  | 333       | 17,75      | 5,63            |
| 366 - Bagel                     | 276       | -39,25     | -12,45          |
| Average calorie content: 315,25 |           |            |                 |

| Picture number and title                     | Kcal/100g | Difference | Difference in % |
|----------------------------------------------|-----------|------------|-----------------|
| 423 + 0237 - Roll & curd with chives         | 195,5     | 0,38       | 0,19            |
| 240 - Crisp bread with cottage cheese        | 150       | -45,13     | -23,13          |
| 213 - Crisp bread with cottage cheese        | 154       | -45,13     | -21,08          |
| 487 - Bagel with cream cheese and vegetables | 281       | 85,88      | 44,01           |
| Average calorie content: 195,13              |           |            |                 |

### Side Dishes

| Picture number and title                      | Kcal/100g | Difference | Difference in % |
|-----------------------------------------------|-----------|------------|-----------------|
| 356 - Sprouts, potatoes, carrots              | 36,75     | -38,86     | -50,08          |
| 502 - Mixed cooked vegetables                 | 85        | 11,39      | 15,47           |
| 0317 - Potato Wedges                          | 49,7      | -23,91     | -32,48          |
| TF_123 - Risotto with peas and asparagus tips | 123       | 49,39      | 67,09           |
| Average calorie content: 73,61                |           |            |                 |

### Lunch and Dinner Meals

| Picture number and title     | Kcal/100g | Difference | Difference in % |
|------------------------------|-----------|------------|-----------------|
| 087 - Cheeseburger           | 214       | 21         | 10,88           |
| 069 - Fish sandwich          | 230       | 37         | 19,17           |
| 058 - Ham sandwich           | 155       | -38        | -19,69          |
| 072 - Sandwich Roastbeef     | 173       | -20        | -10,36          |
| Average calorie content: 193 |           |            |                 |

| Picture number and title           | Kcal/100g | Difference | Difference in % |
|------------------------------------|-----------|------------|-----------------|
| TF_076 - Lasagne                   | 290       | 101,78     | 54,08           |
| 068 - Kebab                        | 192       | 3,78       | 2,01            |
| TF_137 - Spaghetti with meat sauce | 142       | -46,22     | -24,56          |
| 0315 - Shashlik                    | 130,22    | -58        | -30,82          |
| Average calorie content: 188,22    |           |            |                 |

### Desserts

| Picture number and title            | Kcal/100g | Difference | Difference in % |
|-------------------------------------|-----------|------------|-----------------|
| 0107 - Chocolate cake               | 375       | 75,5       | 25,21           |
| 0169 - Donut with chocolate topping | 420       | 120,5      | 40,23           |
| 097 - Chocolate cake                | 286       | -13,5      | -4,51           |
| TF_018 - Pudding                    | 117       | -182,5     | -60,93          |
| Average calorie content: 299,5      |           |            |                 |

| Picture number and title          | Kcal/100g | Difference | Difference in % |
|-----------------------------------|-----------|------------|-----------------|
| TF_144 - Nougat                   | 460       | 76,25      | 19,87           |
| TF_158 - Butter cookie with cream | 542       | 158,25     | 41,24           |
| TF_151 - Lemon merengue cake      | 285       | -98,75     | -25,73          |
| 0422 - Cream roll                 | 248       | -135,75    | -35,37          |
| Average calorie content: 383,75   |           |            |                 |

### Snacks

| Picture number and title        | Kcal/100g | Difference | Difference in % |
|---------------------------------|-----------|------------|-----------------|
| 026 - Chips                     | 539       | 60,75      | 12,70           |
| 0603 - Pistachios               | 603       | 124,75     | 26,08           |
| 0294 - Popcorn                  | 424       | -54,25     | -11,34          |
| 0186 - Pretzel sticks           | 347       | -131,25    | -27,44          |
| Average calorie content: 478,25 |           |            |                 |

**Table 1.** Calorie Calculation - Difference of Stimuli Pictures

### 2.1.3 Classification of Stimuli

| High in Calories     |                                        |                  | Low in Calories |                                   |                  |
|----------------------|----------------------------------------|------------------|-----------------|-----------------------------------|------------------|
| Breakfast            |                                        |                  |                 |                                   |                  |
| Image #              | Stimuli                                | M & SD Kcal/100g | Image #         | Stimuli                           | M & SD Kcal/100g |
| 0066.jpg             | Croissant                              | 381 (SD=67,88)   | 0366.jpg        | Bagel with sesame and poppy seeds | 249,5 (SD=37,48) |
| 0184.jpg             | Chocolate croissant                    |                  | 0425.jpg        | Roll                              |                  |
| Breakfast 2          |                                        |                  |                 |                                   |                  |
| 0487.jpg             | Bagel with cream cheese and vegetables | 336 (SD=77,78)   | 0213.jpg        | Crisp bread with cottage cheese   | 152 (SD=2,83)    |
| 0423.jpg<br>0237.jpg | Roll & curd with chives                |                  | 0240.jpg        | Crisp bread with cottage cheese   |                  |
| Side Dishes          |                                        |                  |                 |                                   |                  |
| 0317.jpg             | Potato Wedges                          | 104 (SD=26,87)   | 0356.jpg        | Sprouts, potatoes, carrots        | 43,225 (SD=9,16) |
| TF_123               | Risotto with peas and asparagus tips   |                  | 0502.jpg        | Mixed cooked vegetables           |                  |
| Lunch                |                                        |                  |                 |                                   |                  |
| 087.jpg              | Cheeseburger                           | 222 (SD=11,31)   | 058.jpg         | Ham sandwich                      | 164 (SD=12,73)   |
| 069.jpg              | Fish sandwich                          |                  | 072.jpg         | Sandwich Roastbeef                |                  |
| 0603.jpg             | Pistachios                             |                  | 0186.jpg        | Pretzel sticks                    |                  |

| Lunch 2      |                                 |                     |          |                              |                      |
|--------------|---------------------------------|---------------------|----------|------------------------------|----------------------|
| TF_07<br>6   | Lasagne                         | 241<br>(SD=69,30)   | TF_137   | Spaghetti with<br>meat sauce | 136,11<br>(SD=8,33)  |
| 068.jp<br>g  | Kebab                           |                     | 0315.jpg | Shashlik                     |                      |
| Dessert      |                                 |                     |          |                              |                      |
| 0107.j<br>pg | Chocolate cake                  | 397,5<br>(SD=31,82) | 097.jpg  | Chocolate cake               | 201,5<br>(SD=119,50) |
| 0169.j<br>pg | Donut with chocolate<br>topping |                     | TF_018   | Pudding                      |                      |
| Dessert 2    |                                 |                     |          |                              |                      |
| TF_14<br>4   | Nougat                          | 501<br>(SD=57,98)   | TF_151   | Lemon merengue<br>cake       | 266,5<br>(SD=26,16)  |
| TF_15<br>8   | Butter cookie with<br>cream     |                     | 0422.jpg | Cream roll                   |                      |
| Snacks       |                                 |                     |          |                              |                      |
| 026.jp<br>g  | Chips                           | 571<br>(SD=45,25)   | 0294.jpg | Popcorn                      | 385,5<br>(SD=54,45)  |

**Table 2.** Stimuli-Classification – High and Low-Calorie Food Images

Significance between food stimuli were tested via sample t-tests:

|                                                               |                                                              |
|---------------------------------------------------------------|--------------------------------------------------------------|
| Breakfast: mean value 315,25 (SD=88,14),<br>t(3)=7.15, p=.01  | Breakfast 2: mean value 244<br>(SD=115,35), t(3)=4.23, p=.02 |
| Side Dishes: mean value 73,61 (SD=38,73),<br>t(3)=3.80, p=.03 | Lunch: mean value 193 (SD=34,90),<br>t(3)=11.06, p=.01       |
| Lunch 2: mean value 188,56 (SD=72,74),<br>t(3)=5.18, p=.01    | Dessert: mean value 299,50<br>(SD=133,80), t(3)=4.48, p=.02  |
| Dessert 2: mean value 383,75<br>(SD=140,28), t(3)=5.47, p=.01 | Snacks: mean value 478,250<br>(SD=114,63), t(3)=8.34, p=.01  |

**Table 3.** Mean values and t-tests food stimuli

All results showed a significant difference between the stimuli within one meal group.

#### 2.1.4 Randomization of Stimuli

All images were randomized per category, so that there were 4 various test-sets. This means to change the order of food stimuli pairs on the screen. Once stimuli on the right (top/bottom) and once the same stimuli on the left side (top/bottom), 4 different possibilities of each food image were created.

Bowers et al. (1980) explained in his study that the human attention is more focused to the left side, which is called “Pseudo- neglect”-phenomenon. Through a randomization it is possible to avoid this bias.

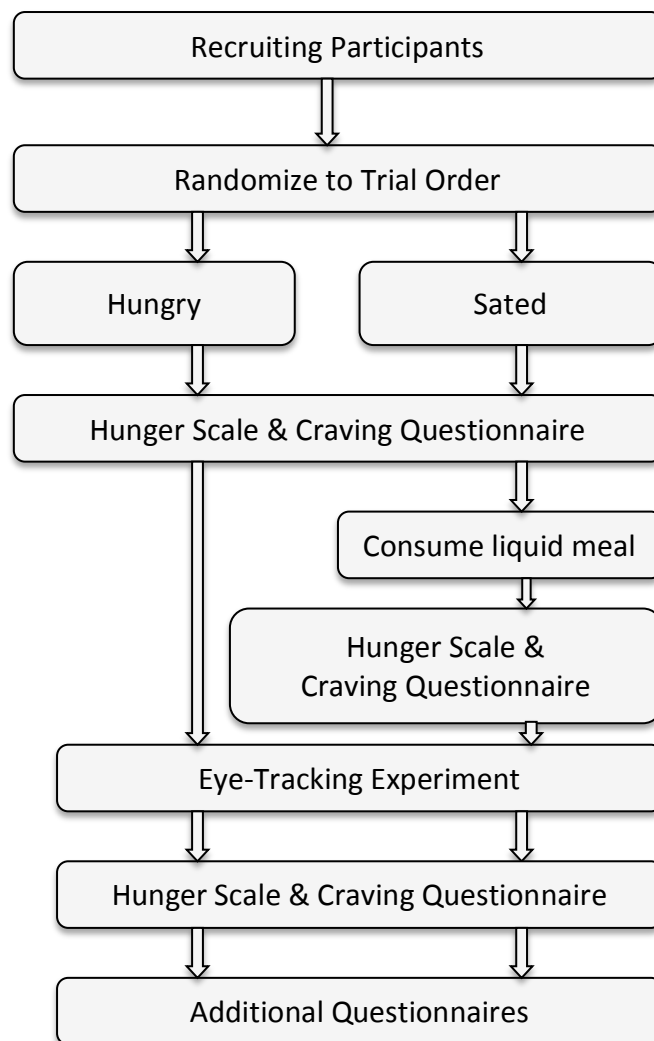
The following figure below shows the randomization of the stimuli “Breakfast”.



**Figure 2.** Randomization of Stimuli Breakfast

## 2.2 Study design

This is how the procedure was done: After recruiting participants, they were randomly assigned to the sated or hungry group first. In the sated one, subjects consumed a standardized meal before the experiment. Fasted ones started immediately upon arrival at the test set with the completion of the Hunger Scale and the Craving Questionnaires. Both were completed before and after the Eye-Tracking sessions. For sated individuals, they had to fill out these questionnaires before and after the pre-load and after the Eye-Tracking Experiment. Both groups, sated and fasted, participated in the Eye-Tracking session. After that, in the end additional questionnaires were filled out concerning appetite, antipathy, weight status, restraint or external eating habits. See flow diagram below for a detailed overview.



**Figure 3.** Flow diagram - study overview



### **3. Experimental task –Testing documentation**

In the following section the exact experiment structure is described. Testing was scheduled on six non-consecutive weekdays in the morning, around breakfast and lunchtime, from 9 a.m. to 2 p.m.

#### **3.1 Recruiting Participants**

134 individuals were recruited by spontaneous invitations in courses and seminars or through advertisements and posters at the University of Natural Resources and Life Sciences, the Department of Nutritional Sciences in Vienna and the Marketing University of Applied Sciences in Wieselburg.

The age of the study population was determined prior to testing with 18-32 years. All test subjects had to be fluent in German and able to fill in questionnaires and complete computerized experiments.

It was supposed that participants of these faculties are more in the position to distinguish between food images high and low in calories. The calorie difference between the food images was not communicated.

#### **3.2 Randomization to Trial Order – Hungry and Sated**

Participants were randomly assigned to the hunger or sated group. They were told whether they would receive the pre-load or they would continue fasting before starting the Eye-Tracking experiment. So at the time of testing, it was assumed that individuals were all moderately hungry and sated.

#### **3.3 Before Eye-Tracking – Questionnaires**

For filling in the questionnaires subjects remained seated separated by room dividers or in an extra room with minimal disturbance from the investigators throughout the

experimental session. Before and after each task, or more precisely at the beginning and at the end of the eye-tracking session, both, hungry and sated participants rated their hunger level on a Visual Analogue Scale (VAS) named “Grand Hunger Scale” and completed the Food Craving Questionnaire (FCQ). Both questionnaires are illustrated and explained in detail further below and in the appendix.

### 3.3.1 Grand Hunger Scale

The Grand Hunger Scale (GHS) was used as a fast index to assess subjective level of hunger during the experimental session. Questions out of this scale included information about “how hungry participants were at the time of testing” and “how much of their favourite food they could eat at the moment” (Mogg et al., 1998).

Responses of the two hunger questions are indicated by a Visual Analogue Scales (VAS) (coded from 0 to 100) defined as „not at all hungry“ versus „extremely hungry“ for the question concerning “hunger” and „none at all“ versus „as much as I could get“ for the question concerning “favourite food”.

 universität wien

33% ausgefüllt

**2. Wie hungrig bist Du gerade?**  
Bitte setze ein X an den Punkt auf der Linie, der am besten beschreibt, wie hungrig Du im Moment bist. Zum Beispiel wenn Du nicht sehr hungrig bist, platziere das X näher zum linken Ende, wenn Du sehr hungrig bist, platziere das X näher zum rechten Ende.

gar nicht hungrig ————— X ————— sehr hungrig

**3. Wie viel von Deinem Lieblingsessen könntest Du im Augenblick essen?**  
Bitte platziere ein X an der Stelle der Linie, die am besten beschreibt, wie viel deines Lieblingsessens Du im Moment imstande wärest zu essen.

gar nichts ————— X ————— soviel wie möglich

Zurück Weiter

Andrea Schauer BSc - 0907479 - Studie der Ernährungswissenschaften - 2015

**Figure 4.** Grand Hunger Scale with slider to mark on the VAS

The original hunger questionnaire consists of 4 questions:

- (1) "time since last meal", which is estimated to the nearest 15 minutes.
- (2) A "hunger scale" with a rating from 0 for "not hungry at all" to 100 for "extremely hungry".
- (3) A "favourite food scale", for the amount of favourite food each individual could imagine to eat at the moment - rated on a scale from 0 for "none" to 100 for "as much as I could get"
- (4) And then finally, "time until next meal", which is estimated to the nearest 15 minutes (Mogg et al., 1998).

Because „time since last meal“ and „time until next meal“ were not relevant for our study, questions 1 and 4 were not used for analysis.

The average score of the GHS was calculated into a single hunger index by adding together the two analogue scales hunger and favourite food. (0 to 100 in millimetres - 200 in total). The final individual score ranged from 0 to 200, whereby higher scores indicate a greater amount of hunger (Pothos et al., 2008).

### **3.3.2 Food Craving Questionnaire – State Version:**

The Food Cravings Questionnaire (FCQ) is one of the most often utilised methods for the assessment of food cravings. The whole questionnaire consists of a trait (FCQ-T – with 39 items) and a state (FCQ-S – with 15 items) version. In this study only the state version was used for assessment of momentary food cravings. It includes the following dimensions: first of all, "intense desire to eat" as well as "anticipation of positive reinforcement that may result from eating", "anticipation of relief from negative states", "feelings as a result of eating", "lack of control over eating" as well as "craving as a physiological state" (Cepeda-Benito et al., 2000). The Questionnaire is listed in detail in the Appendix.

### **3.3.3 Sated Group - Pre-Load**

After finishing the hunger questionnaire for the first time, one half of the study subjects were asked to ingest a standardized pre-load in form of a milk shake, which they had to empty entirely within 10 minutes.

Therefore Layenberger Fit Feelgood powder of two different flavours, red berry yoghurt and chocolate-nuts, was chosen to mix a balanced shake, which consisted of 43 g (3 scoops) of powder, mixed with 250 ml low-fat milk (1,5% fat). The energy content of one portion was 1189 kJ (283 kcal – 27,1g carbohydrate, 24,1g protein, 7,7g fat per meal) (Layenberger, 2015).

Approximately 20 minutes after consumption they had to fill out the GHS for the second time. In total 30 minutes was the elapsed time between pre-load consumption and task initiation. The time-interval implemented after consumption of a pre-load must be appropriate for energy compensation. Findings according to Almiron-Roig et al. (2013), pointed out that, physiologically 20 minutes seemed to be the minimum interval in which post absorptive effects of pre-loads have an influence on energy levels. For healthy individuals, a rate of approximately 2–4 kcal per minute, is assumed in which nutrients are delivered from the stomach to the small intestine. Based on that, a time period of 60–125 minutes would be necessary to empty 250 kcal.

Two different studies were compared to find an appropriate pre-load. In the study of Castellanos et al. (2009), they used a standardized shake of vanilla-flavoured Ensure-Plus with an energy content of 350 kcal in total. Participants were offered additional refills in this study until they declined further. 30 minutes was the elapsed time between shake and Eye-Tracking session.

In another study of Nijs et al., (2010) participants were satiated with a milk shake, called “Weight Care”, which they had to finish in 15 minutes. It consisted of 500 ml whole milk, 4 scoops of Weight Care powder and a tablespoon sugar – the total energy content was 600 kcal.

Based on the findings described above, a time delay between the satiety manipulation and the start of the experiment, such as was done in the study of Castellanos et al. (2009) was implemented in the present study.

As a manipulation check, if the satiety manipulation was successful, subjective hunger levels (VAS) of participants before and after the pre-load consumption were compared.

### **3.4 Eye – Tracking Session**

Tobii X2-60 and T60 Eye-Tracking devices as well as Tobii Studio software (version 3.2.2.130) were used for recording and analysing individual's gazing behaviour. Subjects took a seat in front of the Eye-Tracker screen, while an infrared ray of light was directed upon their eyes. Before the calibration of the Eye-Tracker could be implemented the distance and height of the eye position for each participant was controlled via infrared camera as well as the sitting position was adjusted.

If the sitting position was perfect the participants were encouraged to stay in the same position for the whole experiment. For calibration, participants had to follow with their eyes a red point on a white background, while it was wandering from the middle to each corner, the so called calibration points.

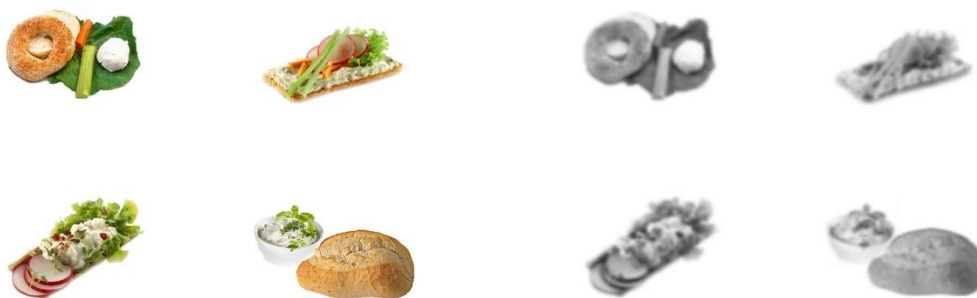
Afterwards, they were informed shortly via an introduction slide about the process of Eye-Tracking and how to act in front of an Eye-Tracker. Dummy slides occurred to practice for the real test session. During that time, subjects had the chance to ask questions if something was unclear before they started the session. These trials were not analysed and exclusively implemented to get used to the procedure. The session was the same procedure as in the real experiment where participants had to choose one-food image out of 4 stimuli. Between the dummy slides the black cross was used to make sure that the gaze patterns were the same as before the experiment.

Thereafter, subjects were instructed to look at the monitor in a relaxed way and to prevent movements. Each test began with an instruction text. After this, to define the starting point of gazing, a fixation cross in the central area was displayed between the

instruction texts and between the following food images.

Then the actual testing session started - participants had to choose one picture which they like best out of each stimuli-set. Based on pre-testing the stimulus material consisted of 8 x 4 sets of food pictures, in total 32 colour images. All of them were presented in 4 pairs on the screen (top left, top right, bottom right and bottom left) against a white background. An average day was simulated with all 8 stimuli, starting with Breakfast, Side Dishes, Meals for Lunch or Dinner and finally Sweets and Snacks.

During this process, eye gaze patterns as well as eye movements were recorded while participants were exposed to the food pictures. Because eye gaze patterns could have been abstracted, by looking for the pointer, while they chose an image, subjects were not able to see a mouse cursor. If an image were chosen, they had to press the left mouse button to get to the final slide. On this slide the same images were presented again but all in grey and they had to choose again the preferred stimuli. Because of the mouse tab it is possible to precisely represented later which meal the participants have chosen.



**Figure 5.** Demonstration - Stimuli Choice – Breakfast

Each trial started with a fixation cross in the screen centre, to guarantee that each participants gaze pattern started from the middle section. Otherwise a “fixation fail” message was displayed and the trial started again. After 2 seconds the fixation cross slide disappeared and the next stimuli-set occurred. This procedure is useful to prevent that automatically that food image who was fixed before at that point would be fixed again at the same point. The participants were asked not to avert their eyes from the

screen during the whole test session to guarantee a correct recording of eye movements.

Five different values of gazing behaviour from Eye-Tracking data were collected:

- 1) “time to first fixation” - which is the time, in seconds, from the start of the media display until the participant fixated on an area of interest (AOI),
- 2) “first fixation duration” – which is the duration of the first fixation, in seconds, on an AOI,
- 3) “fixation duration” – which is the duration, in seconds, of each individual fixation within an AOI,
- 4) “fixation count” – which is the number of times the subject fixates on an AOI and
- 5) “visit duration” – which is the duration, in seconds, of each individual visit with an AOI (Tobii Technology, 2012).

In this thesis only fixation duration was used for the interpretation of data.

### **3.5 After Eye-Tracking – Questionnaires**

After completion of the eye-tracking task, participants finally completed four questionnaires concerning aversions, weight status and their eating habits .

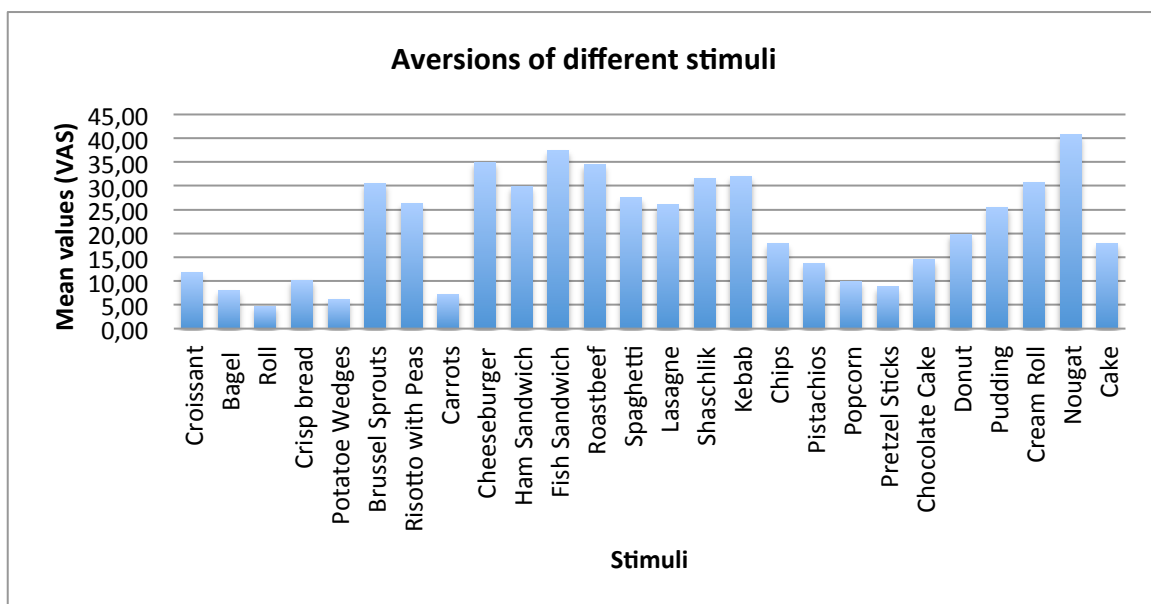
#### **3.5.1 Antipathy Questionnaire**

This questionnaire was implemented after the Eye-Tracking session to identify aversions for the exposed food cues. Not all images, which were presented during the experiment were indicated in the antipathy questionnaire, because some images, like croissants were presented twice. So 26 out of 32 food items were listed. Level of aversion was determined through a Visual Analogue Scale (VAS) (0= no aversion to 100= huge aversion).

On average, as can be seen in Figure 6 below, some food pictures were more attractive or accepted than other ones. A higher level of antipathy was obtained for images like Nougat with mean values of 40,73 (SD= 38,63), Cream Roll with 30,80 (SD= 39,61),

Cheeseburger with 35,00 (SD= 41,18), Brussel Sprouts with 30,56 (SD= 37,85), Ham Sandwich with 29,84 (SD= 41,17), Fish Sandwich with 37,38 (SD= 40,55). Compared to those with a low antipathy level, so to say a high acceptance, like Roll with a mean value of 4,67 (SD= 17,14), Potatoe Wedges with 6,16 (SD= 17,97), Carrots with 7,24 (SD= 19,58), Bagel with 7,91 (SD= 19,12) and finally Pretzel Sticks with 8,78 (SD= 24,23).

Interestingly, as can be seen in the figure below, most of the lunch and dinner stimuli had high antipathy levels. Aversions for single items could be attributed to the fact, that the majority of these stimuli were meat products, such as Cheeseburger, Ham Sandwich, Lasagne and Kebab. That could be due to the fact that there is a growing trend in young individuals away from meals which include meat. An evaluation of the background information question “form of nutrition” with choices “vegetarian”, “vegan” and “nothing special” showed that, 11 individuals were vegetarian, 1 vegan and the other 68 indicated that they had no special form of nutrition. The amount of vegetarians could possibly underline this suggestion.



**Figure 6.** Aversions of different food stimuli

### 3.5.2 Appetite Questionnaire

The next part contained a questionnaire regarding appetite about almost every food



item that was presented during the eye tracking experiment. For this one it was the same situation as for the apathy questionnaire. 26 out of 32 food pictures were listed in the appetite questionnaire. Investigation of appetite was assessed through a Visual Analogue Scale (VAS) (0= no appetite to 100= huge appetite). It is assumed that appetite for certain meals is higher than for others.

The appetite questionnaire was implemented to check if there is a conjunction between appetite for the food items showed during the eye-tracking experiment.

There is a growing evidence that individuals have a preference for foods high in sugar, fat and/or salt. Birch et al. (1996) showed a higher preference for palatable food (energy dense food) in hungry individuals.

### **3.5.3 Dutch Eating Behaviour Questionnaire**

The original Dutch Eating Behaviour Questionnaire (DEBQ) is a 30-item self-report, which measures three kinds of eating behaviours. So there are different scales, which include 10 items each with a score range from 0-5. On one side, an Emotional Eating Questionnaire, which assesses eating in response to emotional activation states. On the other side, an External Eating Questionnaire, which assesses eating in response to external food cues. And finally, a Restraint Eating Questionnaire, which assesses the extent to which the individuals restrain food intake. In this study two out of the three potential questionnaires were used - the External Eating and the Restraint Eating Questionnaire (Van Strien et al., 1986).

### **3.5.4 Descriptive Information Questionnaire**

Mean age of the study participants was 24,20 years (SD= 3,25 years) and mean BMI 21,92 kg/m<sup>2</sup> (SD = 2,70 kg/m<sup>2</sup>).

### **3.5.5 Perceived Self-Regulatory Success Questionnaire**

The Perceived Self-Regulatory Success (PSRS) is a three-item scale, which indicates subjects to rate on 7-point scales how successful they are in weight maintenance and how difficult it is to stay in good shape. Successful or unsuccessful dieters were

evaluated (Fishbach et al., 2003; Meule et al., 2012).

With the evaluation of this questionnaire participants were classified in successful dieters (values from 3 to 14) and unsuccessful dieters (values from 14 to 21). In total 64 individuals were rated as successful dieters with a mean value of 11.94 (SD=1.84) and 16 unsuccessful ones with a mean value of 15.64 (SD=1.15).

### **3.6 Statistical Analysis**

For statistical interpretation, IBM SPSS Statistic Software 22 and Microsoft Excel 2011 were used to evaluate collected data. The following statistical methods were used: Multivariate Analysis of Variance (MANOVA), independent samples t-test as well as Chi-Square Test. Significance level was determined prior to testing and were set to 0.05 (5%). Results with a  $p\text{-value} < 0.05$  were proved as significant, those with a  $p < 0.001$  as highly significant.

All described questionnaires above were listed in detail in the Appendix.

#### **3.6.1 Grand Hunger Scale Results**

After eliminating missing and non applicable data from both, the questionnaires and the eye-tracking experiment, 80 subjects were included in the current study. 117 out of the 134 tested subjects showed acceptable Eye-Tracking results, due to a large number of fixation failures and outliers. Determined thresholds were minimum 60 and maximum 160 participants. After removing the middle hunger group, which consisted of 28 participants and 9 more had to be excluded because of incorrect results of additional questionnaires, in the end 80 participants in total were included in the present study, whereof 61 were women and 19 men.

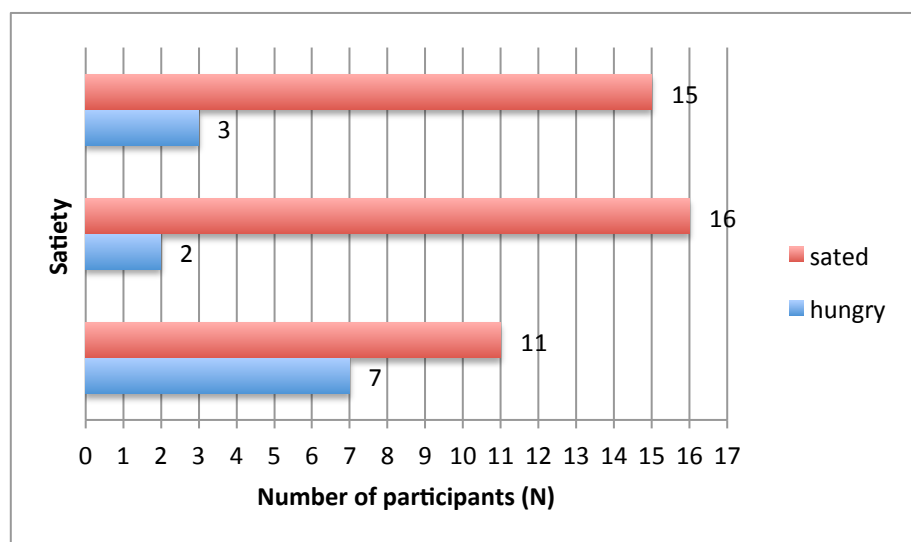
Subjective hunger ratings of the GHS were used to classify participants into three groups. The "low hunger group" with hunger ratings below the score of 91, the "middle hunger group" with values between 91 and 119 and the "high hunger group" with hunger ratings from 121 to 200. The middle group, which included 28 participants, was excluded from the analysis because for those values, it was not possible to make a clear

assignment to the hunger or sated group. So for all further hypotheses just the high and the low group were utilized.

The Hunger Scale before the Eye-Tracking Experiment was balanced with 39 hungry and 41 sated participants. After the Eye-Tracking Session, the study group was equally distributed with 40 hungry and 40 sated subjects. So this calculation included both groups the ones with the pre-load and the ones without. Mean Hunger Scale Values were 94.85 (SD=62.45) before and 93.61 (SD=65.31) after the Eye-Tracking session.

For the ones with the milk shake, 18 out of the 80 consumed a pre-load in form of a milk-shake with 7 hungry and 11 sated participants before consuming the milk-shake. After the pre-load was balanced with 3 hungry and 15 sated participants and after the Eye-Tracking Session with 16 sated and 2 hungry individuals.

Means and standard deviations in the sated group: VAS1= 100 (SD=51.43), VAS2= 42.98 (SD=44.52), VAS3=55.28 (SD=54.75). As can be observed in Figure 8, there was an instantaneous decrease in hunger levels under sated condition after pre-load consumption.



**Figure 7.** Participants with the pre-load before and after the milk shake and after the eye-tracking experiment

## **4. Objectives and Hypotheses**

The primary goal of the current study is the analysis of visual attention for food cues. In detail, to investigate the effect of low and high-calorie images, in normal weight-individuals under hungry and sated condition in a multiple choice paradigm using eye-tracking technologies.

The following hypotheses were established to bring the current topic more into question:

### **Influence of hunger condition on fixation duration for high and low-calorie food images**

- Hypothesis 1: Is there a longer fixation duration for high-caloric food images under hunger condition?
- Hypothesis 2: Is there a longer fixation duration for low-caloric food images under sated condition?

### **Influence of hunger condition on choice for high and low-calorie food images**

- Hypothesis 3: Is there a difference in choice for high or low-caloric food images under hunger and sated condition?
- Hypothesis 4: Is there a difference in choice for high-caloric food images under hunger condition?

### **Influence of BMI on choice for food images high and low in calories**

- Hypothesis 5: Does Body Mass Index influence choice for high and low-caloric food images?

### **Influence of restraint eating on choice for food images high and low in calories**

- Hypothesis 6: Does restraint eating influence choice for high and low-caloric food images?

### **Influence of hunger condition regarding appetite for food images**

- Hypothesis 7: Is there a difference in appetite for bland or palatable food images under hunger or sated condition?

### **Influence of hunger condition concerning craving for food images**

- Hypothesis 8: Is there a difference in craving after presenting food images under hunger or sated condition?
- Hypothesis 9: Does external eating influence craving for food images?

## 4.1 Influence of hunger condition on fixation duration for high and low-calorie food images

### 4.1.1 Fixation duration

The fixation duration is one of the major factors that can be used to determine attentional bias for special food items. Using an Eye Tracker, eye movement data points were recorded, identified and finally sent to the analysis application database. For visualization of the received data, it is further processed into graphically fixations, named “gaze plots” whereas larger areas indicate a longer fixation time. Lines between the “gaze plots” are named as “saccades” and are indicated by fixations and rapid movements between fixations (Tobii Eye Tracking, 2010).



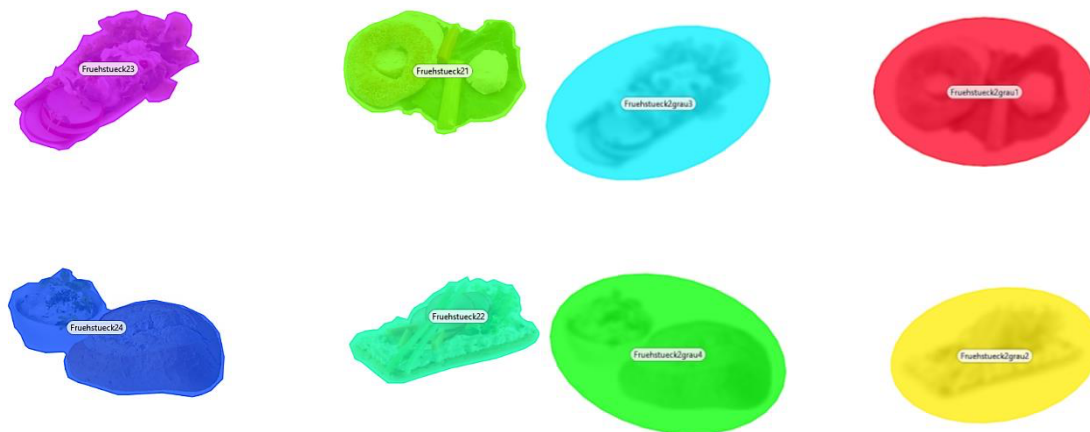
**Figure 8.** Gaze plots with Saccades (US Department of Health and Human Services, 2012)

### 4.1.2 Area of Interest

Highly important for analysis were Areas of Interest (AOI), which were used to assign a certain section for each stimuli, so in total for every slide four distinctive regions. They were created to define eye movements, like fixation duration, around the stimuli centre. Thus, it was easier to draw conclusion from the Eye-Tracking data to the food items.

As can be seen in the figure below there are two different marks for the AOI. The ones

with the more extended area where chosen to identify which food item was chosen by participants and the more defined ones for analysis of attentional biases. This was implemented to prevent that the AOI was failed by participants through false mouse clicks out of the interested stimuli.



**Figure 9.** Sample - Area of Interest for attentional bias and choice of Stimuli Breakfast

Based on theory described above and the current research state, the following hypotheses were defined concerning fixation duration for high or low-calorie images under hunger and sated condition.

**Hypothesis 1: Is there a longer fixation duration for high-caloric food images under hunger condition?**

H0: There is no longer fixation duration for high-caloric food images under hunger condition.

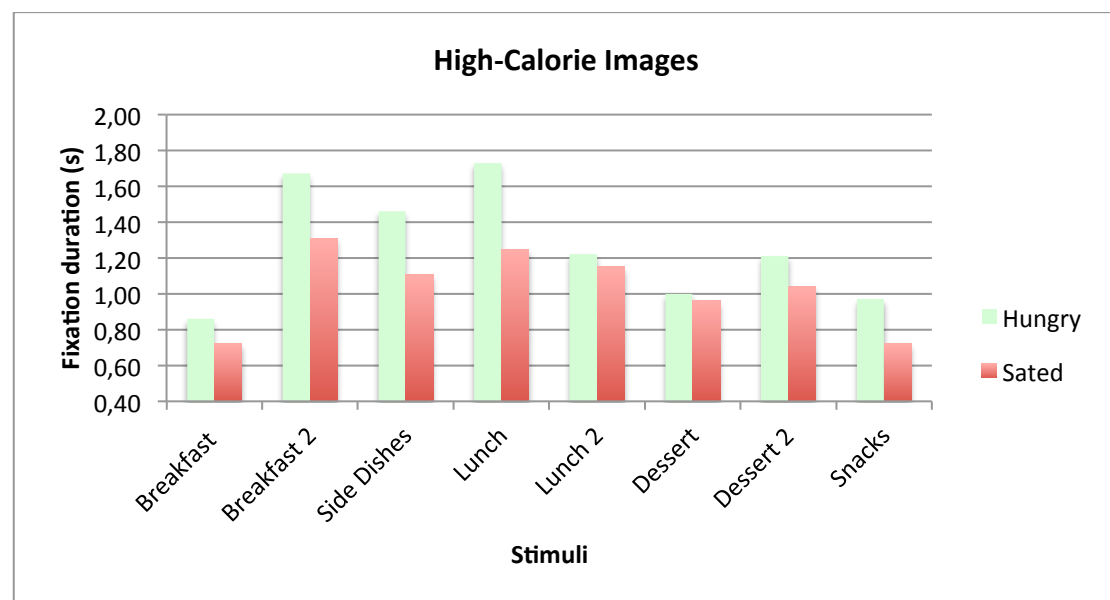
H1: There is longer fixation duration for high-caloric food images under hunger condition.

To test this hypothesis, measured data of summed fixation duration within the AOI for high-calorie food pictures were used. Fixation duration data of each high-calorie food image per slide, so two images per slide, were added up for calculation and thereof a mean value of these two variables was built. In the end there were 8 mean values per stimuli of fixation duration which were summed up to one mean value. Means and

standard deviations for hungry participants were 1.27 seconds (SD=0.67) and for sated ones 1.03 seconds (SD=0.45).

Figure 11 represents the mean fixation duration in seconds for all high-calorie images divided for hungry and sated subjects.

As can be seen in the figure below a slightly longer fixation duration in hungry participants were recorded for all stimuli but especially for stimuli like Breakfast 2, Starters and Lunch. Significance was tested by using an independent t-test with fixation duration of all high-calorie food images as testing variables and satiety as group variable. No significant difference between fixation duration and high-calorie images were found,  $t(66)=-1.82$ ,  $p=.07$ . A more specific analysis of each stimuli using independent t-test showed no significant result as well.



**Figure 10.** Fixation duration for high-calorie food images for hungry and sated subjects

| Gruppenstatistik             |        |    |            |                    |                           |
|------------------------------|--------|----|------------|--------------------|---------------------------|
|                              | Hunger | H  | Mittelwert | Standardabweichung | Standardfehler Mittelwert |
| Fixation_Duration_High_Total | sated  | 41 | 1,0327     | ,45325             | ,07079                    |
|                              | hunger | 39 | 1,2659     | ,66569             | ,10660                    |

| Gruppenstatistik |        |    |            |                    |                           |
|------------------|--------|----|------------|--------------------|---------------------------|
|                  | Hunger | H  | Mittelwert | Standardabweichung | Standardfehler Mittelwert |
| Breakfast 1      | sated  | 41 | ,7238      | ,59999             | ,09370                    |
|                  | hunger | 39 | ,8673      | ,49856             | ,07983                    |
| Breakfast 2      | sated  | 41 | 1,3116     | ,74965             | ,11708                    |
|                  | hunger | 39 | 1,6660     | 1,31478            | ,21053                    |
| Side Dishes      | sated  | 41 | 1,1052     | ,62983             | ,09836                    |
|                  | hunger | 39 | 1,4556     | 1,09052            | ,17462                    |
| Lunch 1          | sated  | 41 | 1,2528     | 1,16014            | ,18118                    |
|                  | hunger | 39 | 1,7310     | 1,16111            | ,18593                    |
| Lunch 2          | sated  | 41 | 1,1516     | ,69235             | ,10813                    |
|                  | hunger | 39 | 1,2205     | ,94817             | ,15183                    |
| Dessert 1        | sated  | 41 | ,9620      | ,56477             | ,08820                    |
|                  | hunger | 39 | 1,0046     | ,49460             | ,07920                    |
| Dessert 2        | sated  | 41 | 1,0357     | ,70782             | ,11054                    |
|                  | hunger | 39 | 1,2138     | ,76391             | ,12232                    |
| Snacks           | sated  | 41 | ,7190      | ,42322             | ,06610                    |
|                  | hunger | 39 | ,9681      | ,76709             | ,12283                    |

**Table 4.** Mean Fixation duration in total and per stimuli for high-calorie images

**Hypothesis 2: Is there a longer fixation duration for low-caloric food images under sated condition?**

H0: There is no longer fixation duration for low-caloric food images under sated condition.

H1: There is a longer fixation duration for low-caloric food images under sated condition.

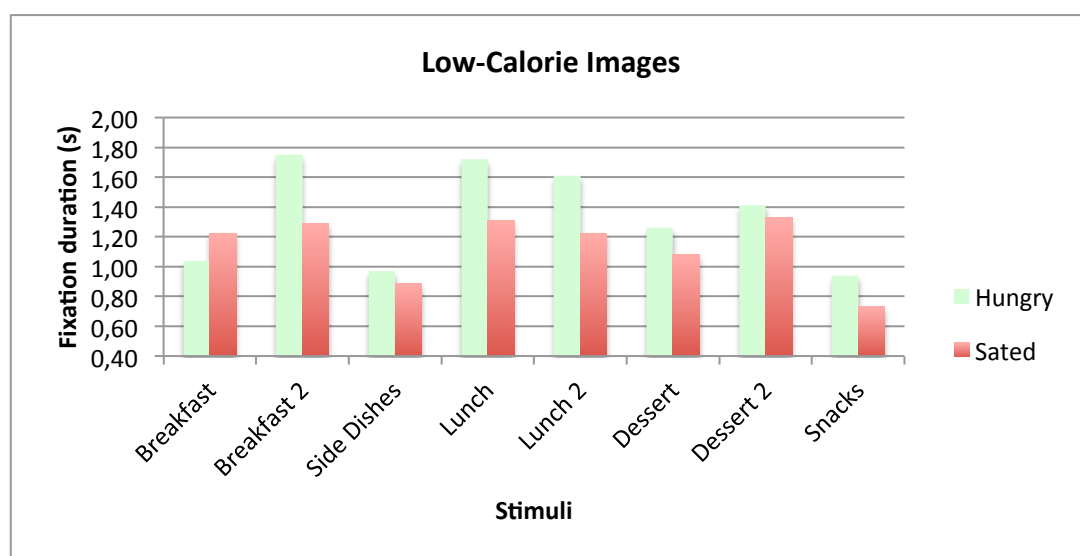


To test this hypothesis, measured data of the summed fixation duration within the AOI for low-calorie food pictures were used. On each slide two low-calorie food images were shown, which were added up for calculation and mean values of these two variables were built. Means and standard deviations for hungry subjects were 1.35 seconds (SD=0.66) and 1.11 seconds (SD=0.43) for sated ones.

As can be seen on the figure below, sated subjects had almost the same fixation duration as hungry subjects. Interestingly, a slightly longer fixation duration for stimuli like Breakfast 2, Lunch and Lunch 2 were found in hungry participants.

Independent t-test was used to analyse the differences in fixation duration of all low-calorie food images under satiety condition. Results showed no significant value,  $t(65)=1.97$ ,  $p=.05$ . There was no significant difference between subjects of different satiety state concerning food related low-energy images. That means that sated participants showed no significantly greater fixation duration bias than participants under hunger condition.

A more specific analysis of each stimuli using independent t-test showed a significant result for Breakfast 2,  $t(78)=2.16$ ,  $p=.03$ , values for all other stimuli were not significant.



**Figure 11.** Fixation duration for low-calorie food images for hungry and sated subjects

| Gruppenstatistik |        |    |            |                    |                           |
|------------------|--------|----|------------|--------------------|---------------------------|
|                  | Hunger | H  | Mittelwert | Standardabweichung | Standardfehler Mittelwert |
| Total            | sated  | 41 | 1,1117     | ,43112             | ,06733                    |
|                  | hungry | 39 | 1,3576     | ,65570             | ,10500                    |

| Gruppenstatistik |        |    |            |                    |                           |
|------------------|--------|----|------------|--------------------|---------------------------|
|                  | Hunger | H  | Mittelwert | Standardabweichung | Standardfehler Mittelwert |
| Breakfast        | sated  | 41 | 1,0415     | ,47556             | ,07427                    |
|                  | hungry | 39 | 1,2173     | ,62284             | ,09973                    |
| Breakfast 2      | sated  | 41 | 1,2901     | ,78700             | ,12291                    |
|                  | hungry | 39 | 1,7496     | 1,09786            | ,17580                    |
| Side Dishes      | sated  | 41 | ,8940      | ,63234             | ,09875                    |
|                  | hungry | 39 | ,9651      | ,69008             | ,11050                    |
| Lunch            | sated  | 41 | 1,3076     | ,79792             | ,12461                    |
|                  | hungry | 39 | 1,7165     | 1,38907            | ,22243                    |
| Lunch 2          | sated  | 41 | 1,2190     | ,77303             | ,12073                    |
|                  | hungry | 39 | 1,6082     | 1,11047            | ,17782                    |
| Dessert          | sated  | 41 | 1,0772     | ,67750             | ,10581                    |
|                  | hungry | 39 | 1,2573     | ,74034             | ,11855                    |
| Dessert 2        | sated  | 41 | 1,3321     | ,99544             | ,15546                    |
|                  | hungry | 39 | 1,4112     | ,90842             | ,14546                    |
| Snacks           | sated  | 41 | ,7322      | ,39268             | ,06133                    |
|                  | hungry | 39 | ,9353      | ,67447             | ,10800                    |

**Table 5.** Mean Fixation duration in total and per stimuli for low-calorie images

In the following chapter another aspect besides fixation duration is described – choice of food images. The following hypotheses were built to identify, on the one hand if there is a difference in choice concerning calorie content under sated or hunger condition and additionally more specific regarding high-caloric foods under hunger condition. On the other hand regarding BMI and restraint eating.

## **4.2 Influence of hunger condition on choice for high and low-calorie food images**

Continuously exposure to food cues is normal, whereas people have to think multiple times during the day about their food consumption. As overweight and obesity prevalence increases, research concerning food choices gets more and more into focus. Particularly, because food choices are determining energy intake.

A previous neurological study mainly focused on choice for food versus non food items under sated condition in normal-weight participants. Results showed that participants chose significantly more low-calorie than high-calorie images under state of satiety. (Charbonnier et al., 2015)

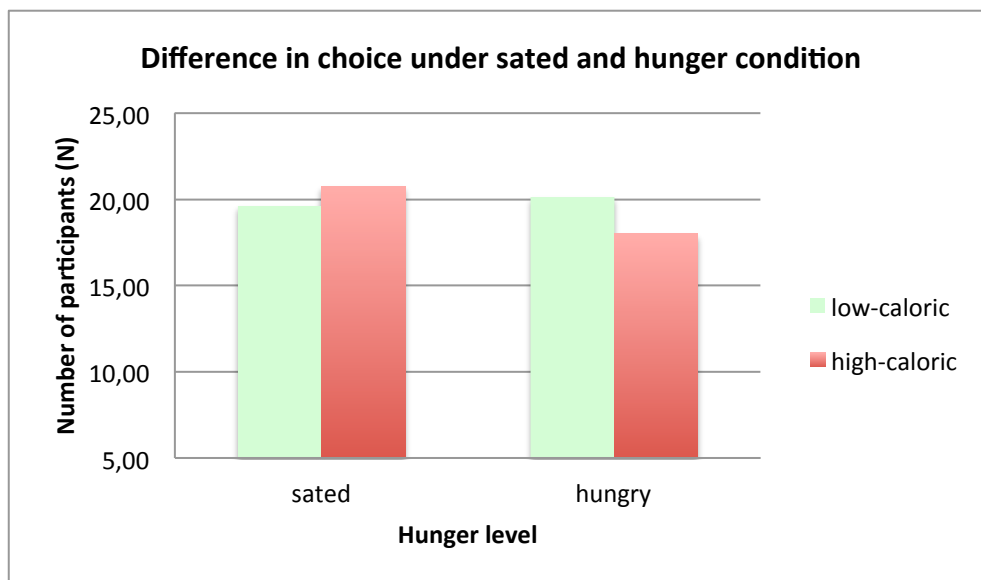
As an addition in this study, it was tested if these findings would also match just for food images under state of hunger and satiety and independent of hunger state.

**Hypothesis 3: Is there a difference in choice for food images high or low in calories under hunger and sated condition?**

H0: There is no difference in choice for food images high or low in calories under hunger and sated condition .

H1: There is a difference in choice for food images high or low in calories under hunger and sated condition.

As can be seen in the graph below, there is no difference between the two groups concerning calorie content. 19 sated individuals chose low-calorie images and 21 images high in calories. In the hunger group 20 chose low-caloric and 18 high-caloric images. Statistical Analysis with help of Chi-Square test  $\chi^2(27, N= 80)=24.97, p=.58$ , did not show any significant results and supported this suggestion.



**Figure 12.** Difference in choice for high and low-calorie images under hunger condition

**Hypothesis 4: Is there a difference in choice for high and low caloric food images independent of hunger level?**

H0: There is no difference in choice for high-caloric and low-caloric food images independent of hunger level?

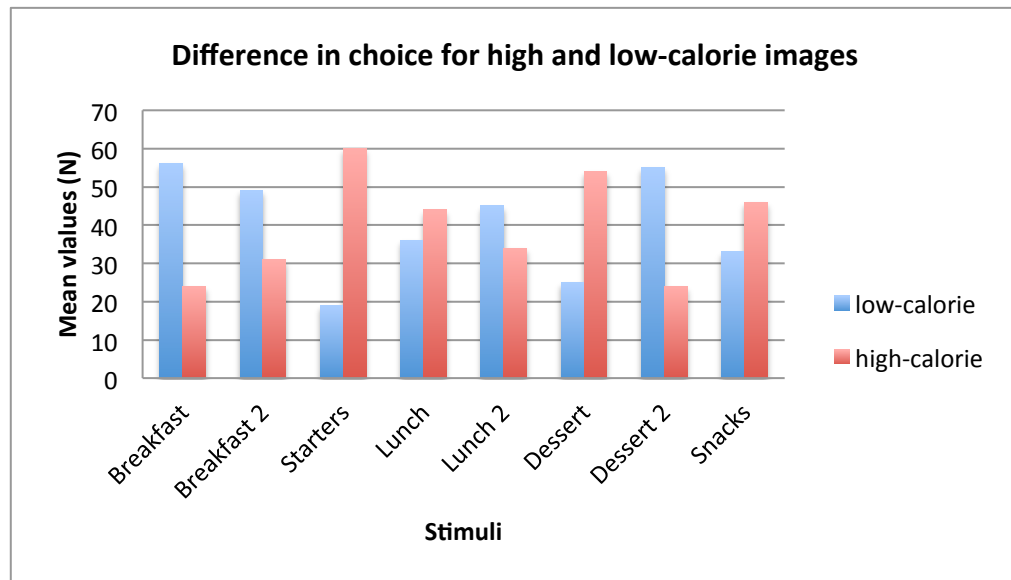
H1: There is a difference in choice for high-caloric and low-caloric food images independent of hunger level?

This hypothesis was implemented to test if there is a relation between certain stimuli and choice behaviour. Choice for all 8 stimuli of hungry and sated participants for high and low calorie items was used for analysis.

As can be seen in the figure below, there was a tendency that more participants chose low-caloric images like Breakfast, Breakfast 2, Lunch 2, Dessert 2 - so 4 out of 8 stimuli, as well as the other way round, for stimuli like Starters, Dessert and Snacks – 3 out of 8 stimuli, there were more subjects who chose high-caloric images.

Chi-Square test was used to examine the difference for all 8 stimuli between high and low-calorie images. There was a significant difference in choice for Breakfast  $\chi^2(1, N= 80)=12.80$ ,  $p<.001$ , Breakfast 2  $\chi^2(1, N= 80)=4.05$ ,  $p=.04$ , Side Dishes  $\chi^2(1, N= 80)=22.05$ ,  $p<.001$ , Dessert  $\chi^2(1, N= 80)=11.25$ ,  $p=.001$ , and Dessert 2  $\chi^2(1, N= 80)=11.25$ ,

$p=.001$ . Results were significant between 5 out of all 8 stimuli groups. This result leads to the conclusion, that under hunger condition, more participants chose low-calorie images. For a better distinction mean values in total for both low 3.98 (SD=1.54) and high-images 4.03 (SD=1.54) were compared, which showed that distribution is equal.



**Figure 13.** Difference in choice for high and low-calorie images under hunger condition for each stimuli

### **4.3 Influence of BMI on choice for high and low-calorie food images**

There are a few mixed findings regarding BMI and food choice. For example research from Castellanos et al. (2009) suggested that BMI is associated with an attention bias for high-calorie food cues. Whereas a study of Nummenmaa et al. (2011) found that avoidance of energy dense food was related to a higher BMI in mainly healthy-weight individuals. Gearhardt et al. (2012) supported these findings and showed that a higher BMI was associated with less attention for high palatable food cues and even with more attention regarding low energy dense food. Finally, there are also findings, which reported no significant association between attention bias for high energy dense items and BMI (Loeber et al., 2012).

Based on this, a new approach beneath attentional bias is to test if there is also a conjunction between choice for images with different caloric content and BMI.

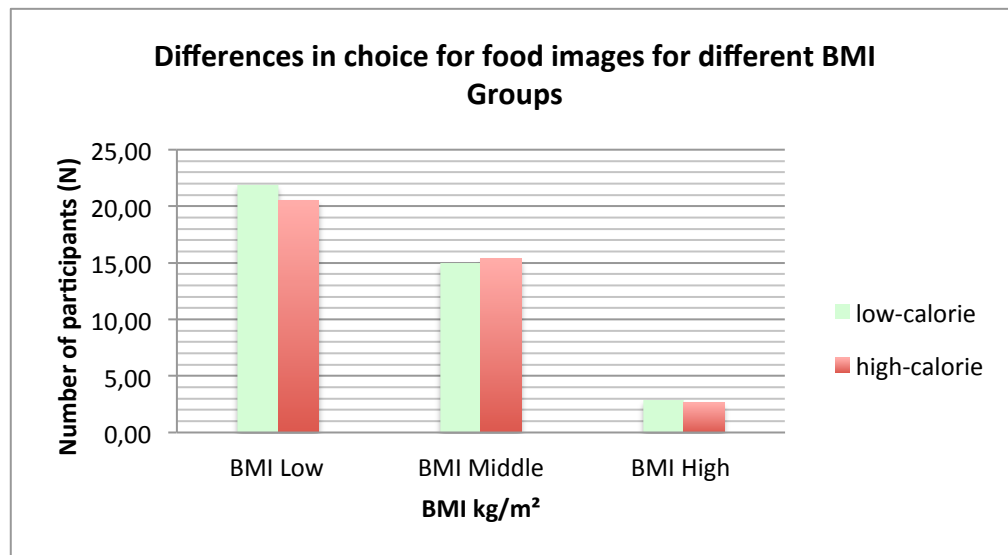
#### **Hypothesis 5: Does Body Mass Index influence choice for food images high and low in calories?**

H0: There is no relation between Body Mass Index and choice for high and low-caloric food images.

H1: There is a relation between Body Mass Index and choice for high and low-caloric food images.

BMI was split into tertiles, the first group with 43 participants was determined as “low” with a range from 16,80 to 21,91 kg/m<sup>2</sup>, the second one as „middle“ with 31 participants and a range from 22,04 to 24,49 kg/m<sup>2</sup>, and the third one as „high“ with 6 participants and a range from 26,06 to 31,83 kg/m<sup>2</sup>). Because of the fact that most participants in our study had a very low BMI, what can be explained by the high number of people with excellent nutrition background and interest. To test this hypothesis MANOVA was used, with BMI groups as dependent and calorie content as independent variables.

The results of Pillair-Spur  $F(8,70)=37.61$ ,  $p=.44$ , supported findings of Loeber et al. (2012) and showed that there was no significant difference in choice for food images high and low in calories and BMI.



**Figure 14.** Differences in choice for high and low-calorie food images for different BMI Groups

#### 4.4 Influence of restraint eating on choice for food images

**Hypothesis 6: Does restraint eating influence choice for high and low-caloric food images?**

H0: Restraint eating has no influence on choice for food images high and low in calories.

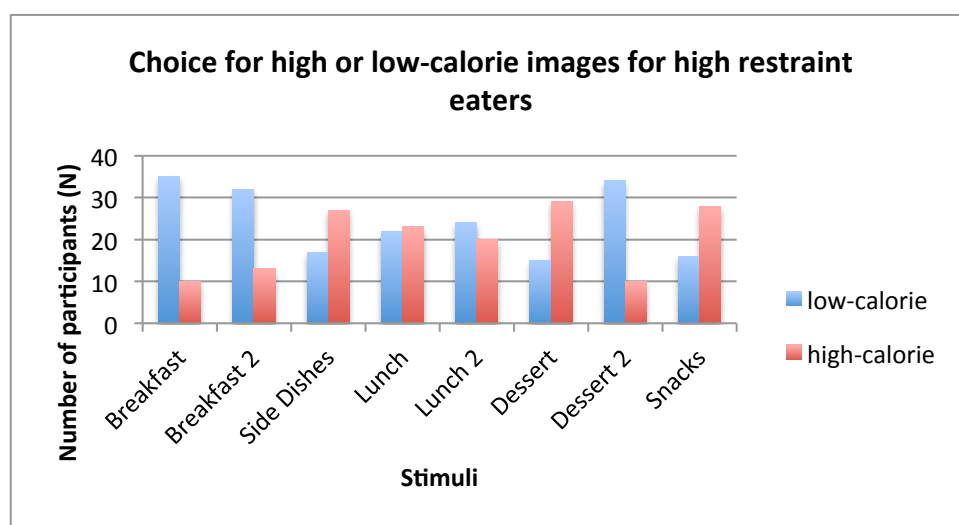
H1: Restraint eating has an influence on choice for food images high and low in calories.

One aim in the present study was to examine if restrained eating is related to food choice. Therefore participants were split into two groups with a high and a low restraint-level. The values for the “not restraint” eaters ranged from 10 to 25 and for the “restraint eaters” from 25 to 40. Resultant 62 subjects were allocated to the high and 18 to the low group.

To test if there is a significant difference for high and low-calorie images just in high restraint eaters a Chi-Square test was implemented. Results were significant for Breakfast

$\chi^2(1, N=45)=13.89, p<.001$ , Breakfast 2  $\chi^2(1, N=45)=8.02, p=.01$ , Dessert  $\chi^2(1, N=45)=11.25, p=.03$ . and Dessert 2  $\chi^2(1, N=45)=11.76, p=.001$ .

This means that restraint eating has an influence on choice for food items for certain stimuli.



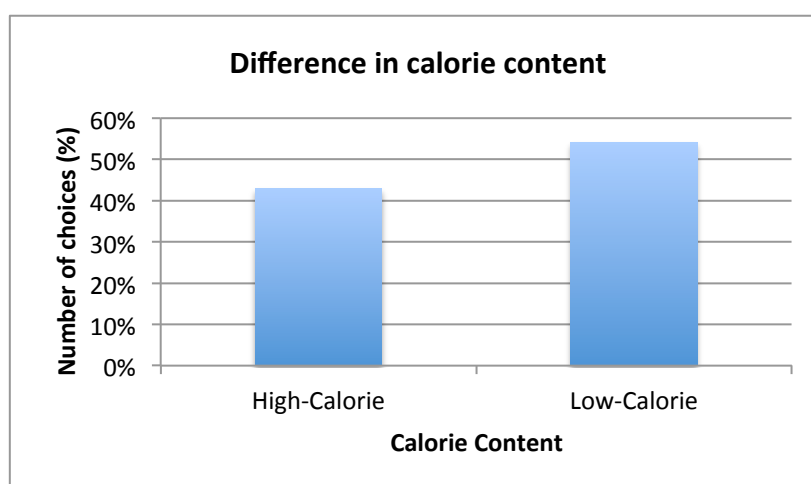
**Figure 15.** Choice of high and low calorie images in high restraint eaters for each stimuli

As can be seen in the graph above, choice for low-calorie images in stimuli Breakfast, Breakfast 2 and Dessert 2 were considerably higher as for high-calorie images in high restraint eaters. Just for Dessert high-calorie images were significantly higher.

Resultant it can be said, that 4 out of 8 presented stimuli were significant, which leads to the conclusion that there is a significant difference at all.

This result might be attributed to the fact that Breakfast, Breakfast 2 and Dessert 2 pictures low in calories were more attractive for the participants than high-calorie images.





**Figure 16.** Difference in choice for high and low-calorie images for high-restraint eaters in total

As can be seen in the graph above, that choice for low-calorie images in total for all 8 stimuli, with approximately 50 %, was much more likely than 40% for high-calorie ones. Implemented Chi-Square test,  $X^2(6, N=62)=19.74$ ,  $p=0.01$ , showed a significant difference.

#### **4.5 Influence of hunger condition regarding to appetite for food images**

**Hypothesis 7: Is there a difference in appetite for bland or palatable food images under hunger or sated condition?**

H0: There is no difference in appetite under hunger or sated condition.

H1: There is a difference in appetite under hunger or sated condition.

The main question is if there is a higher rate for high-calorie food images after the eye-tracking experiment in hungry individuals. To answer this question ratings of VAS of the appetite questionnaire, which was implemented after the Eye-Tracking experiment, were analysed.

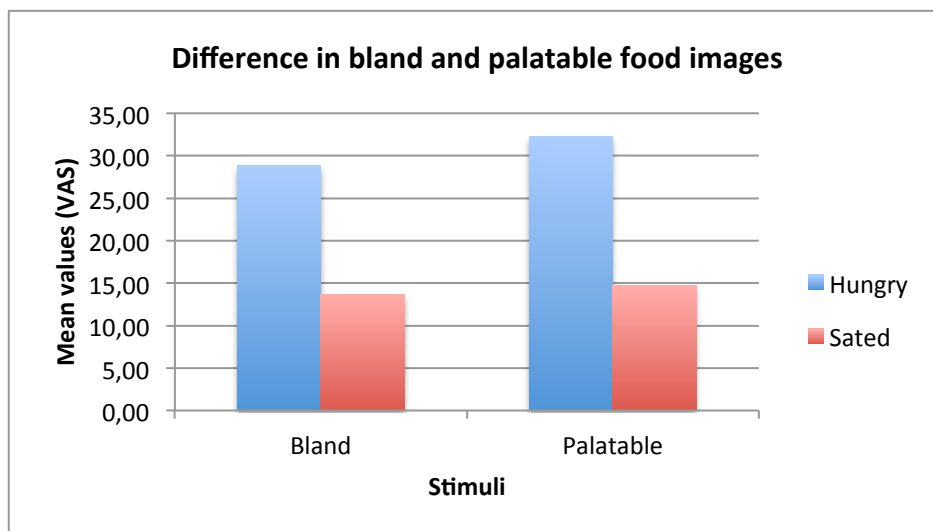
For a better distinction of the food stimuli in high and low-energy foods, they were split into two groups, in “palatable” and “bland” foods. Palatable such as Fish Sandwich, Cheeseburger, Kebab, Donut, Chocolate Cake, Chips, Cream Roll and Nougat. Bland food

images were for example Shashlik, Popcorn, Pretzel sticks, Pudding, Brussel Sprouts, Carrots, Roastbeef Sandwich and Pistachios.

It is suggested that there is a correlation for palatable foods and hunger. Thus, a main effect of food type is expected. Palatable foods were expected to have a high appetite level on the VAS and “bland” for those with a low level on the VAS.

As can be seen in the figure, means and standard deviations for hungry individuals were 28.83 (SD= 24.15) for bland 32.23 (SD=26.10) for palatable foods. Means and standard deviations for sated individuals were 13.69 (SD= 16.82) for bland 14.74 (SD=18.09) for palatable foods.

Finally, independent t-test was carried out to examine the relationship between hunger and appetite for palatable food cues. Resultant it can be said, that there is a direct association regarding appetite for palatable food cues and hunger  $t(67.31)=3.47$ ,  $p=.001$  as well as for bland food cues  $t(67.50)=3.24$ ,  $p=.002$ .



**Figure 17.** Difference between bland and palatable food cues regarding hunger condition

## 4.6 Influence of the hunger condition concerning craving for food images

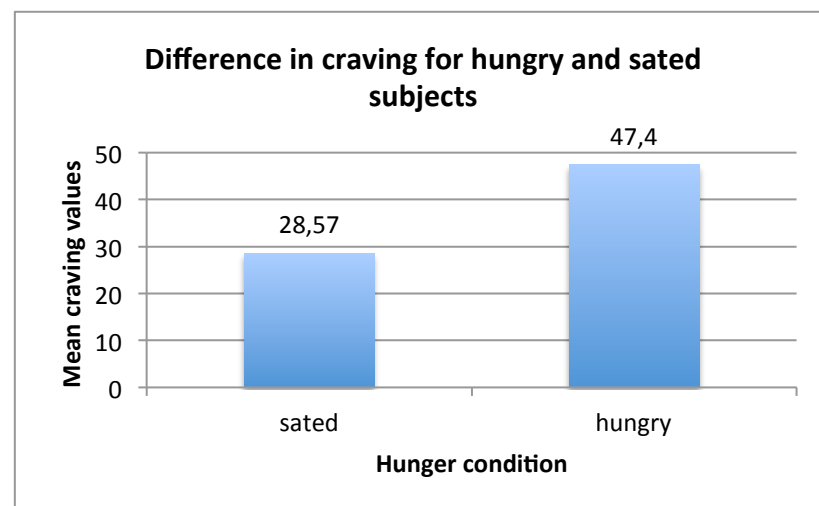
**Hypothesis 8: Is there a difference in craving after presenting food images under hunger or sated condition?**

H0: There is no difference in craving after presenting food images in all participants under hunger or sated condition.

H1: There is a difference in craving after presenting food images in all participants under hunger or sated condition.

To follow up to the hypothesis, which predicts that craving has an influence on hunger state after presenting food cues. Mean values of craving, analysed through the FCQ questionnaire, before and after the Eye-tracking experiment were compared. Higher values indicated a higher level of craving.

Independent samples t-test resulted in a significant difference,  $t(78)=-6.65$ ,  $p<.001$ , between hungry and sated individuals.



**Figure 18.** Difference in craving under hungry or sated condition

### Hypothesis 9: Does external eating influence craving for food images?

H0: External eating has no influence on craving for food images.

H1: External eating has an influence on craving for food images.

One aim in the present study, was to test if external eating is related to food craving. Therefore participants were split into two groups with a high and a low external-level. The values for the “not external” eaters ranged from 10 to 25 and for the “external eaters” from 25 to 40. Finally, 75 subjects were allocated to the high and 5 to the low group. Concerning this distribution it is clear that the majority of participants had external eating habits.

| Gruppenstatistik |              |    |            |                    |                              |
|------------------|--------------|----|------------|--------------------|------------------------------|
|                  | External     | H  | Mittelwert | Standardabweichung | Standardfehler<br>Mittelwert |
| Craving          | not external | 5  | 22,20      | 13,971             | 6,248                        |
|                  | external     | 75 | 39,79      | 15,278             | 1,764                        |

**Table 6.** Means and standard deviations for low and high external eaters

Independent samples t-test showed a significant difference,  $t(78)=-2.50$ ,  $p=.01$ , which means that external eating has an influence on craving for food items. Findings of Nijs et al. (2009) described in chapter 1 can be approved - participants with high-external eating habits reported significantly higher food cravings than those with low-external eating habits.

Thus because of the huge difference in the amount of groups, on the one hand 75 external and on the other hand just 5 not external eaters, the amount of “not external eaters” was not really meaningful and a comparison almost impossible.



## **5. Results – Summary and Interpretation**

### **5.1 Influence of hunger condition on fixation duration for high and low-calorie food images**

No significant connection between fixation duration and hunger level was found. But there is a slight tendency in hungry participants to be more sensitive and responsive to low and high-calorie images compared to sated ones. As can be seen in figure 12 compared to figure 11, means for fixation duration concerning items low in calories, for hungry subjects were 1.35 seconds (SD=0.66) and 1.11 seconds (SD=0.43) for sated ones, compared to foods high in calories with 1.27 seconds (SD=0.67) and for sated ones 1.03 seconds (SD=0.45).

The higher attention for pictures with a low energy content are supported by findings of Werthmann et al., (2014), who reported that individuals might be convinced of the concept of “health” when presenting high-caloric and low-caloric food images at the same time, and then automatically focus their attention more on low-energy food cues. Whereas study results of Castellanos et al., (2009) showed that when high-energy dense stimuli were presented together with neutral or non-food stimuli this association was less likely.

### **5.2 Influence of hunger condition on choice**

Findings for food choice in relation to hunger level was not significant. There was a slight tendency to chose more low-caloric images in hungry participants. A precise look at the different stimuli independent of satiety state showed that participants had a higher preference for low-calorie images in stimuli like Breakfast, Breakfast 2 and Dessert 2, and for high-calorie images in stimuli like Side Dishes, Snacks and Dessert. So the overall conclusion is that certain stimuli were more attractive than others. This could be due to the fact, that especially for meals like Side Dishes the differences between the presented pictures were to big. On the one hand, rice and potatoes compared to on the other hand

vegetables. This might be the reason for the high number of individuals who chose the images with the higher calorie content. Concluding it can be said, that for certain stimuli there is a difference in choice, and even more the tendency in choosing images low in calories, but in total there is an equal allocation of food choice for both high and low calorie foods.

### **5. 3 Influence of BMI on choice**

There was no significant difference in choice for food images high and low in calories and BMI. In all BMI groups, “low”, “middle” and “high”, the quantity of participants was almost equal.

### **5.4 Influence of restraint eating on choice**

In total 62 participants, so more than half of the study subjects were restraint eaters. The results concluded, that there are differences in choice of high-restraint eaters and that restraint eating has an influence on choice for food items for certain stimuli. There is a slightly higher tendency in choice for low-calorie images. So findings of Higgs et al. (2012) can be supported, that individuals with restraint eating habits avoid food images high in calories, in order to follow their dieting rules or to show attentional attitude.

### **5.5 Influence of hunger condition regarding to appetite for food**

Findings of the appetite questionnaire after the experiment showed a significant difference between hungry and sated participants for bland and palatable foods. However, hungry participants recorded higher scores for both palatable and bland food cues compared to sated ones. Which could be due to the fact, that after Eye-Tracking, participants might be more primed for food cues than before and that might be the reason why appetite increased.

### **5.6 Influence of hunger condition on craving**

There is a significant difference in craving under hunger condition, as well as high

external eaters had higher craving values than low external eaters. In this study, findings concerning external eaters showed that they tend more to craving as non-external eaters.

So results of Nijs et al. (2009) can be supported, which showed that individuals with high-external eating habits reported stronger subjective cravings compared to low-external eaters.

Interestingly in this study, most participants, 75 out of 80, were scored as high external eaters. This could be attributed to the fact, that during the last time food cues were promoted aggressively or because of the recently shown food cues during the Eye-Tracking experiment.



## **6. Discussion**

### **6.1 Review and Limitations**

Regarding limitations in the current study, the utilisation of a standardized liquid meal should be focused. That means a fixed amount of milk shake was used to induce satiety in participants. This approach offered a few advantages in terms of easy and fast applicability, precise control and knowledge of nutrient and calorie content. Although the majority of participants reported a reduction in sensation of hunger after consumption of the milk shake, this was not equally satiating in all individuals. Therefore, in further studies, the amount of pre-load could be adjusted to a percentage of the daily energy requirement, to ensure similar levels of satiety condition in each participant.

Another critical point could be the elapsed time, which was 20 minutes, after drinking the milk-shake. According to results of Almiron-Roig et al. (2013) during that time it might be not fully possible for postprandial hormones to send signals of satiety to the brain.

For future studies food intake prior to testing should be noted or a clear fasting regulation should be implemented. For example in the study of Castellanos et al. (2009) participants were asked to refrain from food intake for at least 8 hours prior to the experiment.

Concerning Eye-Tracking, correct measures of eye movements were not recorded in 17 individuals. A possible explanation could be that instructions for the procedure were not enough defined at the beginning of the testing session.

Despite a good set-up with help of the implemented pre-test, acceptance for food stimuli might have been not well-balanced. For certain stimuli it could have been too difficult to differentiate between high and low-calorie foods. Especially for Dessert and Breakfast, chosen food items might have been too similar. Finally, further studies could

possibly differentiate between on the one hand foods high and low in calories and on the other hand neutral stimuli pairs to delimitate that participants would chose low-calorie foods before high calorie ones for the reason of „health“. In combination with neutral cues this might be less likely.

## **6.2 Conclusion and Outlook**

Attentional bias and choice of food cues is an interesting field for additional research, but even more of interest especially in this thesis is the relation between food, craving and eating behaviours. Interventions against food temptations could prevent individuals from being attracted by food. High palatable food cues are common in western societies and have a huge influence on eating behaviour and further implicate food intake.

For that reason, Eye-Tracking may provide a useful research tool in assessing effective psychological interventions for the investigation of treatments against craving and additionally also obesity. It is a perspective to study and treat this important public health concern.

Taking different eating motivations into account, for example, eating enjoyment versus avoidance of food, further studies are necessary. Regarding to restraint eaters, even in this study more than half of the tested participants were restraint eaters, which means that most of them worry about their weight and food intake. This could be due to the fact that mostly health conscious individuals participated in the experiment. It is not clear if in these individuals restrained eating is associated with an attentional avoidance or an attentional approach concerning food cues. Because of this in future studies restrained eaters should be compared with normal eaters concerning exposure of highly palatable food cues, which was not topic of this thesis.

Especially, in the field of external eating further research should examine the possible strategies to prevent craving in this eating pattern. In turn craving promotes intake for food, which leads to the fact, that people have an intense desire to eat when they were exposed to sight or smell of food.

Resultant can be said, that satiety had no impact on attentional bias and choice for images with different calorie content. Self-reported measures of appetite pointed out, that hungry participants had higher scores for food cues compared to sated ones, which could be attributed to the prior exposure of food images. Further significant findings were that restraint eaters chose food images of low-calorie content when they were hungry. As well as for individuals with high external eating habits, higher craving values were recorded. Although, further studies are needed to confirm this conclusions.



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## 10. Appendix

### Testing documentation - Questionnaires

#### Introduction



0% ausgefüllt

#### Fragen zum Hungergefühl

Bitte versuche die Fragen so ehrlich und genau wie möglich zu beantworten.  
Wenn Du unsicher bist frag bitte nach.

1. Bitte trage hier Deine Teilnehmernummer ein:

Weiter

Andrea Schauer BSc - 0907479 - Studie der Ernährungswissenschaften - 2015

#### Hunger Questionnaire - Grand Hunger Scale - German Version



33% ausgefüllt

2. Wie hungrig bist Du gerade?

Bitte setze ein X an den Punkt auf der Linie, der am besten beschreibt, wie hungrig Du im Moment bist.  
Zum Beispiel wenn Du nicht sehr hungrig bist, platziere das X näher zum linken Ende, wenn Du sehr hungrig bist, platziere das X näher zum rechten Ende.

gar nicht hungrig X sehr hungrig

3. Wie viel von Deinem Lieblingsessen könntest Du im Augenblick essen?

Bitte platziere ein X an der Stelle der Linie, die am besten beschreibt, wie viel deines Lieblingsessens Du im Moment imstande wärest zu essen.

gar nichts X soviel wie möglich

Zurück

Weiter

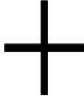
Andrea Schauer BSc - 0907479 - Studie der Ernährungswissenschaften - 2015

## Food Craving Questionnaire – German Version

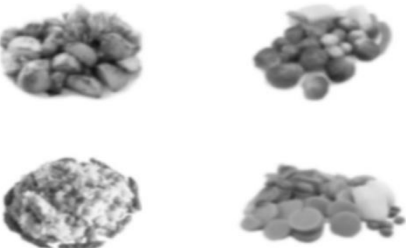
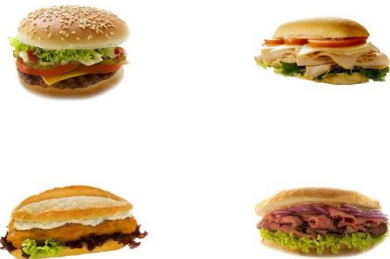
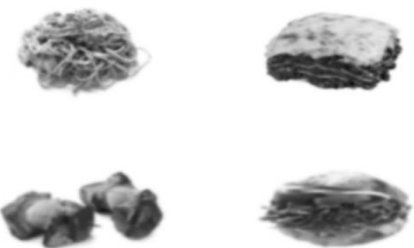
4. Bitte gib an, wie sehr die folgenden Aussagen jetzt gerade, **IN DIESEM MOMENT**, auf Dich zutreffen. Die Formulierung [eines oder mehrere bestimmte Nahrungsmittel] bezieht sich auf etwas, worauf Du jetzt gerade Lust hast.

|                                                                                                                            | Stimme<br>überhaupt<br>nicht zu<br>1 | Stimme<br>nicht zu<br>2 | neutral<br>3          | Stimme zu<br>4        | Stimme<br>sehr stark<br>zu<br>5 |
|----------------------------------------------------------------------------------------------------------------------------|--------------------------------------|-------------------------|-----------------------|-----------------------|---------------------------------|
| 1. Ich verspüre den intensiven Wunsch [eines oder mehrere bestimmte Nahrungsmittel] zu essen.                              | <input type="radio"/>                | <input type="radio"/>   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>           |
| 2. Ich verspüre ein starkes Verlangen nach [einem oder mehreren bestimmten Nahrungsmitteln].                               | <input type="radio"/>                | <input type="radio"/>   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>           |
| 3. Ich verspüre den Drang, [eines oder mehrere bestimmte Nahrungsmittel] zu essen.                                         | <input type="radio"/>                | <input type="radio"/>   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>           |
| 4. [Eines oder mehrere bestimmte Nahrungsmittel] zu essen, würde mir alles einfach perfekt erscheinen lassen.              | <input type="radio"/>                | <input type="radio"/>   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>           |
| 5. Wenn ich das essen würde, wonach ich mich gerade sehne, würde sich sicher meine Stimmung verbessern.                    | <input type="radio"/>                | <input type="radio"/>   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>           |
| 6. [Eines oder mehrere bestimmte Nahrungsmittel] zu essen, würde sich großartig anfühlen.                                  | <input type="radio"/>                | <input type="radio"/>   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>           |
| 7. Wenn ich etwas essen würde, würde ich mich nicht so träge und antriebslos fühlen.                                       | <input type="radio"/>                | <input type="radio"/>   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>           |
| 8. Wenn ich mein Verlangen stillen könnte, würde ich mich weniger schlecht gelaunt und gereizt fühlen.                     | <input type="radio"/>                | <input type="radio"/>   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>           |
| 9. Wenn ich mein Verlangen stillen könnte, würde ich michmunterer fühlen.                                                  | <input type="radio"/>                | <input type="radio"/>   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>           |
| 10. Wenn ich [eines oder mehrere bestimmte Nahrungsmittel] hätte, könnte ich nicht aufhören, davon zu essen.               | <input type="radio"/>                | <input type="radio"/>   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>           |
| 11. Mein Verlangen, [eines oder mehrere bestimmte Nahrungsmittel] zu essen, scheint überwältigend zu sein.                 | <input type="radio"/>                | <input type="radio"/>   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>           |
| 12. Ich weiß, dass ich solange an [eines oder mehrere bestimmte Nahrungsmittel] denken werde, bis ich es tatsächlich habe. | <input type="radio"/>                | <input type="radio"/>   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>           |
| 13. Ich habe Hunger.                                                                                                       | <input type="radio"/>                | <input type="radio"/>   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>           |
| 14. Wenn ich jetzt etwas essen würde, würde sich mein Magen nicht mehr so leer anfühlen.                                   | <input type="radio"/>                | <input type="radio"/>   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>           |
| 15. Ich fühle mich schwach, weil ich nichts gegessen habe.                                                                 | <input type="radio"/>                | <input type="radio"/>   | <input type="radio"/> | <input type="radio"/> | <input type="radio"/>           |

## Eye-Tracking (from the left to the right) – Testing Documentation

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>Sie werden nun pro Bild 4 Produkte sehen. Bitte schauen Sie sich alle 4 an und klicken Sie 1x mit der linken Mausetaste, sobald Sie sich in Gedanken für eines der Produkte entschieden haben.</p> <p>Danach verschwimmen die Bilder und es erscheint der Mousezeiger. Klicken Sie bitte mit dem Mousezeiger auf das zuvor ausgewählte Produkt.</p> <p>WICHTIG - Zwischendurch werden weiße Folien mit einem schwarzen Kreuz angezeigt. Fixieren Sie mit Ihren Augen die Mitte des Kreuzes. Die Folie verschwindet automatisch und ein neues Produktbild erscheint.</p> <p>Zum Starten, drücken Sie nun die linke Mausetaste.</p> |                                                                                              |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |  <p>Für welches Produkt haben Sie sich entschieden?<br/>Klicken Sie bitte auf Ihre Wahl.</p> |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                             |

|                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|    | <p>Haben Sie noch Fragen? Wenn ja, stellen Sie diese nun bitte Ihrem Testbetreuer.</p> <p>Sie werden nun pro Bild wieder 4 Speisen sehen. Die Bilderabfolge in der Studie stellt einen Tagesablauf an Speisen dar. Bitte stellen Sie durch Ihre Auswahl Ihr Tagesmenü zusammen.</p> <p>Wenn Sie bereit sind mit dem Eyetracking-Test zu starten, klicken Sie bitte mit der linken Moustaste.</p> |
|    |                                                                                                                                                                                                                                                                                                                |
|  |                                                                                                                                                                                                                                                                                                             |
|  |                                                                                                                                                                                                                                                                                                              |

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|-------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <p>+</p>                                                                            |    |
|    | <p>+</p>                                                                             |
|   |   |
| <p>+</p>                                                                            |  |
|  | <p>+</p>                                                                             |



|                                                                                                                                                                         |                                                                                                                                                                            |
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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p style="text-align: center;"><b>Geschlecht</b></p> <p> <input type="radio"/> weiblich<br/> <input type="radio"/> männlich </p> <p style="text-align: center;">Next</p>                                                                                                                                                                                                    | <p style="text-align: center;"><b>Alter</b></p> <p> <input type="radio"/> 18<br/> <input type="radio"/> 19<br/> <input type="radio"/> 20<br/> <input type="radio"/> 21<br/> <input type="radio"/> 22<br/> <input type="radio"/> 23<br/> <input type="radio"/> 24<br/> <input type="radio"/> 25<br/> <input type="radio"/> 26<br/> <input checked="" type="radio"/> 27<br/> <input type="radio"/> 28<br/> <input type="radio"/> 29<br/> <input type="radio"/> 30<br/> <input type="radio"/> 31<br/> <input type="radio"/> 32 </p> <p style="text-align: center;">Finished</p> |
| <p>         Danke, das aktive Eye-Tracking ist nun<br/>         beendet.<br/>         Bitte gehen Sie nun in den anderen Raum, um<br/>         den 2. Teil der Studie abzuschließen. Bitte<br/>         vergessen Sie Ihren Nummernzettel nicht.<br/> <br/>         Vielen Dank für Ihre Teilnahme am ersten Teil!<br/> <br/>         Noch ein letztes Mal klicken ;-) </p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

## Antipathy Questionnaire

1. Hast Du gegen eines oder mehrere der gezeigten Nahrungsmittelbilder eine Abneigung?

- ☐ Ja  
☒ Nein

3. Gegen welche der gezeigten Nahrungsmittel hast Du eine Abneigung?

|                          | keine Abneigung | große Abneigung |
|--------------------------|-----------------|-----------------|
| Croissants               | X               |                 |
| Bagel                    | X               |                 |
| Brötchen                 | X               |                 |
| Knäckebrot mit Aufstrich | X               |                 |
| Bratkartoffeln           | X               |                 |
| Kohlsprossen             | X               |                 |
| Risotto mit Erbsen       | X               |                 |
| Karotten                 | X               |                 |
| Cheeseburger             | X               |                 |
| Schinken Sandwich        | X               |                 |
| Fisch Sandwich           | X               |                 |
| Roastbeef Sandwich       | X               |                 |
| Spaghetti Bolognese      | X               |                 |
| Lasagne                  |                 | X               |
| Schaschlik               | X               |                 |
| Kebab                    |                 | X               |
| Chips                    | X               |                 |
| Pistazien                | X               |                 |
| Popcorn                  |                 | X               |
| Salzstangen              | X               |                 |
| Schokokuchen             |                 | X               |
| Donut                    | X               |                 |
| Pudding                  |                 | X               |
| Schaumrolle              | X               |                 |
| Türkischer Honig         |                 | X               |
| Torte                    |                 | X               |

## Appetite Questionnaire

### 4. Wie groß ist momentan Dein Appetit auf folgende Nahrungsmittel?

|                          | sehr klein            | sehr groß             |
|--------------------------|-----------------------|-----------------------|
| Croissants               | <input type="range"/> |                       |
| Bagel                    | <input type="range"/> |                       |
| Brötchen                 | <input type="range"/> |                       |
| Knäckebrot mit Aufstrich | <input type="range"/> |                       |
| Bratkartoffeln           | <input type="range"/> |                       |
| Kohlsprossen             | <input type="range"/> |                       |
| Risotto mit Erbsen       | <input type="range"/> |                       |
| Karotten                 | <input type="range"/> |                       |
| Cheeseburger             | <input type="range"/> |                       |
| Schinken Sandwich        | <input type="range"/> |                       |
| Fisch Sandwich           | <input type="range"/> |                       |
| Roastbeef Sandwich       | <input type="range"/> |                       |
| Spaghetti Bolognese      | <input type="range"/> |                       |
| Lasagne                  |                       | <input type="range"/> |
| Schaschlik               | <input type="range"/> |                       |
| Kebab                    |                       | <input type="range"/> |
| Chips                    | <input type="range"/> |                       |
| Pistazien                | <input type="range"/> |                       |
| Popcorn                  | <input type="range"/> |                       |
| Salzstangen              | <input type="range"/> |                       |
| Schokokuchen             |                       | <input type="range"/> |
| Donut                    | <input type="range"/> |                       |
| Pudding                  |                       | <input type="range"/> |
| Schaumrolle              | <input type="range"/> |                       |
| Türkischer Honig         |                       | <input type="range"/> |
| Torte                    |                       | <input type="range"/> |

## Dutch Eating Behavior Questionnaire - German Version - Restraint Eating

### Fragen zum Ernährungsverhalten

|                                                                                               | niemals               | selten                | manchmal              | oft                   | sehr oft              |
|-----------------------------------------------------------------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 1. Ich versuche oft, zwischen den Mahlzeiten nicht zu essen, weil ich auf mein Gewicht achte. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 2. Wenn ich in letzter Zeit zugenommen habe, esse ich weniger als sonst.                      | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 3. Ich denke an mein Gewicht bei der Entscheidung, was ich esse.                              | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 4. Ich versuche während der Mahlzeiten weniger zu essen, als ich gerne essen würde.           | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 5. Ich esse bewusst weniger, um nicht zuzunehmen.                                             | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 6. Ich esse bewusst kalorienarme Lebensmittel.                                                | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 7. Ich achte genau auf das, was ich esse.                                                     | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 8. Ich versuche oft, am Abend nichts zu essen, weil ich auf mein Gewicht achte.               | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 9. Ich lehne oft Speisen oder Getränke ab, weil ich um mein Gewicht besorgt bin.              | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 10. Wenn ich an einem Tag zuviel gegessen habe, esse ich am nächsten Tag weniger.             | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

## Dutch Eating Behavior Questionnaire - German Version - External Eating

### Fragen zum Ernährungsverhalten

|                                                                                                           | niemals               | selten                | manchmal              | oft                   | sehr oft              |
|-----------------------------------------------------------------------------------------------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 1. Wenn ich an einer Imbissstube oder einem Café vorbeikomme, möchte ich mir gerne etwas Leckeren kaufen. | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 2. Wenn Speisen gut riechen oder aussehen, esse ich mehr als sonst.                                       | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 3. Wenn ich beim Bäcker vorbeikomme, habe ich Lust, mir etwas Leckeren zu kaufen.                         | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 4. Ich kann nicht widerstehen, schmackhafte Speisen zu essen.                                             | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 5. Wenn ich eine Mahlzeit zubereite, neige ich dazu, davon zu naschen.                                    | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 6. Wenn ich andere essen sehe, möchte ich auch gerne etwas essen.                                         | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 7. Wenn mir ein Gericht gut schmeckt, esse ich mehr als sonst.                                            | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 8. Wenn ich etwas Schmackhaftes sehe oder rieche, würde ich es am liebsten sofort essen.                  | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 9. Wenn ich etwas Leckeren zu essen habe, esse ich es sofort.                                             | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| 10. Ich esse mehr als sonst, wenn ich andere essen sehe.                                                  | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

## Background Information Questionnaire

### BEVÖLKERUNGSSTATISTISCHE INFORMATION

Bitte gib die folgenden Informationen wahrheitsgemäß an.  
Sie dienen NICHT zur Identifikation sondern zur allgemeinen Beschreibung der TeilnehmerInnen an dieser Studie.

#### 1. Bist Du Student? Wenn Ja welche Studienrichtung?

- ☐ Ja
- ☐ Nein

#### 2. Ich ernähre mich...

- ☐ vegetarisch
- ☐ vegan
- ☐ keines von beiden

#### 3. Größe

cm

#### 4. Gewicht

kg

## Perceived Self-Regulatory Success Questionnaire – German Version

Wie gut gelingt es Dir auf Dein Gewicht zu achten?

überhaupt nicht gut 1 2 3 4 5 6 7 sehr gut

Wie gut gelingt es Dir abzunehmen?

überhaupt nicht gut 1 2 3 4 5 6 7 sehr gut

Wie schwierig findest Du es in Form zu bleiben?

überhaupt nicht gut 1 2 3 4 5 6 7 sehr gut

## **Abstract in English**

The main research question of this master thesis was to determine the attention bias for high and low-caloric stimuli as well as the choice for these food cues due to the eating behaviour in normal-weight participants under hunger and sated condition. Important aspects were, whether the saturation state has an influence on the choice behaviour on the one hand as well as, on the other hand, whether the food choice is dependent on different eating habits.

Through the use of an eye-tracking system, it was possible to establish fixation duration and choice behaviour for each stimuli. A further consideration of this study was to understand how Eye-Tracking can be combined with other research techniques like self-completion questionnaires. For that reason additional nutrition questionnaires were implemented to assess different eating behaviours through participants.

In total 80 normal-weight individuals aged 18 to 32 years participated in our study, thereof 40 were in a sated and 40 in a hunger condition. Hunger levels were self-indicated by using Visual Analogue Scales. For testing, 32 food cues were selected, thereof 2 high and 2 low-calorie images were shown on each slide. Testing sessions were arranged like a normal day menu with Breakfast, Side Dishes, Lunch and Dinner Menus, Desserts and Snacks.

Resultant study findings showed that satiety had no impact on attentional bias (measured with fixation duration) and choice for images with different calorie content. However, self-reported measures of appetite after Eye-Tracking pointed out, that hungry participants had higher scores for food cues compared to sated ones, which could be attributed to the prior exposure of food images.

Further significant findings were that restraint eaters chose food images of low-calorie content under hunger condition. As well as for individuals with high external eating habits, higher craving values were recorded. However, further studies are needed, to confirm these conclusions.

## Abstract in German

Die Hauptforschungsfrage dieser Masterarbeit bestand darin, das Entscheidungsverhalten für hoch- und niederkalorische Lebensmittel von normalgewichtigen hungrigen und satten Probanden zu hinterfragen. Besonderes Augenmerk wurde darauf gelegt, ob der Sättigungszustand einen Einfluss auf einerseits das Auswahlverhalten von hoch- und niederkalorischen Speisen hat, sowie andererseits, ob die Speisenauswahl von unterschiedlichen Ernährungsgewohnheiten abhängig ist.

Durch die Verwendung eines Eye-Trackers war es möglich, zu ermitteln, welchen Stimuli die meiste Aufmerksamkeit gewidmet wurde. Außerdem wurden Fragebögen zum Ernährungsverhalten durchgeführt, um die unterschiedlichen Gewohnheiten zu erfassen. Insgesamt wurden 80 valide Messwerte erhoben, wovon 40 hungrige und 40 satte Probanden waren. Das Hunger und Sättigungsverhalten wurden anhand von Selbsteinschätzungen der ProbandInnen erhoben. Für die Testung wurden 32 Speisen ausgewählt, wovon 2 hoch und 2 niederkalorische Bilder pro Folie gezeigt wurden. Die Bildabfolge war ähnlich wie ein wirkliches Tagesmenü aufgebaut, beginnend mit Frühstück, weiter zu Beilagen, Hauptmahlzeiten und/oder Abendmahlzeiten, Desserts, sowie Snacks.

Zusammenfassend kann gesagt werden, dass der Sättigungsgrad keinen Einfluss auf das Auswahl- und Blickverhalten von nieder- und hochkalorischen Stimuli hat. Jedoch hat ein Fragebogen zum Appetitverhalten nach dem Eye-Tracking ergeben, dass vermehrt Hungrige Appetit auf Lebensmittel hatten.

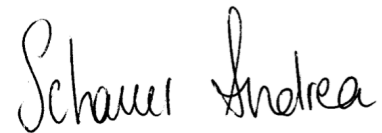
Bezüglich Personen mit zurückhaltenden Ernährungsgewohnheiten hat sich herausgestellt, dass diese niederkalorische Lebensmittel bevorzugen, wenn sie hungrig sind. Jene die sich häufig von Lebensmitteln verleiten lassen, also externe Esser sind, zeigten vermehrt Gelüste im Gegensatz zu denen, die solche Reize eher nicht betreffen. Weitere Studien bezüglich diesen Fragestellungen sind notwendig, um die Resultate zu bestätigen.



**Affirmation**

I hereby declare that this thesis was in all parts exclusively prepared on my own and that other resources than those explicitly indicated, have not been utilized.

All implemented passages quoted from publications or paraphrased from these sources were properly cited. Furthermore, this work was not submitted in the same or in a similar version to another examination board and was not published elsewhere.

A handwritten signature in black ink, reading "Schauer Andrea". The script is cursive and fluid.

Vienna, 21.11.2015

Andrea Schauer

## CURRICULUM VITAE

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### Education:

- 2013 till now - Master Study Nutritional Sciences University of Vienna – Public Health
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- 2004-2009 - Commercial Highschool Ried im Innkreis

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- 02/2015 - 10/2015 - Product Development and Recipe creations for Kochabo – Vienna – development of new recipes - creation, set-up and maintenance of all Recipe Informations – Test cooking – Nutritional calculations – preparing of articles
- 04/2014 – 06/2015 - Voluntary Work for Society of Nutritionist in Vienna ( Verein der Ernährungswissenschaftler Österreichs – VEÖ) Work group: public relations – administrative tasks, print work, assistance in planning and organising events
- 09/2014 – 12/ 2014 - Costumer Care Work for a Vegan and Vegetarian Restaurant/Deli „Esstisch“ - Vienna
- 02/2013 – 09/2013 - Nutrition Acadamey Austrian Society of Nutrition – Assistant for training courses of kindergarten teachers, organisation and development of different exercises - Vienna
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- 09/2012 - 12/2014 - Promotion agency Eaystaff – promotion and sale of various products for LGV, Unilever, Waff, Wiener Einkaufsstraßen, Woman Day, Milka
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- 07/2012 – Pharmacy „Einhorn“ Wels – administrative work
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- Travelling
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