Socialia

DISSERTATIONES
PSYCHOLOGICAE
UNIVERSITATIS
TARTUENSIS
47

UKU VAINIK

Towards a comprehensive framework for the psychological mechanisms of obesity and overeating

DISSERTATIONES PSYCHOLOGICAE UNIVERSITATIS TARTUENSIS
47

DISSERTATIONES PSYCHOLOGICAE UNIVERSITATIS TARTUENSIS
47

UKU VAINIK

Towards a comprehensive framework for the psychological mechanisms of obesity and overeating

UNIVERSITY OF TARTU PRESS

Department of Psychology, University of Tartu, Estonia

The dissertation has been accepted for the commencement of the degree of Doctor of Philosophy (in Psychology) on October 5, 2015 by the Council of the Faculty of Social Sciences and Education, University of Tartu.

Supervisor: Jüri Allik, *PhD*, Professor
University of Tartu, Estonia

Lesley Kathleen Fellows*, MD CM, DPhil*, Professor
McGill University, Canada

Opponent: John Edward Blundell, *PhD*, Professor
University of Leeds, United Kingdom

Commencement: December 8, 2015

Publication of this thesis is granted by the Department of Psychology, University of Tartu, and by the Doctoral School of Behavioural, Social and Health Sciences created under the auspices of European Union Social Fund

European Union
European Social Fund

Investing in your future

ISSN 1024-3291
ISBN 978-9949-32-992-2 (print)
ISBN 978-9949-32-993-9 (pdf)

University of Tartu Press
www.tyk.ee

CONTENTS

1. INTRODUCTION 7
   1.1. Environment and obesity 8
      1.1.1. From irregularity to food swamps 8
      1.1.2. Irregularity influencing human behaviour 11
      1.1.3. Potential solutions 12
   1.2. Aims and hypotheses 12
2. STUDY I. MAIN PERSON VARIABLES RELATED TO OBESITY AND EATING-RELATED BEHAVIOURS 14
   2.1. Neurocognitive tasks 14
      2.1.1. Food drive 15
         2.1.1.1. Results from Study I 15
         2.1.1.2. Mechanisms underlying food drive. 15
         2.1.1.3. Promising tasks capturing wanting, liking, and learning 16
      2.1.2. Cognitive control 19
         2.1.2.1. Results from Study I 19
         2.1.2.2. Converging evidence and future directions 19
   2.2. Questionnaires 21
      2.2.1. Results from Study I 22
      2.2.2. Further synthesis of personality traits and obesity 23
   2.3. Brain mechanisms 24
   2.4. General summary 26
3. STUDIES II AND III. UNDERSTANDING TRAIT-OUTCOME ASSOCIATIONS 27
   3.1. Study II. A novel method for detecting jingle fallacy 27
   3.2. Study III. Jangle fallacy – unity and diversity of eating traits questionnaires 28
   3.3. General conclusion 30
4. STUDY IV. PERSONALITY AND SITUATION PREDICTORS OF EATING CONSISTENCY 32
   4.1. Choosing eating-related outcomes 32
   4.2. Consistency as a function of person and situations 33
   4.3. Results and discussion 33
5. PRACTICAL APPLICATIONS 36

CONCLUSION 40

ACKNOWLEDGEMENTS 42

REFERENCES 43

SUMMARY IN ESTONIAN 61

PUBLICATIONS 63

CURRICULUM VITAE 65

ELULOOKIRJELDUS 66

LIST OF ORIGINAL PUBLICATIONS

This dissertation is based on the following original publications, further referred to by respective Roman numerals:

I. **Vainik, U.**, Dagher, A., Dubé, L., & Fellows, L. K. (2013). Neurobehavioural correlates of body mass index and eating behaviours in adults: A systematic review. *Neuroscience & Biobehavioral Reviews*, 37(3), 279–299. doi:10.1016/j.neubiorev.2012.11.008

II. **Vainik, U.**, Mõttus, R., Allik, J., Esko, T., & Realo, A. (2015). Are trait-outcome associations caused by scales or particular items? Example analysis of personality facets and BMI. *European Journal of Personality*, n/a-n/a. doi:10.1002/per.2009

III. **Vainik, U.**, Neseliler, S., Konstabel, K., Fellows, L. K., & Dagher, A. (2015). Eating traits questionnaires as a continuum of a single concept. Uncontrolled eating. *Appetite*, 90, 229–239. doi:10.1016/j.appet.2015.03.004

IV. **Vainik, U.**, Dubé, L., Lu, J., & Fellows, L. K. (2015). Personality and situation predictors of consistent eating patterns. *PlosONE*. Submitted.

For all the studies, the author set the aims, conducted the analyses and wrote the papers as the first author.

1. INTRODUCTION

Eating is one of the key functions of any living organism, including humans. Organisms have to acquire energy in order to maintain their body, explore the world, and reproduce. Given the absolute necessity of acquiring energy, it is perhaps no surprise that eating is a pleasurable thing to do. The principle is nicely summed in a quote commonly attributed to Voltaire, “Nothing would be more tiresome than eating and drinking if God had not made them a pleasure as well as a necessity.”

Although this quote may not be authentic, Voltaire certainly discussed the pleasure derived from eating and drinking in his Philosophical dictionary. He warned that „if a man were always eating, or always in the full ecstasy of enjoyment, his organs would be incapable of sustaining it, /.../ he would be unable to fulfil the destinies he was born to, and /../ the human race would absolutely perish through pleasure.“(Voltaire, 1838, p. 487 / 2353.0).

The first evidence for Voltaire’s dark prediction can be seen only 75 years later. There is anecdotal evidence from a Boston medical journal that lamented the decrease of thin people and the increase of “persons of extremely indolent habits of life” who no longer walked more “than the few steps that are needed from the chamber to the elevator, from the elevator to the dining-room, or lounging-room, and then to the automobile”(“The Automobile Knee,” 1912, p. 816). Figure 1 demonstrates the spread of such concerns in English written media. There was a considerable increase in the usage of the words „obesity“ and „overeating“ through the 20th century. These concerns reflected a reality of increasing weight in the population: an analysis of measured weight and height data in the United States confirms that mean body mass index (BMI = kg/m^2) steadily increased from the 1880’s, with a few slowdowns during the Great Depression and WWII (Komlos & Brabec, 2010a, 2010b). This phenomenon is not restricted to the United States: A recent analysis of worldwide self-report and measured BMI data shows that while the growth of obesity rates in the developed world has slowed since 2006, obesity levels are still increasing, reaching record levels in the developing world (Ng et al., 2014).

Obesity is a problem of energy balance – more calories are consumed than spent (Hill, 2006). Growth in national obesity rates is largely explained by an increase in calorie intake (e.g., Swinburn, Sacks, & Ravussin, 2009; Hall et al., 2011). The increased intake, in turn, is largely driven by the surrounding environmen – as reviewed below, humanity has achieved an unprecedented food security which facilitates overeating. At the same time, people differ in responsiveness to this environment, as not everyone is obese. Given that obesity is the result of an interaction between the environment and the individual person, a comprehensive framework is needed. While establishing a complete framework is beyond the scope of the thesis, current thesis aims to link various evidence gathered from psychological research with wider context.

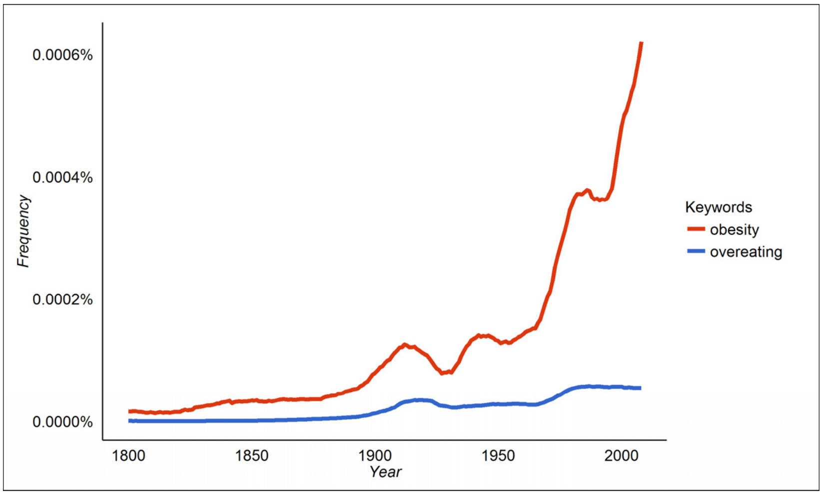

Figure 1. A Google Ngram search of the relative popularity of keywords "obesity" and "overeating" in all the words of the corpus of English books (Google Ngram, 2015) .

The majority of this thesis will study how eating decisions and obesity could be explained by individual differences in psychological constructs, such as cognitive function and personality traits. Study I presents a systematic review of the evidence so far. As several personality traits highlighted in Study I have been captured relatively coarsely, Studies II & III present approaches to clarifying and better measuring some of these constructs. Finally, the known obesity-related personality traits will be tested together with environmental factors to predict a possible aspect of unhealthy behaviour – eating consistency Study IV. Here, each paper is briefly summarized along with an updated discussion on recent developments in the field and/or future research avenues. I then dedicate a short chapter to discussing some preliminary suggestions for how this work could be applied when choosing interventions for regulating cravings, before providing an overall conclusion.

1.1. Environment and obesity

1.1.1. From irregularity to food swamps

Throughout most of human history, food supplies have been irregular (Prentice, Hennig, & Fulford, 2008). One clear mechanism is seasonal variation – from autumn harvest to spring hunger. Also, large events influence the availability of food. For instance, after the Black Death had considerably reduced the population of Europe, the remaining people enjoyed relatively high availability of meat (Mennel, 1987; Põltsam-Jürjo, Aas, & Kruuser, 2013). This availability declined later in the early modern period (1500–1800), when population growth led to an increase in demand that could not be met by the available food production technology.

Technological revolution from the 1800's onward improved food availability. For instance, feasts of the social elite refocused from food quantity to food quality as quantity was no longer exclusive (Mennel, 1987). During the 20th century, there were further advances in food production (Paarlberg & Paarlberg, 2001). Particularly in the last 50 years, the Green Revolution, a combination of agricultural innovation and state support, has tripled food production in the developed world with just 30% increase of land use (Pingali, 2012). As a result, the proportion of household income spent on food in the US has dropped from 45% in 1900 to just 15% in 2006 (see Chart 42 in Dolfman & McSweeney, 2006). This increase in cheap food is seen as the main driver of both body weight increase (Swinburn et al., 2009) and food waste (Hall, Guo, Dore, & Chow, 2009).

Interestingly, economic recessions have been shown to cause decrease in national obesity levels and improvement of other health indices (e.g., Ruhm, 2000). A possible reason could be that during economic crisis, overeating becomes more expensive. The association between economic development and obesity can also be exemplified in Estonia. As can be seen in Figure 2, the prevalence of normal weight and obese people correlates very strongly with real wages. The association is less clear for overweight people, possibly because this category is a "transfer zone" – during recession obese become overweight and overweight people become normal-weight; during economic development the opposite happens.

While mostly real wages and obesity prevalence grow in parallel, economic crisis leads to decrease in wages and obesity rates. First crisis happened in 1990–92. Before 1990, the Soviet Union kept food prices artificially low with the help of massive subsidies (Kuddo, 1995). These subsidies were eliminated with the restoration of independence. This decision together with unstable food supplies from the Soviet Union resulted in a grave lack of food, with consumer prices increasing 35.5 times from the end of 1989 to 1992 (Kukk, 1997). The food shortage forced the government to ration the supplies ("Food running out," 1992; Huuhtanen, 1992; Kuddo, 1995). Accordingly, the proportion of overweight people decreased considerably in that time period (Figure 2). After adoption of its own currency, the Estonian economy stabilized. As the result, the prevalence of obesity has slowly grown again – by 2014 Estonia has almost reached the levels of 1990. Only the global financial crisis of 2008–2010 slowed this process, particularly for men (Figure 2).

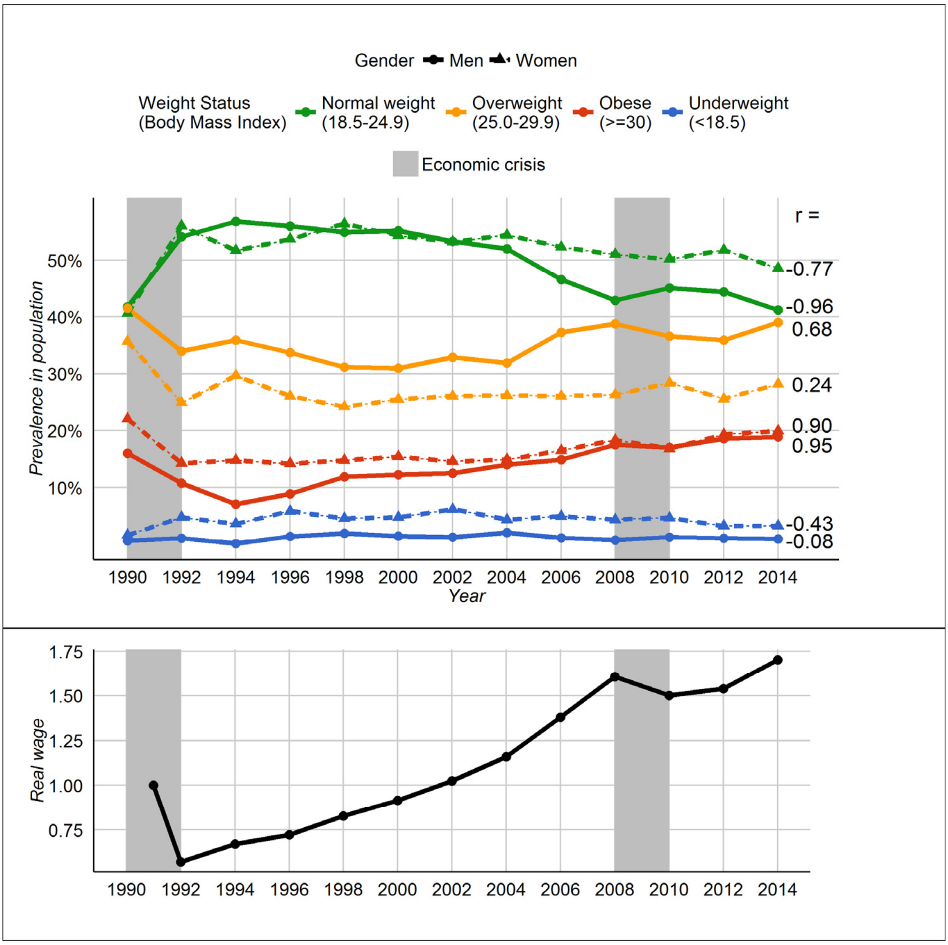

Figure 2. Above. Prevalence of normal weight, overweight, obese, and underweight people by year in Estonian adult population (random sample of the population, n=5000, ages 16–64). Data taken from Estonian National Institute for Health Development database (NIHD, 2015; Tekkel & Veideman, 2015). r = correlations between prevalence and real wage (1992–2014). If $r \geq 0.68$, then $p \leq 0.06$, Holm-corrected.

Below. Real wage = Consumer Price Index-adjusted wage in Estonia. Reference points (real wage=1): 1991 4th quarter and 2001 3rd quarter. Yearly real wage averaged from four quarters of a given year. Data taken from Statistics Estonia database (2015).

Although the population of Western countries is mostly well nourished today, not everyone has access to food of similar quality. One component is price – several studies have shown that healthful food is more expensive per calorie than unhealthy food (e.g., Jones, Conklin, Suhrcke, & Monsivais, 2014; reviewed in Rao, Afshin, Singh, & Mozaffarian, 2013). Therefore, the unhealthy food categories might be a more economical choice for the less affluent, facilitating obesity. Another component is physical access. Particularly in the US, there is some evidence for "food deserts" – areas that lack retail stores that provide access to affordable and healthy food (reviewed in Beaulac, Kristjansson, & Cummins, 2009). Other researchers (Rose et al., 2009) suggest that "food swamp" is a more appropriate term – while food as such is available everywhere, in regions with lower socioeconomic status there is a higher availability of energy dense snack foods. This is due to the prevalence of small corner stores, where more shelf space is dedicated to snacks than fruit or vegetables (Rose et al., 2009). Recently, the association between lower SES and higher soda consumption was shown using store sales data (Buckeridge, Charland, Labban, & Ma, 2014). A higher availability of unhealthy food has been related to increased risk of higher BMI and increased fast-food consumption in both cross-sectional (e.g., Burgoine, Forouhi, Griffin, Wareham, & Monsivais, 2014; Kestens et al., 2012) and longitudinal settings (e.g., Boone-Heinonen et al., 2011). The latter study found that only men in lower socioeconomic brackets were influenced by the availability of fast-food restaurants.

1.1.2. Irregularity influencing human behaviour

Despite the occasional hiccups, humanity has now entered an era of food stability and higher obesity rates. Obesity seems to be caused by evolutionarily developed adaptions for an irregular food environment that are maladaptive in the current environment. The role of evolution is supported by obesity being hereditary, with estimates ranging from 47–90% based on twin studies (Elks et al., 2012). For instance, as starvation decreases number of offspring by 30–50% (Prentice et al., 2008), any mechanism facilitating fat storage could provide an evolutionary advantage by facilitating reproduction (see Genné-Bacon, 2014 for an overview of other evolutionay theories). Interestingly, the mechanisms supporting fat storage might have a behavioural origin. According to one recent analysis, most known genes regulating obesity are expressed in the brain (Locke et al., 2015). Therefore, focusing on brain-based behavioural phenotypes could be a fruitful strategy for understanding individual differences in developing obesity.

Historical evidence lists various strategies for surviving food supply irregularity, such as gorging when food is available, but also cultivating land in different locations to avoid drought, and sharing successful catch with other community members (e.g., Diamond, 2012). Similarly, rural Estonians of the early 19th century have been described to have voracious appetite and lose all dignity on the rare opportunities to eat pork (Baer, 1814 , 2013). Aspects of these behaviours can be later seen in Studies I–IV, which outline how eating behaviour is influenced by individual differences in responsiveness to food signals, planning of eating related behaviour, as well as by social situations.

1.1.3. Potential solutions

Based on the evidence outlined above, a logical way to reduce the obesity crisis would be to "fix" the food environment. However, successful government regulation has yet to come. So far, strategies fighting obesity mainly place responsibility on the individual, urging her to make the right decisions and asking companies to provide detailed nutritional information to support those decisions. Unfortunately, such detailed information is least effective in guiding decisions (Helfer & Shultz, 2014). Further, food companies often apply subliminal marketing efforts that are rarely regulated, but nevertheless may lead to overconsumption (Chandon & Wansink, 2010).

One often-discussed solution is taxing unhealthy components of food. As early as 1776, Adam Smith suggested taxing sugar, alcohol, and tobacco as unnecessary for life (Adam Smith, 1776). There have been a few taxing efforts along these lines in the last decades, but the effects seem to be modest (Bødker, Pisinger, Toft, & Jørgensen, 2015; Cornelsen & Carreido, 2015). While taxation does not seem to hurt, many reviews highlight the need for more comprehensive obesity curbing action than taxation alone (Cornelsen & Carreido, 2015; Dobbs et al., 2014; Sarlio-Lähteenkorva & Winkler, 2015; Swinburn et al., 2015; Wansink & Chandon, 2014).

As more comprehensive methods have yet to be implemented, the burden of regulating food intake is on the individual (Swinburn et al., 2015). As such, there is a need to understand why some people are more prone to overeat and/or become obese than others. Such an understanding could lead to more effective person-based interventions.

1.2. Aims and hypotheses

As reviewed previously, Western people live in a food rich environment and individuals differ in their responsiveness to this food plenty. These individual differences in obesity seem to relate, to a substantial degree, to brain-based mechanisms. Therefore, the main goal of the thesis is to elucidate the psychological mechanisms that explain individual differences in obesity and overeating. In Study I, we systematically reviewed the literature to understand which psychological measures have been related to obesity and overeating so far. The review focused on neurobehavioural measures – neurocognitive tasks and questionnaires. While the review was exploratory, we hypothesized that not all the measures have an independent association with obesity and sought ways to reduce the constructs to a few core meaningful mechanisms. Besides listing the measures, we also assessed the measures' reliability, as this is rarely reported. Finally, we assessed if the brain mechanisms suggested by neurocognitive and behavioural measures could in principle overlap with the brain mechanisms suggested by brain imaging literature.

After familiarizing myself with the field, I suspected the presence of century old measurement problems – jingle and jangle fallacies (Kelley, 1927; Thorndike, 1904). In particular, some questionnaires seemed overtly general (jingle fallacy) – i.e. having multiple constructs within a single questionnaire. Other questionnaires seemed to capture a very similar construct, although they had different names (jangle fallacy). These fallacies might cause confusion in the literature. Therefore, we outlined methods to test for such fallacies and thereafter tested the most common instruments suspected of these fallacies. In Study II we designed a new statistical approach of testing indifference of the indicator. According to this approach, each indicator of a latent trait within a questionnaire should relate to an outcome in a similar manner to avoid jingle fallacy. In Study III we used state-of-the-art statistical techniques to test the unity and diversity of various eating-related traits that were suspected of jangle fallacy.

It is well known that using weight status as an outcome is also partly a jingle fallacy – people might have heterogeneous pathways towards gaining weight. Therefore, it has been proposed that one should "zoom in" and study the particular different phenotypes leading to obesity (Blundell & Cooling, 2000). This was the main aim in Study IV, where we focused on a particular eating behaviour – eating consistency. Eating consistency stands for having similar meals across different eating occasions, which seems to have a protective effect on health (reviewed in Study IV). Such consistency was measured with Experience Sampling Method that enabled us to compare different eating episodes.

A further goal of Study IV was to predict consistent behaviour from both person and situation characteristics. Person characteristics included personality traits outlined in Studies I–III. Situations characteristics included both objective features of the environment (e.g., more availability of food, being in social situations) and subjective states (having consumed alcohol, having conducted physical activity). It is well known from various lab studies, that situation the person is experiencing can influence her eating behaviours (Cohen & Farley, 2008; Wansink, 2004).

The goal of the thesis is to synthesize the four studies into a coherent overview of current state of the field. As the field has developed since some of the papers were published, I will offer an updated perspective on the topics that the papers discussed. I will not highlight the detailed methods for each paper – rather I focus on the key methodological decisions that are important in understanding the main results. Finally, I will offer a preliminary perspective on how these studies could inform the choice of individual-level interventions to manage food cravings.

2. STUDY I. MAIN PERSON VARIABLES RELATED TO OBESITY AND EATING-RELATED BEHAVIOURS

There are various ways to study the person features that influence eating decisions. As decisions originate from the brain, functional brain imaging provides a detailed understanding of brain activity during eating decisions. However, research with brain imaging is relatively expensive and confined to experimental settings. For this reason, the current review focused on neurobehavioural measures – neurocognitive tasks and questionnaires. There has been considerable work on mapping neurobehavioural measures to particular brain circuits (summarized below). Therefore, these behavioural measures could be taken as proxies for brain mechanisms. At the same time, the behavioural measures have the advantage of being applicable in a much more flexible manner, on a wider scale, and in real-life settings.

The aims of Study I were first to identify the neurobehavioural measures that have been robustly related to obesity or other eating-related behaviours and then to summarize the potential underlying brain mechanisms. As questionnaires had been more thoroughly previously reviewed than neurocognitive tests, these measures were approached separately. Thereafter, we summarized the brain mechanisms suggested by both type of measures.

2.1. Neurocognitive tasks

Neurocognitive tasks assess specific behaviors either through pencil-and-paper or computerized testing. The goal of the neurocognitive tasks is to measure domains of cognition, such as attention, memory, cognitive control, providing a proxy measure of the underlying brain mechanisms. For identifying relevant neurocognitive tasks, a systematic literature search was performed, identifying 7069 papers. Upon closer inspection, we identified 65 papers relating 66 different neurocognitive tasks either to BMI, laboratory food intake or discrepancy between intended and actual food intake. For simplicity, we excluded studies involving manipulations, such as fasting before testing or administration of alcohol, focusing on satiated healthy samples. The vast majority of studies were cross-sectional, but there were also a few longitudinal studies. Summarising the evidence proved difficult, as 47% of the tasks had been used only once. To tackle this problem, we grouped the tasks according to the neuropsychological domain they are purported to measure according to existing taxonomies (e.g., Miyake et al., 2000) and neuropsychological expertise.

From the 66 tasks surveyed, only 8 tasks provide replicable associations with BMI or eating behaviours (Figure 1 & Table 1 in Study I). Largely, the tasks belong to two categories – food drive (or food motivation) and cognitive (or executive) control. Tasks relating to other cognitive domains, including memory, language, and visuospatial ability had little or no relation with obesity, although they were also less studied.

2.1.1. Food drive

2.1.1.1. Results from Study I

Food drive tasks characterize how participants value a particular food stimulus compared to other food or non-food stimuli. As our environment has plenty of calorie-dense food cues, people with higher food drive are hypothesized to have higher likelihood in engaging with food items and food cues. Such engagement could facilitate overeating and possibly obesity. The brain imaging literature suggests that this mechanism is mediated by a dopaminergic limbic network including brain areas, such as insula, nucleus accumbens, amygdala and orbito-frontal cortex (e.g., Berridge & Kringelbach, 2015; Dagher, 2012; Tang, Fellows, Small, & Dagher, 2012; van der Laan, de Ridder, Viergever, & Smeets, 2011). Heightened activity in this network has been shown to predict future weigh gain (reviewed in Val-Laillet et al., 2015). The neurocognitive tasks aim to capture the function of this brain network in various ways.

The task most robustly related to obesity and eating behaviours is the relative reinforcing value of food task, which explicitly measures participants' motivation to press a lever for food in a gambling setting, compared to other reinforcers such as reading a magazine (e.g., Saelens & Epstein, 1996). Since the review, the task has increasingly gained popularity and has robustly been related to hunger, energy density/palatability of food and body weight (reviewed in Temple, 2014). There is also some evidence, that versions of the task can be applied to children as young as 3–5 years (Rollins, Loken, Savage, & Birch, 2014) or even 9–18 months (Kong, Feda, Eiden, & Epstein, 2015). Therefore, this task is a reliable choice for wide age ranges if one can afford the somewhat cumbersome setup.

Most other reviewed measures of food drive relied on implicit attention bias, assessing how much attention participants allocate to food stimuli. Ideally, such tasks should capture food motivation implicitly, avoiding demand effects that can be a problem in these studies. However, success has been mixed. Implicit association tests has been heavily used in the literature and show some promise, however the test-retest reliability may be below 0.4 (Frank, Giel, Heinze, & Preissl, 2015). Other tasks relying on eye-tracking or visual probe have reported even less consistent results. These issues may relate to varying methodology; these tasks seem very sensitive to fine details of experimental design. At least two other reviews have reached similar conclusions (Nijs & Franken, 2012; Werthmann, Jansen, & Roefs, 2015).

2.1.1.2. Mechanisms underlying food drive.

Since the review, a few other promising tasks have emerged that dissociate components of food drive. Ideally, such focus on the individual components should be more informative. These promising tasks will be reviewed next along with their reliability, if available. We focused on test-retest reliability, as good test-retest reliability supports the validity of a measure (McCrae, Kurtz, Yamagata, & Terracciano, 2011).

In the review, food motivation or food drive was treated as a unitary construct with various overt or covert methods to capture it. However, the animal literature suggests that food drive might have at least three subcomponents – liking, wanting, and learning (Berridge & Kringelbach, 2015; Berridge & Robinson, 2003; Berridge, Robinson, & Aldridge, 2009). Liking captures the hedonic pleasure that a food stimulus generates. Wanting captures the innate drive to obtain a reward. According to Berridge, these mechanisms can be captured explicitly or implicitly. Objective "wanting" and "liking" (with quotation marks) are visible behaviourally but that behaviour might not be recognized by the organism. Subjective wanting and liking happens when the organism recognizes its behaviour. A third component is learning – how an organism associates food with various elements in the environment, relying on associative or cognitive processes. This learning might lead to declarative knowledge or habits (Berridge & Robinson, 2003). Berridge and Kringelbach (2015) suggest that in principle, similar mechanisms should be discernible in humans. Indeed, there have been attempts to discern wanting and liking (Finlayson, King, & Blundell, 2007b; discussed further below). However, some authors suggest that these processes might be impossible to disentangle in humans (for a discussion, see Havermans, 2011; Finlayson & Dalton, 2012; Havermans, 2012; Tibboel et al., 2011). Most studies have not explicitly stated which mechanism they aim to measure. At the same time, sometimes effort is taken to ensure that different stimuli are similarly liked (e.g., Tang, Fellows, & Dagher, 2014), suggesting that the goal is to focus on wanting, which guides the initial action towards food (Berridge & Kringelbach, 2015).

2.1.1.3. Promising tasks capturing wanting, liking, and learning

In their video tutorial, Ziauddeen et al. (2014) propose that two tasks could capture motivation for food, possibly wanting. One of them captures explicit motivation by asking participants to reflect in hand grip force how much they want a particular food item. Conceptually, the task is similar to relative reinforcing value of food, as participants are expected to work harder for rewards more wanted. The paradigm is suitable for neuroimaging studies, which have shown that higher grip force for obtaining monetary rewards correlates with higher brain activity in reward-related structures (Pessiglione et al., 2007). Further, the paradigm is also sensitive to implicit food cues (Ziauddeen et al., 2012). General hand grip measures have good test-retest reliability (Roberts et al., 2011).

Another approach of assessing wanting comes from behavioural economics. A popular method is a version of the Becker-DeGroot-Marshak auction paradigm (Becker, Degroot, & Marschak, 1964), where hungry participants bid for various food items that they can later eat (Plassmann, O'Doherty, & Rangel, 2007). Higher bids relate to higher activity in medial orbitofrontal cortex (Plassmann et al., 2007), a brain area part of the food-drive network. Recently, Tang, Fellows and Dagher (2014) replicated this finding and showed that although participants were unable to explicitly assess the caloric content of foods, they were willing to pay more for food items that have higher caloric density. Further, the task might be responsive to dopaminergic manipulations (Medic et al., 2014). The task's risk-taking parameter should be stable over time (James, 2007). As food has to be bought in real life, the auction paradigm might be closer to modelling real-life food decisions. Ziauddeen et al. (2014) provide a video tutorial how to run this task.

From implicit tasks, a promising paradigm seems to be the attentional blink – the phenomenon of a task-irrelevant, emotionally arousing picture causing blindness to target stimuli presented a few hundred milliseconds after the picture (McHugo, Olatunji, & Zald, 2013). In the food domain, there is only one paper reporting that food-related pictures cause a longer attentional blink if participants are hungry (Piech, Pastorino, & Zald, 2010). As attentional blink is a covert task and susceptible to manipulations of hunger, one could speculate that this task could be capturing objective "wanting" as Berridge defined it. Future studies should determine if this task is also influenced by liking. So far, the paradigm seems promising – the task has been adapted in other labs (Davidson & Kirkham, 2013; Davidson, personal communication), the emotional attentional blink paradigm seems robust (McHugo et al., 2013), and there is evidence of good test-retest reliability at least in neutral attentional blink paradigm (Dale & Arnell, 2013; Kelly & Dux, 2011; Kranczioch & Thorne, 2013). There is also a nice tutorial on how to run attentional blink studies (MacLean & Arnell, 2012).

The Leeds Food Preference Questionnaire is an explicit attempt to discern wanting and liking (Finlayson, King, & Blundell, 2007a; reviewed in Dalton & Finlayson, 2014). In this paradigm, different methodologies are applied to assess liking and wanting responses to food images as a function of their fat content (high or low) and taste (sweet or non-sweet). To capture explicit liking, participants have to explicitly rate food pictures based on how pleasant they find them. In contrast, to capture implicit "wanting", participants' reaction times are measured using the same pictures presented in a forced choice paradigm, indicating in turn, which of the two foods presented they would want to eat at the moment. Faster reaction times for a food type (relative to number of times chosen/not chosen) indicate greater implicit "wanting". Wanting and liking scores across the different food types react differently to meal manipulations, suggesting that these processes are separate (Finlayson, King, & Blundell, 2008). At the same time, certain eating behaviours such as sensory-specific satiety or trait binge eating seem to relate to both liking and wanting (Finlayson, Arlotti, Dalton, King, & Blundell, 2011; Griffioen-Roose, Finlayson, Mars, Blundell, & de Graaf, 2010), suggesting that both processes are involved and that these processes can only be separated in more specific behaviours. The task has suitable test-retest reliability (Dalton & Finlayson, 2014).

Food cue learning is a well-demonstrated mechanism in animal literature (e.g., Schultz, 2007). Therefore, individual differences in learning about food rewards might also partly explain human obesity or overconsumption. After all, people have to learn which foods they want. In animal literature, food cue learning is a well-demonstrated mechanism. Recently Burger and Stice (2014) showed in a functional Magnetic Resonance Imaging (fMRI) study that in human female adolescents, faster changes in the mesolimbic areas in the brain during cue-reward learning predicted increased weight gain 2 years later. Purely behavioural evidence using a probabilistic learning task (Frank, Seeberger, & O'Reilly R, 2004) also suggests that obese persons might have trouble learning from negative outcomes in tasks involving both food and money (Coppin, Nolan-Poupart, Jones-Gotman, & Small, 2014). However, the probabilistic learning task has been shown to have poor test-retest reliability (Baker, Stockwell, & Holroyd, 2013), so evidence regarding this task should be interpreted with caution.

Rat models offer yet another aspect of cue-reward learning – sign tracking vs goal tracking. When cue-reward association has been learned and arrival of a reward is signaled with a cue, sign trackers vigorously lick the cue, whereas goal trackers take notice of the cue and wait for the actual reward (Flagel, Watson, Robinson, & Akil, 2007). Sign trackers are likely to develop later addictive behaviour (Saunders & Robinson, 2010). As high cue responsiveness is also seen in obese humans, there is work in progress to adapt the paradigm for humans (Weir, 2012; Margaret Wardle, personal communication).

In sum, research so far has highlighted a few reliable tasks that capture food drive, which in turn are associated with various eating behaviours. New tasks have been proposed that focus on more fine-grained brain mechanisms high-lighted from the animal literature. Time will tell if these tasks manage to capture different aspects of food drive. I also hope that future research will apply several food drive tasks in a single study. This will provide an opportunity to empirically verify whether different underlying mechanisms exist and how different food drive tasks relate to each other. First evidence suggests that correlations between tasks are moderate (French et al., 2014). More systematic efforts of relating different measures have provided valuable insight in other eating-related measures (Study III; Price, Higgs, & Lee, 2015). Further, it seems that using tasks to measure person characteristics in a regular satiated state might not be enough – participants' performance in various environmental settings (for instance, when hungry, under stress) might provide additional information.

2.1.2. Cognitive control

2.1.2.1. Results from Study I

While food drive refers to recognizing and approaching available food cues, cognitive control is important in integrating long-term goals in decision-making. Such behaviour is generally captured by the term "executive functions", which "refer to a range of control mechanisms that modulate and organize more basic cognitive operations" (Tsuchida & Fellows, 2013, p. 1790). Executive processes are assessed by executive tasks, which can be categorized by the cognitive domain they are purported to measure (Lezak, 2004; Miyake et al., 2000). There are both brain imaging and lesion data showing that these tasks rely on the frontal parts of the brain (Aron, Robbins, & Poldrack, 2014; Fellows & Farah, 2005; Nee, Wager, & Jonides, 2007; Tsuchida & Fellows, 2009, 2013).

Study I concluded that lower scores in several domains of executive function relate to higher BMI, weight gain, increased food intake and a gap between intended and actual food intake. Most robust effects seem to derive from inhibition tasks such as stop-signal and Stroop. The evidence is less clear for tasks measuring switching (Trail-Making Test B, Wisconsin Card Sorting Test), working memory, and decision-making tasks (delay-discounting or Iowa Gambling Task). It should be noted, that the Iowa Gambling Task is a learning task and therefore cannot be used for repetitive screening because of poor test-retest reliability. Most other tests have been recently reconfirmed to have acceptable test-retest reliability (Weafer, Baggott, & de Wit, 2013).

Quite a few studies also reported an interaction between measures of food drive and cognitive control. This fits with several theoretical proposals that although some people might have higher food drive, higher cognitive control skills might provide an opportunity to overcome that drive (e.g., Appelhans, 2009; Hofmann, Friese, & Strack, 2009; van den Bos & de Ridder, 2006). Other have unified the two domains by combining a cognitive control task (e.g., stop-signal, delay discounting, or Stroop) with food stimuli. Study I also summarises these tasks, and there is further conflicting evidence as to whether using food stimuli adds benefit or not (Houben, Nederkoorn, & Jansen, 2013; Toms, 2015).

2.1.2.2. Converging evidence and future directions

The role of weakened cognitive control in obesity was reviewed already before Study I (Smith, Hay, Campbell, & Trollor, 2011). Thereafter, many other reviews have further cemented the negative association between obesity and cognitive function (Dahl & Hassing, 2013; Fitzpatrick, Gilbert, & Serpell, 2013; Yates, Sweat, Yau, Turchiano, & Convit, 2012), and expanded the association to children (Carnell, Benson, Pryor, & Driggin, 2013; Liang, Matheson, Kaye, & Boutelle, 2014; Miller, Lee, & Lumeng, 2015; Reinert, Po'e, & Barkin, 2013). One review also focused on the association between physical exercise and cognitive function (Verburgh, Königs, Scherder, & Oosterlaan, 2013). The association seems to be bi-directional – some papers reviewed in Study I show that poorer cognitive control predicts weight gain, whereas other evidence suggests that poorer metabolic health leads to further decrease in cognitive function (Smith et al., 2011; Yates et al., 2012). Compared to these reviews, Study I still stands out in two main ways. First, we combined evidence from cognitive control tasks with evidence from food drive tasks and questionnaires. The second unique feature was including reliability information.

Since the association is so well documented, the main challenge of studies on cognitive control is to select the most distinct and precise measures of cognitive control. While at first, all measures seem to correlate weakly and therefore could be considered distinct (Duckworth & Kern, 2011), a recent meta-principal component analysis suggested that cognitive control tasks could be reduced to a few key domains (Sharma, Markon, & Clark, 2014). These empirical domains largely concur with the ones proposed in Study I (Figure 3). The important difference is that stop-signal is more similar to delay discounting than to other inhibition tasks.

The analysis of Sharma et al. also highlights that some cognitive control domains are most clearly captured by tasks previously rarely used in obesity research. For instance Matching Familiar Figures Test (MFFT) purely loads on the inhibition component (Sharma et al., 2014, Table 5). MFFT has not been associated with obesity in adults, however results from children suggest, that the association should be there (Braet, Claus, Verbeken, & Vlierberghe, 2007; Stager, 1981). Since the stop-signal task seems "less pure" as it also captures impulsive decision-making, future studies might consider MFFT as a more pure measure of inhibition. MFFT test-retest reliability in adults range from .56 to .65 (Brodzinsky & Dein, 1976) but the brain correlates have not been localized very well (Caplan & Shechter, 1990). However, the results of Sharma et al are not the final evidence – they did not include updating/working memory tasks. Further, the results of principal component analysis very much depend on variables included – the dominance of MFFT in inhibition might also have happened because two MFFT indices were included in the analysis, as opposed to one stop-signal index. Still, as the stop-signal data are commonly distorted by slowing participants (Verbruggen, Chambers, & Logan, 2013), possible more easily administrable alternative measures of inhibition could be explored.

Another challenge is to collect a large enough sample. One systematic review attempting to calculate an effect size between cognitive control tasks and obesity highlighted how only half of the studies included were powered enough to detect large effects (Fitzpatrick et al., 2013). However, a few studies reviewed also reported medium or small effect sizes. Therefore, the large effect seen in some studies might be the result of a publication bias to only publish significant results. Such ambiguity in research is not limited to health psychology – publication bias was evidenced in an analysis of random psychological journals demonstrating how published effect size correlates negatively with sample size (Kühberger, Fritz, & Scherndl, 2014). Further, in random sample of psychological studies, less than half could be replicated

(Open Science Collaboration, 2015). To support clearer findings, future studies should be adequately powered. For instance, the average effect size in social and personality psychology is r=.21 (Richard, Bond, & Stokes-Zoota, 2003). Detecting such correlation requires considerably larger sample than is typically employed. For establishing significance with $\alpha = 0.05$ and $\beta = 0.2$ one would need a sample of 176 (Hulley, 2013, Appendix 6C, p. 79). To accurately assess the magnitude of r=.21, a sample of 238 is needed (Schönbrodt & Perugini, 2013).

Regarding task selection, a possible future direction is to employ decision-making tasks that provide an opportunity to disentangle different components of everyday food choices. One promising approach is demonstrated by Sullivan et al. (2015), where they ask participants to choose between two pictures on a computer screen. Based on tracking participants' mouse path the authors suggest that the tastiness information is processed around 200 ms earlier than healthiness information. Further, the authors demonstrate individual differences in self-control – some people have little latency difference between processing tastiness and healthiness, but others process tastiness considerably earlier (Sullivan et al., 2015).

In sum, the role of cognitive control is well-documented. However, research that more clearly focuses on more specific aspects of cognitive control could provide useful additional information. Such an approach could establish the relevant subdomains. Another direction is to design well-controlled but more ecologically valid tasks that provide more detailed insight into the decision-making process. A better understanding of the process could lead to interventions that are targeted at a particular behaviour. Intervention possibilities are further discussed in Chapter 5.

2.2. Questionnaires

Questionnaires can be thought of as a special type of neurocognitive tests, where given a question, participants have to reflect on their own (typical) behaviour and categorize their behaviour based on the response set given. The mental processes involved are diverse and often underestimated (Schwarz & Oyserman, 2001). Nevertheless, using questionnaires is an extremely common approach and worth separate attention. A single mental dimension, (i.e. trait or construct) is often measured by several questions (i.e., indicators), which are then averaged or summed together (Likert, 1932). Usually, the questionnaires ask about personality traits – what people commonly people want, say, do, feel, or believe (Ozer & Benet-Martínez, 2006).

When Study I was being conducted, several questionnaire-based constructs had already been proposed to relate to obesity, with accompanying reviews having been published (Bogg & Roberts, 2004; Bryant, King, & Blundell, 2008; Chalmers, Bowyer, & Olenick, 1990; de Ridder, Lensvelt-Mulders, Finkenauer, Stok, & Baumeister, 2011; French, Epstein, Jeffery, Blundell, & Wardle, 2012; Guerrieri, Nederkoorn, & Jansen, 2008; Herman & Polivy, 2008; Johnson, Pratt, & Wardle, 2011; Lowe & Thomas, 2009; Macht, 2008). Therefore, a more narrative review approach was taken. Further, we aimed to map the different types of questionnaires by the broadness vs specificity of the traits they capture. In addition, the more specific traits were mapped into a broader big five personality framework, to preliminarily test the hypothesis that the specific traits are rather similar to each other (see McCrae & Löckenhoff, 2010 for a similar approach). This hypothesis was later explicitly tested in Study III. We also reported the reliability scores of popular tests.

2.2.1. Results from Study I

The questionnaires were divided into three broad categories – omnibus personality questionnaires, specific personality questionnaires and specific eating-related questionnaires. From big five type of questionnaires, the strongest obesity-related associations have been with facets of Neuroticism (high N5: Impulsiveness), and Conscientiousness (low C2: Order, low C5: Self-discipline), with more subtle effects with facets of Extraversion (high E3 Assertiveness, low E4 Activity) and Agreeableness (low A1: Trust, low A4: Compliance). Openness has not been related to obesity, but does relate to choosing healthier diets. Other omnibus questionnaires have further highlighted the role of Conscientiousness and Impulsivity. Impulsivity and self-control are similarly highlighted in studies with questionnaires only capturing these traits. Yet another commonly tested specific trait is sensitivity to reward. Finally, based on previous reviews we found at least five very commonly tested eating-related traits – emotional eating, external eating, disinhibition, restraint, and susceptibility to hunger. All these measures reported acceptable reliabilities (Table 4 in Study I).

We suspected that these 12 different constructs were rather similar to each other. For a preliminary assessment of their similarities, we gathered evidence of how similar or different were the specific personality measures' "personality profiles" – which domains in the five-factor model did the questionnaires correlate with. Fundamentally similar measures should manifest similar correlation profiles with external criteria (Fiske, 1971; Lubinski, 2004). If the specific measures are very similar, one could expect very similar personality profiles. If the specific measures are different, the profiles should also be different. As can be seen in Table 3 in Study I, the profiles are mostly very similar. The questionnaires relating to loss of control (urgency, reward sensitivity, disinhibition, hunger, emotional eating, external eating) relate positively to Neuroticism and negatively to Conscientiousness, whereas the questionnaires capturing restraint relate positively to Neuroticism and positively to Conscientiousness. This evidence suggests the emergence of two main mechanisms – loss of control and attempts to restrain eating. Reward sensitivity might be a third component as this component relates positively to Extraversion, whereas the eating-related traits relate mostly negatively to Extraversion.

Such convergence of questionnaires implies that there are considerably fewer eating-related traits than the diverse names suggest. Therefore, not all of the 12 different constructs need to be measured. As all questionnaires have acceptable reliabilities, one can choose a study-specific testing set based on other criteria, such as participant burden, desired specificity of the traits vs comparability of results with other domains of impulse control. For instance, eating-specific questionnaires are bound to have a higher correlation with eating-related outcome than domain-general questionnaires (e.g., Tsukayama, Duckworth, & Kim, 2012; Panov, 2014; Murphy, Stojek, & MacKillop, 2014). At the same time, when various impulse-control outcomes are compared, domain-general measures are also needed. Study IV highlights one possible solution – many of the above-reviewed questionnaires were empirically reduced to 5 main factors. Three factors focused on domain-general cognitive-control/ Conscientiousness, reward sensitivity/Extraversion, and punishment sensitivity /Neuroticism, and two others focused on eating-relate loss of control and restrained eating style.

2.2.2. Further synthesis of personality traits and obesity

The three domain-general personality traits (cognitive-control, reward sensitivity, and punishment sensitivity) are innate aspects of any impulse-related behaviour (Whiteside & Lynam, 2001). Therefore, it is not surprising that these personality domains also influence eating and obesity. The same personality domains were recently highlighted in a systematic review on obesity and personality traits (Gerlach, Herpertz, & Loeber, 2015). Similarly, an individual-participant meta-analysis confirmed the association between obesity and Conscientiousness, but failed to demonstrate an association with Neuroticism or Extraversion (Jokela et al., 2012). The lack of association with domain-level Extraversion might be explained by Extraversion's facets having opposite associations with obesity, as summarized in Section 2.2.1. Lack of association with Neuroticism might be explained by the notion that the effect of Neuroticism is largely due to a single sub dimension N5: Impulsiveness (Gerlach et al., 2015, Study II). Based on Study II one could even argue that the association between obesity and Neuroticism is domain-specific, as it pertains only to eating-related items. At the same time, other measures of Neuroticism without these eating-related items still sometimes relate to BMI (Armon, Melamed, Shirom, Shapira, & Berliner, 2013; Magee & Heaven, 2011; Sutin & Terracciano, 2015), suggesting that the association between Neuroticism and obesity could be instrument-specific. In sum, the most robust domain-general personality traits seem to point to Conscientiousness/ cognitive control and Extraversion/reward sensitivity. The emergence of these core dimensions is very similar to the evidence from neurocognitive tests (Section 2.1). The only difference here is that reward sensitivity is domain-general.

The association between BMI and Agreeableness has not found support in the two systematic reviews (Gerlach et al., 2015; Jokela et al., 2012). A possible explanation could be that Agreeableness might indirectly reflect the effects of Extraversion, as Agreeableness and Extraversion have strong negative association (DeYoung, Quilty, & Peterson, 2007). The same reviews further highlight a lack of association between Openness and BMI. It seems that Openness is more related to healthier dietary choices (Lunn, Nowson, Worsley, & Torres, 2014).

The inherent problem of associating eating behaviours with domain-general personality questionnaires is small effect size. For instance, Jokela et al. (2012) highlight how 1SD higher Conscientiousness lowers obesity risk (OR=0.84). This corresponds to an effect size d = –0.1 (=log(0.84)/1.81 , see Chinn, 2000). Study II found effects of similar magnitude. Therefore, using domain-general personality tests is more reasonable in samples of several hundred people. One possible way to improve the effect size could be using personality scales focusing clearly on a single personality trait (See Study II for further discussion). Another possible way would be focusing on more particular eating behaviours with fewer and clearer personality determinants (see Study IV as an example).

The effect sizes for the relationship between eating-specific questionnaires and obesity are naturally larger (Table 1 in Study III, see also Study II). The assumed similarity of eating-specific questionnaires has now found empirical support (Study III; Price et al., 2015). The detailed results and the nature of these traits are summarized in Study III.

2.3. Brain mechanisms

The brain mechanisms underlying eating behaviours and obesity have been extensively studied with brain imaging techniques. Many review papers (Berthoud & Morrison, 2008; Carnell, Gibson, Benson, Ochner, & Geliebter, 2011; Dagher, 2012; Pursey, Stanwell, et al., 2014) outline the three main levels of eating regulation – hypothalamic system tracking homeostatic signals facilitating keeping energy balance; limbic emotion/memory system tracking potential and past rewards; and cortical cognitive control system incorporating more abstract goals into behaviour, such as social context, availability of nutrients in the future, and staying healthy. As hunger manipulations were not included in Study I, the current section focuses on the neurobehavioural proxies of emotion/ memory and cognitive control systems. Further, having a neurobehavioural proxy of the hypothalamic system is rather difficult. For instance, a recent paper showed how hunger ratings relate to ventromedial prefrontal activation (Lawrence, Hinton, Parkinson, & Lawrence, 2012), suggesting that self-reported hunger is not a direct proxy for the state of hypothalamic system but rather a higher-level interpretation of that system. Therefore, it seems that objective differences in levels of hypothalamic function can only be inferred from manipulations with hunger or context (Crum, Corbin, Brownell, & Salovey, 2011). While hypothalamic hormones such as ghrelin or PYY can be objectively measured, their levels tend to be individual

(Cummings, Frayo, Marmonier, Aubert, & Chapelot, 2004). Therefore, various hunger levels need to be captured.

The tasks capturing cognitive control have been well-mapped to the prefrontal cortex (e.g., Lezak, 2004). There is also evidence for greater prefrontal cortical thickness relating to higher scores in Conscientiousness (DeYoung et al., 2010). As both types of measures relate to obesity and other eating behaviours (sections 2.1.2, 2.2.1), one could assume that the prefrontal cortex has a role in eating regulation. This has been indeed demonstrated in imaging literature (reviewed in Dagher, 2012; Pursey, Stanwell, et al., 2014). The causal role of prefrontal cortex in regulating cravings has been documented in a meta-analysis, where upregulating left or right dorsolateral prefrontal cortex with neurostimulation methods decreased cravings for drugs or food (Jansen et al., 2013). The role of neurocognitive tasks in capturing cognitive control was elegantly demonstrated by Lowe et al (2014) – magnetic bursts that down-regulate left prefrontal cortex both increased snacking behaviour and decreased score on one neurocognitive inhibition task (Stroop). Other tasks, such as Go/No-Go and Stop-Signal had no effect, possibly because these tasks could reflect activity in right inferior frontal gyrus instead (Aron et al., 2014).

There is also evidence for the involvement of limbic structures in measures capturing food drive. In neurocognitive tasks, higher bids for food in the Becker-DeGroot-Marshak auction paradigm relate to higher activity in medial orbitofrontal cortex (Plassmann et al., 2007; Tang et al., 2014). The same region is activated during money-related hand grip task (Pessiglione et al., 2007). Relative reinforcing value of food task has not been tested in brain imaging studies, but carriers of certain DRD2 alleles have higher willingness to work for food, suggesting the role of dopaminergic systems in influencing task performance (Epstein et al., 2004, 2007).

The evidence for the involvement of questionnaires in food-induced brain responses is less clear. In Study I, we proposed based on the existing literature that several eating- and reward-related questionnaires reflect the function of both prefrontal and limbic structures. Recently, van der Laan and Smeets (2015) formally tested if questionnaires mentioned in Study I indeed relate to common food-induced brain responses. The underlying assumption was that if questionnaires are as interrelated as Study I suggested, different questionnaires should correlate with activity in similar brain structures. However, the patterns vary considerably from study to study, possibly due to heterogeneous study designs. There is some evidence of the questionnaires relating to activity clustered in prefrontal and subcortical structures, but the authors highlight that this might also be due to studies selectively reporting results only from these regions of interest. The clearest cluster suggests that several questionnaires capturing food drive (impulsivity, external eating, disinhibition, and food addiction) are associated with activity in medial orbitofrontal cortex (van der Laan & Smeets, 2015), mirroring our proposal in Study I. In sum, there is some evidence supporting our proposed brain-questionnaire link in eating behaviours, but more systematic evidence is needed.

To conclude, neurocognitive tasks seem to be more reliable in reflecting brain mechanisms than questionnaires. While questionnaires might be improved to better reflect brain mechanisms, current evidence is rather mixed. One possible reason for lack of evidence is the lack of clarity regarding the traits that questionnaires are measuring. In this regard, I hope that Studies II and III facilitate more accurately capturing the underlying traits with questionnaires in the future. Another reason could be that questionnaires tap various cognitive mechanisms (Schwarz & Oyserman, 2001) that are hard to relate to a particular brain area. This is especially clear for broad personality instruments that are designed to sample various aspects of behaviour, cognition, values and so forth. Perhaps focusing on more narrow traits (i.e., nuances) could facilitate clearer links. The benefits of studying nuances are also discussed in Study II.

2.4. General summary

The goal of Study I was to highlight the most reliable neurobehavioural measures related to obesity and other maladaptive eating behaviours. Out of 66 different neurocognitive tasks proposed, only 8 tasks provided reliable associations. The tasks could be grouped into two domains – cognitive control and food drive. From questionnaires, at least twelve different traits have been suggested, which could again broadly be grouped in the same two domains. There is growing evidence that these measures could be reasonable proxies for underlying brain mechanisms influencing eating decisions. Accurate proxies of brain mechanisms provide opportunities to incorporate brain-based models into large-scale studies where neuroimaging would be impractical.

At the same time, work on neurocognitive measures is far from complete. While many measures of cognitive control have been proposed, tested, and related to each other, the measures of food drive have been considerably less examined. This is probably because measures of cognitive control are applied by researchers from various domains, whereas food drive measures are mostly used by a smaller group of researchers studying eating behaviours. The current thesis tried to update Study I by surveying additional promising measures of food drive – time will tell if these measures fulfil their initial expectations.

Similarly, there is additional work to be done with questionnaires. For a newcomer to the field, the potential overlap between the questionnaires bearing different names was overwhelming. At the same time, some other questionnaires seemed surprisingly generic. Studies II and III focus on understanding how questionnaires can be related to outcomes most effectively.

3. STUDIES II AND III. UNDERSTANDING TRAIT-OUTCOME ASSOCIATIONS

What is the most practical distinction of personality traits? Should one use a generic measure that combines various aspects of behavior into general impulsivity or Extraversion? Or should one focus on very fine-grained nuances (c.f., McCrae, 2014) of behaviour that focus on minute details, such as emotional or external eating? These questions first arose in the scientific literature in the context of categorising species. For instance, Charles Darwin wrote that "those who make many species are the "splitters," and those who make few are the "lumpers." "(Darwin, 1857).

When analyzing psychological constructs, jingle and jangle fallacies are more common terms. To decide on the presence or absence of these fallacies, we focus on extrinsic convergent validation – fundamentally similar questionnaires or questionnaire items should manifest similar correlation profiles with external criteria (Fiske, 1971; Lubinski, 2004). In both of the studies we assumed the existence of a latent underlying trait whereby the trait is a latent common cause of its indicators (Bollen & Lennox, 1991; Borsboom, Mellenbergh, & van Heerden, 2003). While other methods for modelling questionnaires exist such as composite variables or network analysis (Borsboom & Cramer, 2013; Edwards & Bagozzi, 2000), many questionnaires analyzed have been developed using factor analytical tools which assumes the existence of underlying latent variables (Borsboom, 2006; Borsboom et al., 2003; Gorsuch, 1997). Further, a latent variable approach seems to be the most common in contemporary personality psychology (Borsboom, 2006; DeYoung, 2014; McCrae, 2014).

3.1. Study II. A novel method for detecting jingle fallacy

Jingle fallacy, coined by Aikins (1902) and Thorndike happens when „the words [for different constructs] are identical and we tend to accept all the different things to which they may refer as of identical amount" (Thorndike, 1904, p. 14). A prime example is impulsivity, which is an umbrella term for three or four empirically different subdomains based on questionnaires (Sharma et al., 2014; Whiteside & Lynam, 2001), and another four subdomains based on neurocognitive tasks (Sharma et al., 2014). Given that these subdomains have relatively low inter-correlations (Duckworth & Kern, 2011; Sharma et al., 2014) but still independently relate to various real-life impulsive behaviours, such as alcohol use or delinquency, these impulsivity measures seem to be truly different (Sharma et al., 2014). Therefore, the general term „impulsivity" should only be used in very general context, and the particular type of impulsivity captured should be highlighted.

In Study II we outlined a framework for testing, if an outcome relates to the core trait a questionnaire is supposed to capture, or only to the questionnaire's smaller components. We argue that if the latter is the case, the smaller components should be reported. Otherwise we risk committing the jingle fallacy – having a shared name for distinct constructs that relate to an outcome in different ways. The framework relies on Spearman's (1927) principle of indifference of the indicator (ION, Indifference Of the iNdicator) – all questions of a questionnaire measuring the same construct should relate to an outcome the same way. We test this framework on the association between N5: Impulsiveness and BMI. The Impulsiveness scale is known to have eating-specific items which might be behind the rather high correlation between this particular subdomain and BMI (r=0.27, Sutin, Ferrucci, Zonderman, & Terracciano, 2011), compared with the d=0.1 of general conscientiousness (Jokela et al., 2012).

Indeed, using the outlined item exclusion method, we demonstrated that the association between N5-Impulsiveness and BMI largely pertains to two eating-related items. An additional impulse control item has a smaller effect. As shown in Figure 5 in Study II, when these three items are excluded, no questionnaire-outcome association remains, therefore the questionnaire-outcome association violates ION.

It remains to be tested, how pervasive is the problem of lack of ION in the literature. There is increasing evidence that also the subdomains/facets of the NEO-PI should be further broken into nuances to maximize useful information (McCrae, 2014). For instance, a recent analysis showed there is considerable residual variance in NEO-PI-3 that self-report and informant report agree upon, even after the effects of broad domains and facets were removed (Mõttus, McCrae, Allik, & Realo, 2014). Using a longitudinal twin sample, the same residual variance has been shown to be both hereditary and have stable rank-order stability over time (Mõttus, Kandler, Bleidorn, Riemann, & McCrae, 2015). Therefore, there should be information hidden in NEO-PI instruments that the domains and facets fail to capture. In the framework of jingle fallacy – the facets might jingle together several underlying traits.

3.2. Study III. Jangle fallacy – unity and diversity of eating traits questionnaires

Jangle fallacy, in turn, is "equally contaminating to clear thinking" (Kelley, 1927, p. 64). The fallacy involves "the use of two separate words or expressions covering in fact the same basic situation, but sounding different, as though they were in truth different" (Kelley, 1927, p. 64). Kelley highlighted how using terms such as achievement and intelligence for the same phenomenon might cause confusion and segregation of research. Indeed, there is now a consensus that intelligence largely relies on a common *g* factor (Jensen, 1998; Johnson, Bouchard Jr., Krueger, McGue, & Gottesman, 2004; Johnson, Nijenhuis, &

Bouchard, 2008), as Spearman (1904) originally proposed. Similar efforts have been conducted with impulsivity – Whiteside and Lynam (2001) demonstrated how 35 different subscales proposed to capture different aspects of impulsivity can be reduced to four distinct domains. Further, negative affect is the core trait in many inter-related questionnaires (Judge, Erez, Bono, & Thoresen, 2002). Judge et al. showed that measures with different names explain the same variance in theoretically linked outcomes, demonstrating that not all constructs are needed in practice.

In Study III we suspected on the basis of definitions and previously published intercorrelations that many eating-related questionnaires focus on a similar aspect of eating behaviour – Uncontrolled Eating. We tested the similarity of several popular eating-related questionnaires in two samples from Estonia and Canada using bifactor modelling. The results confirmed our expectations – variance of all questionnaires was largely explained by a common factor, which was a major predictor of BMI. At the same time, some questionnaires did have their unique aspects, which explained extra variance in BMI. Still, given the extent of overlap, similarity should be the default interpretation and uniqueness of a questionnaire should be explicitly demonstrated.

Even if the various questionnaires appear to capture a shared underlying trait, they might focus on different aspects of that trait. Recently, a continuum model of loss of control was proposed (Davis, 2013; Figure 1A in Study III). According to that model, people first are in a homeostatic eating phase where no excess food is consumed. Thereafter there is a passive overeating phase, where excess food is consumed without being actively aware of that. Over time, such slightly positive energy balance leads to slow weight gain. More severe overeating episodes are characterized by more acute overeating episodes, eventually leading people to acknowledge overeating, binging, and possibly food addiction.

We tested, using an Item Response Theory approach, whether the questionnaires studied focused on different severity levels on the continuum of Uncontrolled Eating (Figure 1B in Study III). That hypothesis appeared to be partially true. In the Estonian sample, Eating impulsivity focuses on lighter forms of Uncontrolled Eating, Power of Food Scale and (negative) emotional eating scale are in the middle, and binge eating subscale captures most severe forms of Uncontrolled Eating. In the Canadian sample, no such difference was evident, suggesting that Power of Food Scale, emotional eating and disinhibition focus on middle levels of severity. Therefore, it seems indeed the case that first people report occasional bouts of overeating, followed by acknowledgement of loss of control over eating, possibly due to external stimuli (Power of Food Scale), negative emotions (emotional eating), or unsuccessful restraint attempts (disinhibition). When Uncontrolled Eating becomes more severe the risk of binge eating also is more prominent. Granted, the different stages of Uncontrolled Eating could be demonstrated more clearly with questionnaires dedicated to capture these stages. Still, current results show that IRT can be used to demonstrate this continuum.

At time of publication, the study was limited by not including several other popular questionnaires that could potentially relate to Uncontrolled Eating, such as external eating or food addiction. Recently, Price et al (2015) showed that also these traits are very similar to the shared component, further supporting the existence of a shared underlying trait capturing Uncontrolled Eating. As their analysis also included questionnaires on restraint, restraint emerged as a secondary component. They further expanded the results to men, who were excluded in the current analysis due to small sample size and because the tested model was not measurement invariant across sexes.

3.3. General conclusion

The overarching goal of this chapter was to show how we can apply the existing questionnaires in the most informative way to study links between psychological traits and outcomes of interest. It indeed appeared that sometimes there might be a jingle or a jangle fallacy present. In my view, it all depends on the outcome of interest. It may very well be that a questionnaire poses a jingle or jangle fallacy for some outcomes, and has a perfect fit for other outcomes. Therefore, I advocate testing the optimal level of resolution needed when a questionnaire is related to an outcome. Drawing a parallel from categorizing animals – people with the least experience with nature are happy if they can distinguish a bird from a flying insect or a flying mammal, lumping together many species. Avid birdwatchers distinguish each species in order to count the number of species spotted. Ecological scientists, in turn, are sometimes forced to split a single bird species based on geographical location – for instance, a link between dopaminergic gene polymorphisms and seeking behaviour was only replicated in great tits from the Netherlands, but not elsewhere (Korsten et al., 2010). I hope that the current chapter has succeeded in demonstrating, that also questionnaires are sometimes worth lumping and other times worth splitting, whenever the goal is to reach a better understanding of eating-related psychological mechanisms.

The current chapter has also highlighted that behind various construct names, BMI-related traits often reflect a very simple concept – perceiving loss of control over eating. Here it is called Uncontrolled Eating, but other names include disinhibition (Stunkard & Messick, 1985), opportunistic eating (Bryant et al., 2008), food addiction (Gearhardt, Corbin, & Brownell, 2009), reward based eating drive (Epel et al., 2014), food reward responsivity (Price et al., 2015), binge eating (Gormally, Black, Daston, & Rardin, 1982), eating impulsivity (Study III), and so forth. The main question is – what do we gain from asking people if they "sometimes lose control over eating"? Are we capturing something meaningful, or are people just observing their waistline and then concluding that they are unable to control themselves? For instance, there is evidence that BMI changes in either direction lead to a change in (eating) impulsiveness in the same direction (Sutin et al., 2013). However, other evidence suggests that there is more to perceived loss of control over eating than just tracking one's waistline. A recent analysis contrasting successful weight losers vs BMI-matched normal weight controls concluded that the group that lost weight still reports higher restraint and binge eating (Feller et al., 2015). Food addiction, a construct conceptually and empirically very close to other questionnaires capturing Uncontrolled Eating (Price et al., 2015; Ziauddeen & Fletcher, 2013) has been related to certain dopaminergic polymorphisms (Davis et al., 2013). Therefore, people perceiving loss of control over eating do not need to be necessarily overweight and the trait might still have a biological underlying mechanism.

Still, the emergence of Uncontrolled Eating suggests that this phenomenon is what people commonly perceive and what many research tools capture. Tackling loss of control by teaching people attainable food craving regulation strategies is something that therapeutic efforts can target (see Chapter 5). A slightly worrying trend is that although many questions ask about losing control, many questionnaires are interpreted as if they capture food reward sensitivity. A glance at other popular reward sensitivity measures, such as BIS/BAS reveals that in these instruments the items are more diverse and rarely probe explicit loss of control (Carver & White, 1994). Perhaps the questionnaires in the eating literature should also broaden the spectrum of items if they truly want to capture food reward sensitivity? Power of Food Scale has a few items that diverge from the theme of loss of control, and Study III suggests that these items could also be somewhat distinct from rest of Uncontrolled Eating.

I hope that at least part of the research will stop inventing new names to a known construct, agree that we largely capture very similar traits with existing questionnaires, and look for other, complementary mechanisms. For that, we need to rethink our questionnaires. People can only reflect in questionnaires what they explicitly perceive about themselves (Nisbett & Wilson, 1977). To look past Uncontrolled Eating, one way is to parcel the shared trait out with the methods suggested in Study III. This enables studying the additional effects some questionnaires might have on eating behaviours. Another opportunity would be focusing on questionnaires that ask about other, possibly also relevant eating traits. An example would be eating in response to positive emotions. There is evidence that such behaviour exists (Bongers, Jansen, Havermans, Roefs, & Nederkoorn, 2013), possibly in a culture specific manner (Dubé, LeBel, & Lu, 2005). Psychometric analysis of a Positive and Negative Emotional Eating Scale suggests that positive emotional eating is rather different from Uncontrolled Eating-related traits (Sultson, 2014). Many other eating behaviours have been proposed to relate to obesity (Mesas, Muñoz-Pareja, López-García, & Rodríguez-Artalejo, 2012) – I hope that not all of them are explained by sensing a loss of control over food.

4. STUDY IV. PERSONALITY AND SITUATION PREDICTORS OF EATING CONSISTENCY

4.1. Choosing eating-related outcomes

High BMI does not always imply a poorer health status. For instance, some obese people have been shown to be in better metabolic health than normal-weight counterparts, as indexed by lower triglycerides, higher HDL cholesterol, lower blood pressure, smaller waist circumference, and lower plasma glucose levels (Ahima & Lazar, 2013; Pajunen et al., 2011). Therefore, it would be more accurate to use more precise health indices as an outcome, such as the metabolic syndrome indices or fat percentage. However, given that BMI can be self-reported with remarkable accuracy (e.g., Pursey, Burrows, Stanwell, & Collins, 2014), whereas other methods need specialized machinery and biological samples, BMI is likely to stay as a crude health outcome measure.

Another opportunity is to focus on the behavioural "building blocks" of BMI. Two persons that have similar BMI's can nevertheless engage in rather different combinations of eating behaviours and physical activity (Blundell & Cooling, 2000). This could be one reason why BMI has a low correlation with general personality measures, as it is a summary of different behaviours over a longer time period. A possible remedy could be focusing on the individual behavioural components behind high BMI. With some luck, these components could have more concrete psychological determinants, resulting in larger effect size. In genetics, such approach has provided some success, with different risky eating behaviours such as snacking or choosing large portions being related to different polymorphisms (de Krom et al., 2007). At least 10 different types of eating behaviours related to obesity were recently highlighted in a systematic review (Mesas et al., 2012). Our preliminary analysis suggests that most of these behaviours are indeed rather distinct, although not all of these behaviours relate to BMI (Härsing, 2015). Study IV is one attempt in focusing on a more concrete eating behaviour – eating consistency.

Eating consistency refers to having similar meals across various eating situations. This behaviour is increasingly difficult in today's environment of food plenty, as many situations provide unexpected appetizing food. At the same time, staying consistent offers health benefits, such as lower risk of future obesity (Pachucki, 2012) or lower cardiovascular risk factors (e.g., Farshchi, Taylor, & Macdonald, 2005). As with other eating behaviours, considerable individual differences in consistency have been documented.

4.2. Consistency as a function of person and situations

The determinants of eating consistency are largely not known. A detailed understanding of behaviour should take into account both the person and the environment/situation around her, as posited by Kurt Lewin (1936) in his influential formula *B=f(P,E)*. As person variables, we use the personality traits known to influence eating behaviours, discussed in detail in Studies I–III

Situation variables are clearly also important. As reviewed in the Introduction, major changes in the environment influence behaviour on population level. One can also study the micro-environments or situations that surround a single person and vary considerably across time. Countless studies have shown that small manipulations in the immediate environment have a large impact on eating behaviours (for reviews see Cohen & Farley, 2008; Wansink, 2004). In the current study, we focused on several situations that are common for people and that have previously been shown to influence eating, such as eating outside of home, eating with other people, alcohol consumption, as well as physical activity. We further include time (morning vs evening), as Baumeister and Heatherton (1996) suggest evening time to be the key risk factor for unwanted behaviour, such as diet failure. At the same time, Bandura (1996) proposes risky behaviour in the evening is explained by simply various distracting events being more likely to occur in the evening.

Situation variables and consistency were measured with Experience Sampling Method (ESM). ESM provides an opportunity to gather data about everyday natural activities by prompting the participant to respond a set of questions several times a day (Christensen, Barrett, Bliss-Moreau, Lebo, & Kaschub, 2003). For eating consistency, ESM is a reasonable trade-off, offering more accuracy and ecological validity than retrospective self-assessment of consistency, but being less labour-intensive than actual weighing and documentation of consumed foods.

4.3. Results and discussion

The results of Study IV suggest that personality, situations, and their interactions influence eating consistency (Figure 6 in Study IV). Regarding personality, there is a main effect of self-control. This suggests that better planning capabilities facilitate eating similar meals across situations. Although self-control could also be engaged in a restrictive way, another ESM study on self-control (Hofmann, Baumeister, Förster, & Vohs, 2012) suggested, that rather than fighting temptations when they arise, successful self-controllers plan ahead before being confronted with temptations (see Chapter 5 for examples). Similarly, a meta-analysis concluded that higher trait self-control relates to desirable behaviour that is automatic (de Ridder et al., 2011). In the current case, higher self-control could facilitate planning one's meals ahead so that meals would be more similar to what they usually are.

At the same time, many situations decreased the probability of having consistent meals. This included having meals in the evening, with other people, away from home, together with alcohol consumption, and together with physical exercise. The causal mechanism can only be speculated about at this point, as several self-control models could apply here (Inzlicht & Schmeichel, 2012). At the same time, the data clearly shows that situations have an effect and we know from previous findings that inconsistent eating can lead to health risks. Therefore, I believe that one should take into account the inconsistency inducing effects of these common situations. One method could be eating attentively, paying attention to the effect of such situations (Robinson et al., 2013), and perhaps preparing ahead when these situations are occurring more often (see Chapter 5). Future studies demonstrating the mechanisms of these effects will provide an opportunity for more targeted interventions.

Interestingly, both time of day and situations separately influence consistency. This suggests that both Baumeister and Heatherton (1996), as well as Bandura (1996) are correct in outlining time and situations as potential risk factors.

The current study suggests that focusing on a more specific "building block" of unhealthy behaviour can yield clearer mechanistic findings. Compared to the association between Conscientiousness and BMI (d=0.10, Jokela et al., 2012), the association between self-control and consistency was considerably larger (d=0.27[1]). It seems then, that the role of self-control is to stabilize eating behaviour across various meals. It is yet unclear if the consistency captured in current study has a direct effect on health – in the current sample, consistency was unrelated to BMI. The reason could be that there was little variation in BMI, with very few obese participants. It is also possible that eating consistency, as currently studied, is unrelated to BMI, but might induce BMI changes or changes in other health factors in the future. Finally, the current study cannot rule out that ESM-measured eating consistency is a feature of diet variance which might not necessarily introduce unhealthy consequences later on. Future studies need to establish whether ESM-measured eating consistency can truly be considered a building block of BMI, or it is just an interesting feature of human diet.

Including situation variables next to person variables has added an informative additional dimension. Occurrence of various external situations diverted participants from their typical meal. Obtaining such data has been historically rather laborious (Funder, 2009), as participants had to be constantly surveyed by human observers (e.g., Hartshorne & May, 1930). The ESM paradigm, particularly when used with now-ubiquitous smartphones, makes this effort much easier. An important limitation of research on situations has been the scattered evidence that social psychology has offered – which situations should one include? A possible solution was recently offered, when a taxonomy of eight important situational dimensions was created, alongside with a measurement

[1] OR=2.45; I used formula $\ln(2.45)/1.81^2$ as here OR represented 2SD

tool (Rauthmann et al., 2014). A similar effort would be needed to outline most important eating-related situations.

A further aspect of ESM is that the situations have to be consciously perceived in order to be reported (Rauthmann et al., 2014), whereas many food-related manipulations are often unbeknownst to the participants (Cohen & Farley, 2008; Wansink, 2004). The opportunities provided by contemporary smartphones can also ease this limitation – combining GPS data obtained with smartphones (e.g., Linnap & Rice, 2014) with geo-tagged information about the surrounding foodscape, such as restaurant types or marketing efforts (Burgoine & Monsivais, 2013; Charland, Mamiya, & Buckeridge, 2015; Clary & Kestens, 2013) can potentially provide a more accurate picture of the food temptations that the participant is exposed to. Combining such data with person profiling can potentially be very powerful – for instance recently it was shown that participants with higher reward-sensitivity participants are more likely to visit fast-food restaurants if they have the opportunity in their neighbourhood (Paquet et al., 2010).

5. PRACTICAL APPLICATIONS

The two broad mechanisms of cognitive control and food drive outlined in Study I are important in considering practical applications to avoid overeating. Despite the environmental origin of the obesity epidemic, current policies largely rely on personal choice and personal responsibility to manage body weight (section 1.1.3). At the same time, loss of control over eating is the central is the central theme in many questionnaires (Study III). Most people seem to have first-hand experience in loosing control. I conducted a quick analysis of responses to eating impulsivity items in an updated sample of Study II (n=3592). Results revealed that 61% of participants agree that "sometimes they are not able to control their appetite" and 81% acknowledge that "they tend to eat too much of their favorite food".

One reason could be that people are unaware of the spectrum of emotion/food craving regulation strategies, as each intervention approach is promoted separately without an overarching framework. The goal of current section is to provide a quick summary of various food craving regulation strategies and assign these to a common emotion regulation model. It seems that the default strategy (restraint) is probably most difficult to implement, whereas other strategies could be easier to succeed in.

I rely on the process model of emotion regulation (Gross, 1998, 2015), which seems as a reasonable trade-off between comprehensiveness and simplicity. In this model, emotion regulation strategies are distinguished based on which component of emotion development they focus on. Here, the model is applied to map regulation strategies designed for any subjectively felt affective state which can include both emotions and motivation states, such as cravings. Some strategies can be employed before the emotion has developed (situation selection, situation modification). Other stages focus on earlier or later stages of emotion perception (attentional deployment, cognitive change). Finally, one can also aim to suppress the response to an emotion (response modulation). The time dimension has recently been elegantly shown in studies on emotion regulation with EEG – strategies aimed at an earlier phase of emotion development also influence earlier EEG components (e.g., Thiruchselvam, Blechert, Sheppes, Rydstrom, & Gross, 2011; Uusberg, Uusberg, Talpsep, & Paaver, 2015)

It seems logical to assume that strategies focusing on earlier stages are easier to implement, since the food craving has not yet fully developed. Preliminary support for this assumption comes from a study demonstrating that people in high-intensity negative situations prefer to use strategies that quickly deploy their attention away, whereas in low-intensity situations they are more likely to process and reappraise the emotion (Sheppes, Scheibe, Suri, & Gross, 2011). To inspect this assumption, I will review the possible cognitive demands for each type of craving intervention – easier interventions are likely to be applicable for children or participants with self-regulation difficulties, whereas more difficult interventions depend on successful cognitive control. Results of the following narrative review are summarized in Table 1.

Table 1. Linking component process model in two upper rows (Gross, 1998, 2015) with common food craving regulation strategies and tentative level of cognitive control required.

Emotion processing stages	Situation		Attention	Appraisal	Response
Emotion regulation strategies	Situation selection	Situation modification	Attentional deployment	Cognitive change	Response modulation
Food craving regulation strategies	Environment selection	Environment modicitation	Distracting working memory	Reappraising appetitive food	Restraining / dieting; If-then strategies
Cognitive control required	For preselecting situations	For pre-modification of situations	Low level sufficient	Higher levels	Higher levels ; low level sufficient

Note. The table is missing mindfulness, which spans across the stages of attention, appraisal, and response. Mindfulness has been applied in population with lower cognitive control.

The spectrum starts with choosing situations that expose one minimally to the need of emotion regulation and related cognitive control. An example would be avoiding visiting places, where cake is offered. Such preparation could be one reason why participants high in trait self-control are successful in tackling temptations (Hofmann et al., 2012). Once the strategy is implemented, very little cognitive control is needed. The flip side is that people relying on choosing situations have little experience facing actual temptations. Therefore, when they are forced to be exposed to the usually avoided tempting situation, people high in trait self-control might ironically overeat (Imhoff, Schmidt, & Gerstenberg, 2014).

Situation modification is needed when the environment in question cannot be avoided, e.g. home, school, or workplace. The solution is to change the immediate environment in a way that healthy eating would be the default behaviour, for instance by asking someone to hide the cake. Wansink and Chandon (2014) outline various environment modifications and label them easy to implement. There is anecdotal evidence of children eating more salad when their lunchrooms have been redesigned by others (Wansink, 2014). However, it remains to be tested if people with low cognitive control are able to implement these modifications themselves, or they need to rely on external help.

Another relatively simple strategy is to deploy attention from the prominence of appetitive stimuli (e.g., cake) by filling visuospatial memory with other tasks (Van Dillen & Koole, 2007), therefore reducing food drive.

Tested tasks to deploy attention with range from working memory tests (Van Dillen, Papies, & Hofmann, 2013) to playing Tetris (Skorka-Brown, Andrade, & May, 2014). Distraction seems to require relatively little cognitive control, as even some children spontaneously distract themselves in order to delay eating tasty marshmallows in a delay discounting task (Rodriguez, Mischel, & Shoda, 1989).

A fourth approach is cognitive change through cognitive appraisal – re-evaluating tempting stimuli. This can be achieved by imagining the cake to be less appetizing, focusing on the negative consequences of eating the cake and so on (Giuliani, Calcott, & Berkman, 2013; Hollmann et al., 2012; Siep et al., 2012; Stice et al., 2015). However, successful implementation of this strategy seems to require higher levels executive function, particularly updating (Hendricks & Buchanan, 2015; Schmeichel, Volokhov, & Demaree, 2008) and also inhibition (Cohen, Henik, & Moyal, 2012; but see Hendricks & Buchanan, 2015). At the same time, reappraisal is still applicable to children in specific contexts (Mischel & Baker, 1975).

The most common food craving regulation strategy seems to be response modulation, i.e., restraint/dieting (Mann et al., 2007). The principle is simple – when a person is exposed to an appetitive but prohibited food (e.g. cake) she suppresses her cravings to eat it, even when hungry. While it sounds easy, purely restrictive strategies have been shown to be counter-productive. A possible reason is that food drive is maintained or even elevated in a hungry state (Epstein, Truesdale, Wojcik, Paluch, & Raynor, 2003). Classical studies have shown, that when such restraint "breaks down", disinhibition and food binging often follows (Herman & Mack, 1975; Polivy & Herman, 1985). More successful dieting could be expected from participants with higher inhibition abilities (Allan, Johnston, & Campbell, 2010; Hofmann, Adriaanse, Vohs, & Baumeister, 2014). Still, for the general population, restrictive dieting is not a very successful strategy (Mann et al., 2007). It seems that many people overestimate their inhibitory capabilities and underestimate their food drive. Also in other fields of emotion regulation, suppression is largely considered ineffective (Gross, 2015).

A possibly more effective type of response modulation is what-if strategy – when cake is available, I order tea instead. Such a strategy seems effective across a wide range of impulse control domains (Gollwitzer & Sheeran, 2006), and has been shown to benefit populations that have lower levels of cognitive control/ executive function, such as children with ADHD (Gawrilow, Gollwitzer, & Oettingen, 2011) and adults with schizophrenia or opiate abuse (Brandstätter, Lengfelder, & Gollwitzer, 2001).

Finally, an emerging strategy has been mindfulness – to accept the food craving and observe it, but not reacting to the desire. Such an approach has been shown to be effective in both short-term manipulations of craving (Forman et al., 2007; Hamilton, Fawson, May, Andrade, & Kavanagh, 2013; Hendrickson & Rasmussen, 2013; Kond, 2015) and longer-term interventions of reducing body weight and binging according to several systematic reviews (Godfrey, Gallo, & Afari, 2014; Godsey, 2013; Katterman, Kleinman, Hood, Nackers, & Corsica, 2014; Olson & Emery, 2015; O'Reilly, Cook, Spruijt-Metz, & Black, 2014). In the process model, mindfulness is seen to blend several components, such as increased cognitive change, attentional deployment, and decreased response modulation/suppression (Gross, 2015). Similarly, the role of executive function is less clear. It has been suggested that short term mindfulness practitioners rely on top-down (i.e., executive) processes, but longer practice leads to bottom-up processing that is rather automatic (Chiesa, Serretti, & Jakobsen, 2013). Still, mindfulness has been successful in disadvantaged populations (Chiesa et al., 2013).

When the more demanding strategies (restraint, appraisal) seem unattainable at first, there are several methods to improve cognitive function. One method is using neuromodulation techniques stimulating prefrontal cortex, which reduce cravings (Alonso-Alonso, 2013; Jansen et al., 2013) and facilitate cognitive reappraisal (reviewed in Val-Laillet et al., 2015). Special stop-signal programs can be used to train response inhibition (e.g., Lawrence et al., 2015; meta-analyzed in Allom, Mullan, & Hagger, 2015). Also practicing the if-then plans, distraction, appraisal, and mindfulness leads to a gain in executive function (Gawrilow et al., 2011; Hendrickson & Rasmussen, 2013; Mischel & Baker, 1975; Rodriguez et al., 1989; Teper, Segal, & Inzlicht, 2013).

A further aspect is the relative difficulty of implementing the task over time – a theoretical proposal by Magen and Gross (2010) suggests that when distraction or response modulation strategies are used, then they are low leverage – the temptations remain similarly intensive no matter how many times one employs these strategies. However, with environment modification or reappraisal, the leverage is higher as emotions themselves become less prominent and therefore these techniques are easier to implement over time.

In any case, it seems that as many people struggle with restraining, it could be helpful to teach them strategies that focus on earlier stages of craving perception that are easier to implement. Successful practice might provide additional cognitive control to apply more demanding strategies later. If various strategies have been learnt, people could combine different strategies – in a high-stakes situation a simple distraction might be more effective, but complex reappraisal might be applicable in a less-pressed situation (Sheppes et al., 2011). The choice of emotion regulation strategies is wider than currently covered (Koole, 2009). But already based on current literature, it seems to me that the default behaviour – dieting/restraint is probably the most difficult strategy to engage in. Hopefully, future studies will further test the relative difficulty of various strategies. Should the listed strategies prove to be better applicable, I hope they also become more widespread than restraint currently is, helping people to regain control over eating.

CONCLUSION

The prevalence of obesity has triggered an important effort to understand the psychological mechanisms underlying the self-regulation of eating. The current thesis first aimed to provide a framework for knowledge obtained so far. Next, novel methods were demonstrated that provide a more fine-grained understanding of eating behaviours. Besides profiling the person, it seems that profiling the immediate environment/situations around the person provides an additional benefit in understanding human behaviour. Similarly, it seems reasonable to focus on more concrete eating behaviours as an outcome, compared to generic obesity. First steps in choosing interventions were discussed.

Study I provided a systematic synthesis of neurocognitive tasks and questionnaires related to obesity and other maladaptive eating behaviours. Categorizing a diverse set of tasks by their neurocognitive domain revealed that replicable effects largely emerge from two domains – cognitive control and food drive. Only a handful of tasks captured these domains reliably. The study was updated with a narrative review of new promising tasks capturing these dimensions. Also in questionnaires, Study I suggested that considerably fewer constructs relate to BMI the diverse names suggest. Finally, both neurocognitive tasks and questionnaires suggested the involvement of a dualistic interplay between prefrontal cognitive control and limbic food drive.

Studies II and III focused on two common measurement problems – jingle and jangle fallacies. Jingle fallacy suggests that a construct with a single name might actually have several underlying mechanisms. To test that, Study II developed a procedure that analyzes if a questionnaire-outcome association is driven by the common trait, or a sub-trait within a questionnaire. The procedure of item exclusion was developed based on the indifference of indicator principle of Spearman (1927). The principle suggests that all indicators of a trait should relate to an outcome in a similar manner. We then used the procedure to test if BMI relates to the whole trait Impulsiveness, or a subdomain capturing eating impulsivity. Results suggest the latter – BMI mostly associates with eating-specific impulsivity and not with domain-general Impulsiveness. The item exclusion procedure can help to scrutinize the latent trait-outcome association in any context.

In Study III we inspected the possibility of a jangle fallacy – do many common eating behaviour questionnaires with different names actually capture the same underlying mechanism. Bifactor analysis indeed demonstrated that many eating-related questionnaires reflect a similar underlying trait tentatively called Uncontrolled Eating. At the same time, the questionnaires did have their unique aspects that sometimes related to BMI independently of Uncontrolled Eating, suggesting only a partial jangle fallacy. Further the questionnaires differed in the severity of the trait Uncontrolled Eating they focused on – Eating Impulsivity from Study II focused on most mild cases of Uncontrolled Eating, Binge Eating Subscale focused on most severe cases, and other questionnaires covered the middle ground. In sum, the questionnaires are not fully interchangeable. Still, extra effort should be taken to demonstrate that a questionnaire-outcome association pertains to the specific construct the questionnaire is intended to capture. Unless this effort is taken, it seems reasonable to assume that outcomes relating to eating questionnaires relate to the shared Uncontrolled Eating.

Also BMI itself can be seen as a jingle fallacy, as it is a sum of multiple eating decisions taken over several years. For this reason, Study IV focused on a more concrete and specific behaviour – eating consistency. Eating consistency means having similar meals across various eating occasion and this behaviour has been related to various health benefits. Study IV was conducted with Experience Sampling Method that enabled tracking participants over time. Such data also provided an opportunity to include situational settings as predictors of consistency. Results suggest that eating consistency is predicted by both personal and situational variables – participants with higher trait self-control were more consistent, whereas participants were less consistent when they were having meals outside of home, with other people, having drunk alcohol, and after physical activity.

Finally, I presented a short overview of the most common intervention strategies. As Uncontrolled Eating seems to be a common correlate of obesity, it seems that the self-regulation methods people use are not manageable for them. I provide a short overview of most popular craving regulation strategies and assign them to a common emotion regulation framework (Gross, 1998, 2015). I also summarize preliminary evidence on the relative cognitive control required for each strategy. It seems that common dieting is possibly most difficult strategy to use, and people might benefit from using other strategies that are easier to implement. Time will tell if this proposal is consistent with actual data.

To conclude, considerable effort has gone into understanding eating behaviours in order to facilitate maintaining weight in a food-rich environment. The current thesis serves as a breathing point – looking back on what has been achieved, providing a preliminary framework for the evidence, and suggesting structured approaches to move forward in a more organized manner. I hope that more people will have the opportunity to enjoy the unprecedented food security without worrying about the loss of control.

ACKNOWLEDGEMENTS

I am very grateful to both of my supervisors – Lesley Kathleen Fellows and Jüri Allik for providing me an opportunity to pursue my research questions without any restriction. I am also very grateful to my wife, Margit Kõiv-Vainik, who initiated our move to Canada and who has inspired and supported me throughout the years. Without her, the thesis might have been very different or possibly not even started.

There are many other people that have helped me through this journey. My co-authors, co-workers and students have evoked numerous thought-provoking conversations, both in Estonia and Canada. Andero Uusberg offered his helpful comments on Chapter 5. Participants from Estonia and Canada have provided valuable data for me to analyze; some of the datasets were collected and shared with me by co-workers from Estonian Genome Centre and McGill University. Many journal editors and reviewers have given valuable feedback. Scholarships, such as Kristjan Jaak, DoRA T8, Doctoral School of Behavioural, Social and Health Sciences, and CWT Kalevala have enabled my travels to Canada and to various other inspiring scientific meetings. Further, the doctoral school has funded my two interdisciplinary projects and the visits of many distinguished scholars teaching inspiring short courses at University of Tartu. During my studies, I have also been financially supported by grants from the National Institutes of Health (U01 HD061973-03) and Estonian Ministry of Science and Education (IUT02-13).

Finally, I have also received unconditional support from my family and friends. Thank you!

REFERENCES

Adam Smith. (1776). *An Inquiry into the Nature and Causes of the Wealth of Nations*. London: W. Strahan and T. Cadell. Retrieved from https://web.archive.org/web/20150828064906/http://www.gutenberg.org/files/3300/3300-h/3300-h.htm

Ahima, R. S., & Lazar, M. A. (2013). The Health Risk of Obesity – Better Metrics Imperative. *Science*, *341*(6148), 856–858. doi:10.1126/science.1241244

Aikins, H. A. (1902). *The Principles of Logic*. New York: H. Holt and Company. Retrieved from https://archive.org/details/principlesoflogi00aiki

Allan, J. L., Johnston, M., & Campbell, N. (2010). Unintentional eating. What determines goal-incongruent chocolate consumption? *Appetite*, *54*(2), 422–425.

Allom, V., Mullan, B., & Hagger, M. (2015). Does inhibitory control training improve health behaviour? A meta-analysis. *Health Psychology Review*, 1–19. doi:10.1080/17437199.2015.1051078

Alonso-Alonso, M. (2013). Translating tDCS into the field of obesity: mechanism-driven approaches. *Frontiers in Human Neuroscience*, *7*. doi:10.3389/fnhum.2013.00512

Appelhans, B. M. (2009). Neurobehavioral inhibition of reward-driven feeding: Implications for dieting and obesity. *Obesity*, *17*, 640–647. doi:10.1038/oby.2008.638

Armon, G., Melamed, S., Shirom, A., Shapira, I., & Berliner, S. (2013). Personality Traits and Body Weight Measures: Concurrent and Across-Time Associations. *European Journal of Personality*, *27*(4), 398–408. doi:10.1002/per.1902

Aron, A. R., Robbins, T. W., & Poldrack, R. A. (2014). Inhibition and the right inferior frontal cortex: one decade on. *Trends in Cognitive Sciences*, *18*(4), 177–185. doi:10.1016/j.tics.2013.12.003

Baer, K. E. von. (1814). *Dissertatio inauguralis medica, de morbis inter Esthonos endemicis, quam consentiente amplissimo medicorum ordine in Universitate Literarum Caesarea Dorpatensi, pro gradu doctoris medicinae. Loco consueto die 24. aug. publice defendet*. Dorpat : J. C. Schünmann. Retrieved from https://web.archive.org/web/20150828070658/http://dspace.utlib.ee/dspace/handle/10062/29295

Baer, K. E. von. (2013). *Eestlaste endeemilistest haigustest [On the Endemic Diseases of Estonians]*. Tallinn: Tribune.

Baker, T. E., Stockwell, T., & Holroyd, C. B. (2013). Constraints on decision making: Implications from genetics, personality, and addiction. *Cognitive, Affective, & Behavioral Neuroscience*, *13*(3), 417–436. doi:10.3758/s13415-013-0164-8

Bandura, A. (1996). Failures in Self-Regulation: Energy Depletion or Selective Disengagement? *Psychological Inquiry*, *7*(1), 20–24. doi:10.1207/s15327965pli0701_3

Baumeister, R. F., & Heatherton, T. F. (1996). Self-Regulation Failure: An Overview. *Psychological Inquiry*, *7*(1), 1–15. doi:10.1207/s15327965pli0701_1

Beaulac, J., Kristjansson, E., & Cummins, S. (2009). A Systematic Review of Food Deserts, 1966–2007. *Preventing Chronic Disease*, *6*(3). Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2722409/

Becker, G. M., Degroot, M. H., & Marschak, J. (1964). Measuring utility by a single-response sequential method. *Behavioral Science*, *9*(3), 226–232. doi:10.1002/bs.3830090304

Berridge, K. C., & Kringelbach, M. L. (2015). Pleasure Systems in the Brain. *Neuron*, *86*(3), 646–664. doi:10.1016/j.neuron.2015.02.018

Berridge, K. C., & Robinson, T. E. (2003). Parsing reward. *Trends in Neurosciences*, *26*(9), 507–513. doi:10.1016/S0166-2236(03)00233-9

Berridge, K. C., Robinson, T. E., & Aldridge, J. W. (2009). Dissecting components of reward: "liking", "wanting", and learning. *Current Opinion in Pharmacology*, *9*(1), 65–73. doi:10.1016/j.coph.2008.12.014

Berthoud, H.-R., & Morrison, C. (2008). The Brain, Appetite, and Obesity. *Annual Review of Psychology*, *59*(1), 55–92. doi:10.1146/annurev.psych.59.103006.093551

Blundell, J. E., & Cooling, J. (2000). Routes to obesity: Phenotypes, food choices and activity. *The British Journal of Nutrition*, *83 Suppl 1*, S33–38.

Bødker, M., Pisinger, C., Toft, U., & Jørgensen, T. (2015). The Danish fat tax—Effects on consumption patterns and risk of ischaemic heart disease. *Preventive Medicine*, *77*, 200–203. doi:10.1016/j.ypmed.2015.03.031

Bogg, T., & Roberts, B. W. (2004). Conscientiousness and health-related behaviors: A meta-analysis of the leading behavioral contributors to mortality. *Psychological Bulletin*, *130*, 887–919. doi:10.1037/0033-2909.130.6.887

Bollen, K., & Lennox, R. (1991). Conventional wisdom on measurement: A structural equation perspective. *Psychological Bulletin*, *110*(2), 305–314. doi:10.1037/0033-2909.110.2.305

Bongers, P., Jansen, A., Havermans, R., Roefs, A., & Nederkoorn, C. (2013). Happy eating. The underestimated role of overeating in a positive mood. *Appetite*, *67*, 74–80. doi:10.1016/j.appet.2013.03.017

Boone-Heinonen, J., Gordon-Larsen, P., Kiefe, C., Shikany, J., Lewis, C., & Popkin, B. (2011). Fast food restaurants and food stores: Longitudinal associations with diet in young to middle-aged adults: the cardia study. *Archives of Internal Medicine*, *171*(13), 1162–1170. doi:10.1001/archinternmed.2011.283

Borsboom, D. (2006). The attack of the psychometricians. *Psychometrika*, *71*(3), 425–440. doi:10.1007/s11336-006-1447-6

Borsboom, D., & Cramer, A. O. J. (2013). Network Analysis: An Integrative Approach to the Structure of Psychopathology. *Annual Review of Clinical Psychology*, *9*(1), 91–121. doi:10.1146/annurev-clinpsy-050212-185608

Borsboom, D., Mellenbergh, G. J., & van Heerden, J. (2003). The theoretical status of latent variables. *Psychological Review*, *110*(2), 203–219. doi:10.1037/0033-295X.110.2.203

Braet, C., Claus, L., Verbeken, S., & Vlierberghe, L. V. (2007). Impulsivity in overweight children. *European Child & Adolescent Psychiatry*, *16*(8), 473–483. doi:10.1007/s00787-007-0623-2

Brandstätter, V., Lengfelder, A., & Gollwitzer, P. M. (2001). Implementation intentions and efficient action initiation. *Journal of Personality and Social Psychology*, *81*(5), 946.

Brodzinsky, D. M., & Dein, P. (1976). Short-term stability of adult reflection-impulsivity. *Perceptual and Motor Skills*, *43*(3), 1012–1014.

Bryant, E., King, N., & Blundell, J. (2008). Disinhibition: Its effects on appetite and weight regulation. *Obesity Reviews*, *9*(5), 409–419.

Buckeridge, D. L., Charland, K., Labban, A., & Ma, Y. (2014). A method for neighborhood-level surveillance of food purchasing. *Annals of the New York Academy of Sciences*, *1331*(1), 270–277. doi:10.1111/nyas.12332

Burger, K. S., & Stice, E. (2014). Greater striatopallidal adaptive coding during cue–reward learning and food reward habituation predict future weight gain. *NeuroImage*, *99*, 122–128. doi:10.1016/j.neuroimage.2014.05.066

Burgoine, T., Forouhi, N. G., Griffin, S. J., Wareham, N. J., & Monsivais, P. (2014). Associations between exposure to takeaway food outlets, takeaway food consumption, and body weight in Cambridgeshire, UK: population based, cross sectional study. *BMJ*, *348*(mar13 5), g1464–g1464. doi:10.1136/bmj.g1464

Burgoine, T., & Monsivais, P. (2013). Characterising food environment exposure at home, at work, and along commuting journeys using data on adults in the UK. *International Journal of Behavioral Nutrition and Physical Activity*, *10*(1), 85. doi:10.1186/1479-5868-10-85

Caplan, B., & Shechter, J. (1990). Clinical Applications of the Matching Familiar Figures Test: Impulsivity Vs. Unilateral Neglect. *Journal of Clinical Psychology*, *46*(1), 60–67.

Carnell, S., Benson, L., Pryor, K., & Driggin, E. (2013). Appetitive traits from infancy to adolescence: Using behavioral and neural measures to investigate obesity risk. *Physiology & Behavior*, *121*, 79–88. doi:10.1016/j.physbeh.2013.02.015

Carnell, S., Gibson, C., Benson, L., Ochner, C., & Geliebter, A. (2011). Neuroimaging and obesity: Current knowledge and future directions. *Obesity Reviews*, *13*(1), 43–56.

Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS Scales. *Journal of Personality and Social Psychology*, *67*(2), 319–333.

Chalmers, D. K., Bowyer, C. A., & Olenick, N. L. (1990). Problem drinking and obesity: A comparison in personality patterns and life-style. *Substance Use & Misuse*, *25*(7), 803–817.

Chandon, P., & Wansink, B. (2010). Is food marketing making us fat? A multi-disciplinary review. *Foundations and Trends in Marketing*, *5*(3), 113–196. doi:10.1561/1700000016

Charland, K., Mamiya, H., & Buckeridge, D. (2015). Digital Sources of Food Purchasing Data for the Surveillance of Dietary Patterns. *Online Journal of Public Health Informatics*, *7*(1). doi:10.5210/ojphi.v7i1.5676

Chiesa, A., Serretti, A., & Jakobsen, J. C. (2013). Mindfulness: Top–down or bottom–up emotion regulation strategy? *Clinical Psychology Review*, *33*(1), 82–96. doi:10.1016/j.cpr.2012.10.006

Chinn, S. (2000). A simple method for converting an odds ratio to effect size for use in meta-analysis. *Statistics in Medicine*, *19*(22), 3127–3131. doi:10.1002/1097-0258(20001130)19:22<3127::AID-SIM784>3.0.CO;2-M

Christensen, T., Barrett, L., Bliss-Moreau, E., Lebo, K., & Kaschub, C. (2003). A practical guide to experience-sampling procedures. *Journal of Happiness Studies*, *4*(1), 53–78.

Clary, C. M., & Kestens, Y. (2013). Field validation of secondary data sources: a novel measure of representativity applied to a Canadian food outlet database. *The International Journal of Behavioral Nutrition and Physical Activity*, *10*, 77. doi:10.1186/1479-5868-10-77

Cohen, D., & Farley, T. A. (2008). Eating as an automatic behavior. *Preventing Chronic Disease*, *5*(1), A23.

Cohen, N., Henik, A., & Moyal, N. (2012). Executive control attenuates emotional effects – For high reappraisers only? *Emotion*, *12*(5), 970–979. doi:10.1037/a0026890

Coppin, G., Nolan-Poupart, S., Jones-Gotman, M., & Small, D. M. (2014). Working memory and reward association learning impairments in obesity. *Neuropsychologia*, *65*, 146–155. doi:10.1016/j.neuropsychologia.2014.10.004

Cornelsen, L., & Carreido, A. (2015). *Health-related taxes on food and beverages* (Working Paper). Retrieved from https://web.archive.org/web/20150828063003/http://foodresearch.org.uk/health-related-taxes-on-food-and-beverages/

Crum, A. J., Corbin, W. R., Brownell, K. D., & Salovey, P. (2011). Mind over milkshakes: Mindsets, not just nutrients, determine ghrelin response. *Health Psychology*, *30*(4), 424–429. doi:10.1037/a0023467

Cummings, D. E., Frayo, R. S., Marmonier, C., Aubert, R., & Chapelot, D. (2004). Plasma ghrelin levels and hunger scores in humans initiating meals voluntarily without time- and food-related cues. *American Journal of Physiology – Endocrinology And Metabolism*, *287*(2), E297–E304. doi:10.1152/ajpendo.00582.2003

Dagher, A. (2012). Functional brain imaging of appetite. *Trends in Endocrinology and Metabolism: Tem*, *23*(5), 250–260. doi:10.1016/j.tem.2012.02.009

Dahl, A. K., & Hassing, L. B. (2013). Obesity and Cognitive Aging. *Epidemiologic Reviews*, *35*(1), 22–32. doi:10.1093/epirev/mxs002

Dale, G., & Arnell, K. (2013). How reliable is the attentional blink? Examining the relationships within and between attentional blink tasks over time. *Psychological Research*, *77*(2), 99–105. doi:10.1007/s00426-011-0403-y

Dalton, M., & Finlayson, G. (2014). Psychobiological examination of liking and wanting for fat and sweet taste in trait binge eating females. *Physiology & Behavior*, *136*, 128–134. doi:10.1016/j.physbeh.2014.03.019

Darwin, C. (1857, August). The Life and Letters of Charles Darwin – Day 153 of 188 at Turtle Reader. letter to J.D. Hooker. Retrieved from https://web.archive.org/web/20150828063110/http://www.turtlereader.com/authors/charles-darwin/the-life-and-letters-of-charles-darwin-day-153-of-188/

Davidson, G. R., & Kirkham, T. C. (2013). Happy people. The influence of positive affect on appetitive motivation in attentional processing. *Appetite*, *71*, 472. doi:10.1016/j.appet.2013.06.017

Davis, C. (2013). From Passive Overeating to “Food Addiction”: A Spectrum of Compulsion and Severity. *ISRN Obesity*, *2013*, e435027. doi:10.1155/2013/435027

Davis, C., Loxton, N. J., Levitan, R. D., Kaplan, A. S., Carter, J. C., & Kennedy, J. L. (2013). “Food addiction” and its association with a dopaminergic multilocus genetic profile. *Physiology & Behavior*, *118*, 63–69. doi:10.1016/j.physbeh.2013.05.014

de Krom, M., van der Schouw, Y. T., Hendriks, J., Ophoff, R. A., van Gils, C. H., Stolk, R. P., … Adan, R. (2007). Common genetic variations in CCK, leptin, and leptin receptor genes are associated with specific human eating patterns. *Diabetes*, *56*(1), 276–280. doi:10.2337/db06-0473

de Ridder, D. T. D., Lensvelt-Mulders, G., Finkenauer, C., Stok, F. M., & Baumeister, R. F. (2011). Taking stock of self-control: A meta-analysis of how trait self-control relates to a wide range of behaviors. *Personality and Social Psychology Review*, *16*(1), 76–99. doi:10.1177/1088868311418749

DeYoung, C. G. (2014). Cybernetic Big Five Theory. *Journal of Research in Personality*. doi:10.1016/j.jrp.2014.07.004

DeYoung, C. G., Hirsh, J. B., Shane, M. S., Papademetris, X., Rajeevan, N., & Gray, J. R. (2010). Testing predictions from personality neuroscience. Brain structure and

the big five. *Psychological Science*, *21*(6), 820–828. doi:10.1177/0956797610370159
DeYoung, C. G., Quilty, L. C., & Peterson, J. B. (2007). Between facets and domains: 10 aspects of the Big Five. *Journal of Personality and Social Psychology*, *93*(5), 880.
Diamond, J. M. (2012). *The World Until Yesterday: What Can We Learn from Traditional Societies?* New York: Viking.
Dobbs, R., Sawers, C., Thompson, F., Manyika, J., Woetzel, J., Child, P., … Spatharou, A. (2014). *How the world could better fight obesity* (Discussion Paper). McKinsey Global Institute,. Retrieved from https://web.archive.org/web/20150828063149/http://www.mckinsey.com/insights/economic_studies/how_the_world_could_better_fight_obesity
Dolfman, M. L., & McSweeney, D. M. (2006). 100 years of US consumer spending: Data for the nation, New York City, and Boston. Retrieved from https://web.archive.org/web/20150828063618/http://www.bls.gov/opub/uscs/
Dubé, L., LeBel, J. L., & Lu, J. (2005). Affect asymmetry and comfort food consumption. *Physiology & Behavior*, *86*(4), 559–567. doi:10.1016/j.physbeh.2005.08.023
Duckworth, A. L., & Kern, M. L. (2011). A meta-analysis of the convergent validity of self-control measures. *Journal of Research in Personality*, *45*(3), 259–268. doi:10.1016/j.jrp.2011.02.004
Edwards, J. R., & Bagozzi, R. P. (2000). On the nature and direction of relationships between constructs and measures. *Psychological Methods*, *5*(2), 155–174.
Elks, C. E., Den Hoed, M., Zhao, J. H., Sharp, S. J., Wareham, N. J., Loos, R. J. F., & Ong, K. K. (2012). Variability in the heritability of body mass index: a systematic review and meta-regression. *Genomic Endocrinology*, *3*, 29. doi:10.3389/fendo.2012.00029
Epel, E. S., Tomiyama, A. J., Mason, A. E., Laraia, B. A., Hartman, W., Ready, K., … Kessler, D. (2014). The Reward-Based Eating Drive Scale: A Self-Report Index of Reward-Based Eating. *PLoS ONE*, *9*(6), e101350. doi:10.1371/journal.pone.0101350
Epstein, L. H., Temple, J. L., Neaderhiser, B. J., Salis, R. J., Erbe, R. W., & Leddy, J. J. (2007). Food reinforcement, the dopamine D_2 receptor genotype, and energy intake in obese and nonobese humans. *Behavioral Neuroscience*, *121*(5), 877.
Epstein, L. H., Truesdale, R., Wojcik, A., Paluch, R. A., & Raynor, H. A. (2003). Effects of deprivation on hedonics and reinforcing value of food. *Physiology & Behavior*, *78*(2), 221–227.
Epstein, L. H., Wright, S. M., Paluch, R. A., Leddy, J. J., Hawk, L. W., Jaroni, J. L., … Lerman, C. (2004). Relation between food reinforcement and dopamine genotypes and its effect on food intake in smokers. *The American Journal of Clinical Nutrition*, *80*(1), 82–88.
Farshchi, H. R., Taylor, M. A., & Macdonald, I. A. (2005). Beneficial metabolic effects of regular meal frequency on dietary thermogenesis, insulin sensitivity, and fasting lipid profiles in healthy obese women. *The American Journal of Clinical Nutrition*, *81*(1), 16–24.
Feller, S., Müller, A., Mayr, A., Engeli, S., Hilbert, A., & de Zwaan, M. (2015). What distinguishes weight loss maintainers of the German Weight Control Registry from the general population? *Obesity*, *23*(5), 1112–1118. doi:10.1002/oby.21054

Fellows, L. K., & Farah, M. J. (2005). Different underlying impairments in decision-making following ventromedial and dorsolateral frontal lobe damage in humans. *Cerebral Cortex*, *15*(1), 58–63. doi:10.1093/cercor/bhh108

Finlayson, G., Arlotti, A., Dalton, M., King, N., & Blundell, J. E. (2011). Implicit wanting and explicit liking are markers for trait binge eating. A susceptible phenotype for overeating. *Appetite*, *57*(3), 722–728. doi:10.1016/j.appet.2011.08.012

Finlayson, G., & Dalton, M. (2012). Current progress in the assessment of "liking" vs. "wanting" food in human appetite. Comment on "'You Say it's Liking, I Say it's Wanting...". On the difficulty of disentangling food reward in man'." *Appetite*, *58*(1), 373–378. doi:10.1016/j.appet.2011.10.011

Finlayson, G., King, N., & Blundell, J. (2008). The role of implicit wanting in relation to explicit liking and wanting for food: Implications for appetite control. *Appetite*, *50*(1), 120–127. doi:10.1016/j.appet.2007.06.007

Finlayson, G., King, N., & Blundell, J. E. (2007a). Is it possible to dissociate "liking" and "wanting" for foods in humans? A novel experimental procedure. *Physiology & Behavior*, *90*(1), 36–42. doi:10.1016/j.physbeh.2006.08.020

Finlayson, G., King, N., & Blundell, J. E. (2007b). Liking vs. wanting food: Importance for human appetite control and weight regulation. *Neuroscience & Biobehavioral Reviews*, *31*(7), 987–1002. doi:10.1016/j.neubiorev.2007.03.004

Fiske, D. W. (1971). *Measuring the concepts of personality*. Chicago: Aldine Pub. Co.

Fitzpatrick, S., Gilbert, S., & Serpell, L. (2013). Systematic Review: Are Overweight and Obese Individuals Impaired on Behavioural Tasks of Executive Functioning? *Neuropsychology Review*, *23*(2), 138–156. doi:10.1007/s11065-013-9224-7

Flagel, S. B., Watson, S. J., Robinson, T. E., & Akil, H. (2007). Individual differences in the propensity to approach signals vs goals promote different adaptations in the dopamine system of rats. *Psychopharmacology*, *191*(3), 599–607. doi:10.1007/s00213-006-0535-8

Food running out. (1992, January 16). *Ellensburg Daily Record*, p. 8.

Forman, E., Hoffman, K., Mcgrath, K., Herbert, J., Brandsma, L., & Lowe, M. (2007). A comparison of acceptance- and control-based strategies for coping with food cravings: An analog study. *Behaviour Research and Therapy*, *45*(10), 2372–2386. doi:10.1016/j.brat.2007.04.004

Frank, M. J., Seeberger, L. C., & O'Reilly R, C. (2004). By carrot or by stick: cognitive reinforcement learning in parkinsonism. *Science*, *306*, 1940–3. doi:1102941 [pii] 10.1126/science.1102941

Frank, S., Giel, K., Heinze, J., & Preissl, H. (2015). *A food-related implicit association test – implications for obesity*. Presented at the The 39th Annual Meeting of the British Feeding & Drinking Group, Wageningen.

French, S. A., Epstein, L. H., Jeffery, R. W., Blundell, J. E., & Wardle, J. (2012). Eating behavior dimensions. Associations with energy intake and body weight. A review. *Appetite*, *59*(2), 541–549. doi:10.1016/j.appet.2012.07.001

French, S. A., Mitchell, N. R., Wolfson, J., Finlayson, G., Blundell, J. E., & Jeffery, R. W. (2014). Questionnaire and laboratory measures of eating behavior. Associations with energy intake and BMI in a community sample of working adults. *Appetite*, *72*, 50–58. doi:10.1016/j.appet.2013.09.020

Funder, D. C. (2009). Persons, behaviors and situations: An agenda for personality psychology in the postwar era. *Journal of Research in Personality*, *43*(2), 120–126. doi:10.1016/j.jrp.2008.12.041

Gawrilow, C., Gollwitzer, P. M., & Oettingen, G. (2011). If-then plans benefit executive functions in children with ADHD. *Journal of Social and Clinical Psychology*, *30*(6), 616–646.
Gearhardt, A. N., Corbin, W. R., & Brownell, K. D. (2009). Preliminary validation of the Yale food addiction scale. *Appetite*, *52*(2), 430–436.
Genné-Bacon, E. A. (2014). Thinking Evolutionarily About Obesity. *The Yale Journal of Biology and Medicine*, *87*(2), 99–112.
Gerlach, G., Herpertz, S., & Loeber, S. (2015). Personality traits and obesity: a systematic review. *Obesity Reviews*, n/a–n/a. doi:10.1111/obr.12235
Giuliani, N. R., Calcott, R. D., & Berkman, E. T. (2013). Piece of cake. Cognitive reappraisal of food craving. *Appetite*, *64*, 56–61. doi:10.1016/j.appet.2012.12.020
Godfrey, K. M., Gallo, L. C., & Afari, N. (2014). Mindfulness-based interventions for binge eating: a systematic review and meta-analysis. *Journal of Behavioral Medicine*, *38*(2), 348–362. doi:10.1007/s10865-014-9610-5
Godsey, J. (2013). The role of mindfulness based interventions in the treatment of obesity and eating disorders: An integrative review. *Complementary Therapies in Medicine*, *21*(4), 430–439. doi:10.1016/j.ctim.2013.06.003
Gollwitzer, P. M., & Sheeran, P. (2006). Implementation Intentions and Goal Achievement: A Meta-analysis of Effects and Processes. In M. P. Zanna (Ed.), *Advances in Experimental Social Psychology* (Vol. 38, pp. 69–119). Academic Press.
Google Ngram. (2015). Google Ngram Viewer. Retrieved June 19, 2015, from https://books.google.com/ngrams/graph?content=overeating%2Cobesity%2C&year_start=1800&year_end=2000&corpus=15&smoothing=3&share=&direct_url=t1%3B%2Covereating%3B%2Cc0%3B.t1%3B%2Cobesity%3B%2Cc0
Gormally, J., Black, S., Daston, S., & Rardin, D. (1982). The assessment of binge eating severity among obese persons. *Addictive Behaviors*, *7*(1), 47–55. doi:10.1016/0306-4603(82)90024-7
Gorsuch, R. L. (1997). Exploratory Factor Analysis: Its Role in Item Analysis. *Journal of Personality Assessment*, *68*(3), 532–560. doi:10.1207/s15327752jpa6803_5
Griffioen-Roose, S., Finlayson, G., Mars, M., Blundell, J. E., & de Graaf, C. (2010). Measuring food reward and the transfer effect of sensory specific satiety. *Appetite*, *55*(3), 648–655. doi:10.1016/j.appet.2010.09.018
Gross, J. J. (1998). The emerging field of emotion regulation: An integrative review. *Review of General Psychology*, *2*(3), 271–299. doi:10.1037/1089-2680.2.3.271
Gross, J. J. (2015). Emotion Regulation: Current Status and Future Prospects. *Psychological Inquiry*, *26*(1), 1–26. doi:10.1080/1047840X.2014.940781
Guerrieri, R., Nederkoorn, C., & Jansen, A. (2008). The effect of an impulsive personality on overeating and obesity: Current state of affairs. *Psychological Topics*, *17*(2), 265–286.
Hall, K. D., Guo, J., Dore, M., & Chow, C. C. (2009). The Progressive Increase of Food Waste in America and Its Environmental Impact. *PLoS ONE*, *4*(11), e7940. doi:10.1371/journal.pone.0007940
Hall, K. D., Sacks, G., Chandramohan, D., Chow, C. C., Wang, Y. C., Gortmaker, S. L., & Swinburn, B. A. (2011). Quantification of the effect of energy imbalance on bodyweight. *The Lancet*, *378*(9793), 826–837. doi:10.1016/S0140-6736(11)60812-X
Hamilton, J., Fawson, S., May, J., Andrade, J., & Kavanagh, D. J. (2013). Brief guided imagery and body scanning interventions reduce food cravings. *Appetite*, *71*, 158–162. doi:10.1016/j.appet.2013.08.005
Härsing, K. (2015). *Söömiskäitumiste rühmitamine ja seoste leidmine kehamassiindeksiga enesekohaste hinnangute alusel [Classification of eating behaviours and*

finding links to body mass index according to self-assesment] (Thesis). University of Tartu.

Hartshorne, H., & May, M. A. (1930). A Summary of the Work of the Character Education Inquiry. *Religious Education*, *25*(7), 607–619. doi:10.1080/0034408300250702

Havermans, R. C. (2011). “You Say it’s Liking, I Say it’s Wanting …”. On the difficulty of disentangling food reward in man. *Appetite*, *57*(1), 286–294. doi:10.1016/j.appet.2011.05.310

Havermans, R. C. (2012). How to tell where “liking” ends and “wanting” begins. *Appetite*, *58*(1), 252–255. doi:10.1016/j.appet.2011.10.013

Helfer, P., & Shultz, T. R. (2014). The effects of nutrition labeling on consumer food choice: a psychological experiment and computational model. *Annals of the New York Academy of Sciences*, *1331*(1), 174–185. doi:10.1111/nyas.12461

Hendricks, M. A., & Buchanan, T. W. (2015). Individual differences in cognitive control processes and their relationship to emotion regulation. *Cognition and Emotion*, *0*(0), 1–13. doi:10.1080/02699931.2015.1032893

Hendrickson, K. L., & Rasmussen, E. B. (2013). Effects of mindful eating training on delay and probability discounting for food and money in obese and healthy-weight individuals. *Behaviour Research and Therapy*, *51*(7), 399–409. doi:10.1016/j.brat.2013.04.002

Herman, C. P., & Mack, D. (1975). Restrained and unrestrained eating. *Journal of Personality*, *43*(4), 647–660.

Herman, C. P., & Polivy, J. (2008). External cues in the control of food intake in humans: the sensory-normative distinction. *Physiology & Behavior*, *94*(5), 722–728.

Hill, J. O. (2006). Understanding and Addressing the Epidemic of Obesity: An Energy Balance Perspective. *Endocrine Reviews*, *27*(7), 750–761. doi:10.1210/er.2006-0032

Hofmann, W., Adriaanse, M., Vohs, K. D., & Baumeister, R. F. (2014). Dieting and the self-control of eating in everyday environments: An experience sampling study. *British Journal of Health Psychology*, *19*(3), 523–539. doi:10.1111/bjhp.12053

Hofmann, W., Baumeister, R. F., Förster, G., & Vohs, K. D. (2012). Everyday temptations: An experience sampling study of desire, conflict, and self-control. *Journal of Personality and Social Psychology*, *102*(6), 1318–1335. doi:10.1037/a0026545

Hofmann, W., Friese, M., & Strack, F. (2009). Impulse and self-control from a dual-systems perspective. *Perspectives on Psychological Science*, *4*(2), 162–176.

Hollmann, M., Hellrung, L., Pleger, B., Schlögl, H., Kabisch, S., Stumvoll, M., … Horstmann, A. (2012). Neural correlates of the volitional regulation of the desire for food. *International Journal of Obesity*, *36*(5), 648–655. doi:10.1038/ijo.2011.125

Houben, K., Nederkoorn, C., & Jansen, A. (2013). Eating on impulse: The relation between overweight and food-specific inhibitory control. *Obesity*, n/a–n/a. doi:10.1002/oby.20670

Hulley, S. B. (Ed.). (2013). *Designing clinical research* (4th ed.). Philadelphia: Wolters Kluwer/Lippincott Williams & Wilkins. Retrieved from https://web.archive.org/web/20150828063947/http://www.sample-size.net/correlation-sample-size/

Huuhtanen, M. (1992, January 9). Estonia Orders Rationing of Bread, Butter, Cheese. *Associated Press*. Tallinn, Estonia. Retrieved from https://web.archive.org/web/20150828064034/http://www.apnewsarchive.com/199

2/Estonia-Orders-Rationing-of-Bread-Butter-Cheese/id-0802b2b5522b8b6cb46cb434e85f48ca
Imhoff, R., Schmidt, A. F., & Gerstenberg, F. (2014). Exploring the Interplay of Trait Self-Control and Ego Depletion: Empirical Evidence for Ironic Effects. *European Journal of Personality*, *28*(5), 413–424. doi:10.1002/per.1899
Inzlicht, M., & Schmeichel, B. J. (2012). What Is Ego Depletion? Toward a Mechanistic Revision of the Resource Model of Self-Control. *Perspectives on Psychological Science*, *7*(5), 450–463. doi:10.1177/1745691612454134
James, D. (2007). Stability of risk preference parameter estimates within the Becker-DeGroot-Marschak procedure. *Experimental Economics*, *10*(2), 123–141. doi:10.1007/s10683-006-9136-y
Jansen, J. M., Daams, J. G., Koeter, M. W. J., Veltman, D. J., van den Brink, W., & Goudriaan, A. E. (2013). Effects of non-invasive neurostimulation on craving: A meta-analysis. *Neuroscience & Biobehavioral Reviews*, *37*(10, Part 2), 2472–2480. doi:10.1016/j.neubiorev.2013.07.009
Jensen, A. R. (1998). *The g factor: the science of mental ability*. Westport, Conn: Praeger.
Johnson, F., Pratt, M., & Wardle, J. (2011). Dietary restraint and self-regulation in eating behavior. *International Journal of Obesity*, *36*(5), 665–674. doi:10.1038/ijo.2011.156
Johnson, W., Bouchard Jr., T. J., Krueger, R. F., McGue, M., & Gottesman, I. I. (2004). Just one g: consistent results from three test batteries. *Intelligence*, *32*(1), 95–107. doi:10.1016/S0160-2896(03)00062-X
Johnson, W., Nijenhuis, J. te, & Bouchard, T. J. J. (2008). Still just 1 g: Consistent results from five test batteries. *Intelligence*, *36*(1), 81–95. doi:10.1016/j.intell.2007.06.001
Jokela, M., Hintsanen, M., Hakulinen, C., Batty, G. D., Nabi, H., Singh-Manoux, A., & Kivimäki, M. (2012). Association of personality with the development and persistence of obesity: A meta-analysis based on individual–participant data. *Obesity Reviews*, n/a–n/a.
Jones, N. R. V., Conklin, A. I., Suhrcke, M., & Monsivais, P. (2014). The Growing Price Gap between More and Less Healthy Foods: Analysis of a Novel Longitudinal UK Dataset. *PLoS ONE*, *9*(10), e109343. doi:10.1371/journal.pone.0109343
Judge, T. A., Erez, A., Bono, J. E., & Thoresen, C. J. (2002). Are measures of self-esteem, neuroticism, locus of control, and generalized self-efficacy indicators of a common core construct? *Journal of Personality and Social Psychology*, *83*(3), 693–710. doi:10.1037//0022-3514.83.3.693
Katterman, S. N., Kleinman, B. M., Hood, M. M., Nackers, L. M., & Corsica, J. A. (2014). Mindfulness meditation as an intervention for binge eating, emotional eating, and weight loss: A systematic review. *Eating Behaviors*, *15*(2), 197–204. doi:10.1016/j.eatbeh.2014.01.005
Kelley, T. L. (1927). *Interpretation of educational measurements*. Oxford, England: World Book Co.
Kelly, A. J., & Dux, P. E. (2011). Different Attentional Blink Tasks Reflect Distinct Information Processing Limitations: An Individual Differences Approach. *Journal of Experimental Psychology: Human Perception and Performance*, *37*(6), 1867–1873.
Kestens, Y., Lebel, A., Chaix, B., Clary, C., Daniel, M., Pampalon, R., … p Subramanian, S. V. (2012). Association between Activity Space Exposure to Food

Establishments and Individual Risk of Overweight. *PLoS ONE*, *7*(8), e41418. doi:10.1371/journal.pone.0041418
Komlos, J., & Brabec, M. (2010a). *The Trend of BMI Values of US Adults by Centiles, birth cohorts 1882-1986* (Working Paper No. 16252). National Bureau of Economic Research. Retrieved from https://web.archive.org/web/20150828064138/http://www.nber.org/papers/w16252
Komlos, J., & Brabec, M. (2010b). *The Trend of Mean BMI Values of US Adults, Birth Cohorts 1882-1986 Indicates that the Obesity Epidemic Began Earlier than Hitherto Thought* (Working Paper No. 15862). National Bureau of Economic Research. Retrieved from https://web.archive.org/web/20150828064223/http://www.nber.org/papers/w15862
Kond, H. (2015). *Teadvelolekul põhinev lühisekkumine vähendab šokolaaditungi ja šokolaadi söömist. Topeltpime katse [Mindfulness-based short intervention reduces chocolate craving and consumption. A randomized controlled trial.]* (Thesis). University of Tartu, Tartu.
Kong, K. L., Feda, D. M., Eiden, R. D., & Epstein, L. H. (2015). Origins of food reinforcement in infants. *The American Journal of Clinical Nutrition*, *101*(3), 515–522. doi:10.3945/ajcn.114.093237
Koole, S. L. (2009). The psychology of emotion regulation: An integrative review. *Cognition & Emotion*, *23*(1), 4–41. doi:10.1080/02699930802619031
Korsten, P., Mueller, J. C., Hermannstädter, C., Bouwman, K. M., Dingemanse, N. J., Drent, P. J., … Kempenaers, B. (2010). Association between DRD4 gene polymorphism and personality variation in great tits: a test across four wild populations. *Molecular Ecology*, *19*(4), 832–843. doi:10.1111/j.1365-294X.2009.04518.x
Kranczioch, C., & Thorne, J. D. (2013). Simultaneous and preceding sounds enhance rapid visual targets: Evidence from the attentional blink. *Advances in Cognitive Psychology*, *9*(3), 130–142. doi:10.2478/v10053-008-0139-4
Kuddo, A. (1995). How Can Poverty and Inequality Be Avoided in Eastern Europe? In Ü. Kırdar & L. Silk (Eds.), *People: from impoverishment to empowerment*. New York: New York University Press. Retrieved from https://books.google.ee/books?id=xncNQaByIKYC&lpg=PA53&dq=arvo%20kuddo%20how%20can%20poverty%20and%20inequality%20be%20avoided%20in%20eastern%20europe&pg=PA53#v=onepage&q&f=false
Kühberger, A., Fritz, A., & Scherndl, T. (2014). Publication Bias in Psychology: A Diagnosis Based on the Correlation between Effect Size and Sample Size. *PLoS ONE*, *9*(9), e105825. doi:10.1371/journal.pone.0105825
Kukk, K. (1997). Five Years in the Monetary Development of the Baltic States: Differences and Similarities. *Eesti Pank Bulletin*, *5*(32). Retrieved from https://web.archive.org/web/20150828064408/http://www.eestipank.ee/sites/default/files/publication/en/Archive/bulletin/1997/index_26.html
Lawrence, N. S., Hinton, E. C., Parkinson, J. A., & Lawrence, A. D. (2012). Nucleus accumbens response to food cues predicts subsequent snack consumption in women and increased body mass index in those with reduced self-control. *NeuroImage*, *63*(1), 415–422. doi:10.1016/j.neuroimage.2012.06.070
Lawrence, N. S., O'Sullivan, J., Parslow, D., Javaid, M., Adams, R. C., Chambers, C. D., … Verbruggen, F. (2015). Training response inhibition to food is associated with weight loss and reduced energy intake. *Appetite*, *95*, 17–28. doi:10.1016/j.appet.2015.06.009

Lewin, K., Heider, F., & Heider, G. M. (1936). *Principles of topological psychology* (Vol. xv). New York, NY, US: McGraw-Hill.

Lezak, M. D. (2004). *Neuropsychological assessment* (4th ed.). Oxford; New York: Oxford University Press.

Liang, J., Matheson, B. E., Kaye, W. H., & Boutelle, K. N. (2014). Neurocognitive correlates of obesity and obesity-related behaviors in children and adolescents. *International Journal of Obesity*, *38*(4), 494–506. doi:10.1038/ijo.2013.142

Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology*, *22 140*, 55.

Linnap, M., & Rice, A. (2014). Managed Participatory Sensing with YouSense. *Journal of Urban Technology*, *21*(2), 9–26. doi:10.1080/10630732.2014.888216

Locke, A. E., Kahali, B., Berndt, S. I., Justice, A. E., Pers, T. H., Day, F. R., … Speliotes, E. K. (2015). Genetic studies of body mass index yield new insights for obesity biology. *Nature*, *518*(7538), 197–206. doi:10.1038/nature14177

Lowe, C. J., Hall, P. A., & Staines, W. R. (2014). The Effects of Continuous Theta Burst Stimulation to the Left Dorsolateral Prefrontal Cortex on Executive Function, Food Cravings, and Snack Food Consumption. *Psychosomatic Medicine September 2014*, *76*(7), 503–511. doi:10.1097/PSY.0000000000000090

Lowe, M. R., & Thomas, G. (2009). Measures of restrained eating: Conceptual evolution and psychometric update. In D. B. Allison & M. L. Baskin (Eds.), *Handbook of assessment methods for eating behaviors and weight related problems: Measures, theory and research*. London: SAGE.

Lubinski, D. (2004). Introduction to the special section on cognitive abilities: 100 years after Spearman's (1904) "'General intelligence,' objectively determined and measured." *Journal Of Personality And Social Psychology*, *86*(1), 96–111.

Lunn, T. E., Nowson, C. A., Worsley, A., & Torres, S. J. (2014). Does personality affect dietary intake? *Nutrition*, *30*(4), 403–409. doi:10.1016/j.nut.2013.08.012

Macht, M. (2008). How emotions affect eating: A five-way model. *Appetite*, *50*(1), 1–11.

MacLean, M. H., & Arnell, K. M. (2012). A conceptual and methodological framework for measuring and modulating the attentional blink. *Attention, Perception, & Psychophysics*, *74*(6), 1080–1097. doi:10.3758/s13414-012-0338-4

Magee, C. A., & Heaven, P. C. L. (2011). Big-Five personality factors, obesity and 2-year weight gain in Australian adults. *Journal of Research in Personality*, *45*(3), 332–335. doi:doi: 10.1016/j.jrp.2011.02.009

Magen, E., & Gross, J. J. (2010). Getting our act together: Toward a general model of self-control. *Self-Control in Society, Mind and Brain*, 335–53.

Mann, T., Tomiyama, A. J., Westling, E., Lew, A.-M., Samuels, B., & Chatman, J. (2007). Medicare's search for effective obesity treatments: diets are not the answer. *The American Psychologist*, *62*(3), 220–233. doi:10.1037/0003-066X.62.3.220

McCrae, R. R. (2014). A More Nuanced View of Reliability Specificity in the Trait Hierarchy. *Personality and Social Psychology Review*, 1088868314541857. doi:10.1177/1088868314541857

McCrae, R. R., Kurtz, J. E., Yamagata, S., & Terracciano, A. (2011). Internal Consistency, Retest Reliability, and their Implications For Personality Scale Validity. *Personality and Social Psychology Review : An Official Journal of the Society for Personality and Social Psychology, Inc*, *15*(1), 28–50. doi:10.1177/1088868310366253

McCrae, R. R., & Löckenhoff, C. E. (2010). Self-regulation and the Five-Factor Model of personality traits. In R. H. Hoyle (Ed.), *Handbook of personality and self-regulation* (pp. 145–168). Wiley-Blackwell.

McHugo, M., Olatunji, B. O., & Zald, D. H. (2013). The emotional attentional blink: what we know so far. *Frontiers in Human Neuroscience*, *7*, 151. doi:10.3389/fnhum.2013.00151

Medic, N., Ziauddeen, H., Vestergaard, M. D., Henning, E., Schultz, W., Farooqi, I. S., & Fletcher, P. C. (2014). Dopamine Modulates the Neural Representation of Subjective Value of Food in Hungry Subjects. *The Journal of Neuroscience*, *34*(50), 16856–16864. doi:10.1523/JNEUROSCI.2051-14.2014

Mennel, S. (1987). On the Civilizing of Appetite. *Theory, Culture & Society*, *4*, 373–403.

Mesas, A. E., Muñoz-Pareja, M., López-García, E., & Rodríguez-Artalejo, F. (2012). Selected eating behaviours and excess body weight: A systematic review. *Obesity Reviews: An Official Journal of the International Association for the Study of Obesity*, *13*(2), 106–135. doi:10.1111/j.1467-789X.2011.00936.x

Miller, A. L., Lee, H. J., & Lumeng, J. C. (2015). Obesity-associated biomarkers and executive function in children. *Pediatric Research*, *77*(1–2), 143–147. doi:10.1038/pr.2014.158

Mischel, W., & Baker, N. (1975). Cognitive appraisals and transformations in delay behavior. *Journal of Personality and Social Psychology*, *31*(2), 254.

Miyake, A., Friedman, N. P., Emerson, M. J., Witzki, A. H., Howerter, A., & Wager, T. D. (2000). The unity and diversity of executive functions and their contributions to complex. *Cognitive Psychology*, *41*(1), 49–100.

Mõttus, R., Kandler, C., Bleidorn, W., Riemann, R., & McCrae, R. R. (2015). Personality Traits Below Facets: The Consensual Validity, Longitudinal Stability, Heritability, and Utility of Personality Nuances. *Submitted for Publication*.

Mõttus, R., McCrae, R. R., Allik, J., & Realo, A. (2014). Cross-rater agreement on common and specific variance of personality scales and items. *Journal of Research in Personality*, *52*, 47–54. doi:10.1016/j.jrp.2014.07.005

Murphy, C. M., Stojek, M. K., & MacKillop, J. (2014). Interrelationships among impulsive personality traits, food addiction, and Body Mass Index. *Appetite*, *73*, 45–50. doi:10.1016/j.appet.2013.10.008

Nee, D. E., Wager, T. D., & Jonides, J. (2007). Interference resolution: Insights from a meta-analysis of neuroimaging tasks. *Cognitive, Affective & Behavioral Neuroscience*, *7*(1), 1–17.

Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., … Gakidou, E. (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: a systematic analysis for the Global Burden of Disease Study 2013. *The Lancet*, *384*(9945), 766–781. doi:10.1016/S0140-6736(14)60460-8

NIHD. (2015). Health statistics and health research database. Retrieved June 25, 2015, from https://web.archive.org/web/20150828062120/http://pxweb.tai.ee/esf/pxweb200/dialog/varval.asp?ma=TKU40&ti=TKU40%3A+Kehamassiindeks+soo+ja+vanuser%FChma+j%E4rgi+++++++++++&path=../Database/Uuringud/02TKU/04Liikumine/

Nijs, I. M. T., & Franken, I. H. A. (2012). Attentional processing of food cues in overweight and obese individuals. *Current Obesity Reports*, *1*(2), 106–113. doi:10.1007/s13679-012-0011-1

Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we can know: Verbal reports on mental processes. Retrieved from http://deepblue.lib.umich.edu/handle/2027.42/92167

Olson, K. L., & Emery, C. F. (2015). Mindfulness and Weight Loss: A Systematic Review. *Psychosomatic Medicine*, *77*(1), 59–67.

Open Science Collaboration. (2015). Estimating the reproducibility of psychological science. *Science*, *349*(6251), aac4716. doi:10.1126/science.aac4716

O'Reilly, G. A., Cook, L., Spruijt-Metz, D., & Black, D. S. (2014). Mindfulness-based interventions for obesity-related eating behaviours: a literature review. *Obesity Reviews*, *15*(6), 453–461. doi:10.1111/obr.12156

Ozer, D. J., & Benet-Martínez, V. (2006). Personality and the Prediction of Consequential Outcomes. *Annual Review of Psychology*, *57*(1), 401–421. doi:10.1146/annurev.psych.57.102904.190127

Paarlberg, D., & Paarlberg, P. (Eds.). (2001). Frontmatter. In *The Agricultural Revolution of the 20th Century* (pp. i–xvi). Blackwell Publishing. Retrieved from http://onlinelibrary.wiley.com/doi/10.1002/9780470290170.fmatter/summary

Pachucki, M. A. (2012). Food pattern analysis over time: unhealthful eating trajectories predict obesity. *International Journal of Obesity*, *36*(5), 686–694. doi:10.1038/ijo.2011.133

Pajunen, P., Kotronen, A., Korpi-Hyövälti, E., Keinänen-Kiukaanniemi, S., Oksa, H., Niskanen, L., … Peltonen, M. (2011). Metabolically healthy and unhealthy obesity phenotypes in the general population: the FIN-D2D Survey. *BMC Public Health*, *11*(1), 754. doi:10.1186/1471-2458-11-754

Panov, L. (2014). *Toitumiskompetentsust mõõtva küsimustiku ecSatter Inventory adapteerimine eesti keelde [Adaptation of the eating competence measurement scale ecSatter Inventory into Estonian]* (Thesis). Tartu Ülikool. Retrieved from https://web.archive.org/web/20150828070614/http://dspace.utlib.ee/dspace/handle/10062/44203

Paquet, C., Daniel, M., Knäuper, B., Gauvin, L., Kestens, Y., & Dubé, L. (2010). Interactive effects of reward sensitivity and residential fast-food restaurant exposure on fast-food consumption. *The American Journal of Clinical Nutrition*, *91*(3), 771–776. doi:10.3945/ajcn.2009.28648

Pessiglione, M., Schmidt, L., Draganski, B., Kalisch, R., Lau, H., Dolan, R. J., & Frith, C. D. (2007). How the Brain Translates Money into Force: A Neuroimaging Study of Subliminal Motivation. *Science*, *316*(5826), 904–906. doi:10.1126/science.1140459

Piech, R. M., Pastorino, M. T., & Zald, D. H. (2010). All I saw was the cake. Hunger effects on attentional capture by visual food cues. *Appetite*, *54*(3), 579.

Pingali, P. L. (2012). Green Revolution: Impacts, limits, and the path ahead. *Proceedings of the National Academy of Sciences*, *109*(31), 12302–12308. doi:10.1073/pnas.0912953109

Plassmann, H., O'Doherty, J., & Rangel, A. (2007). Orbitofrontal cortex encodes willingness to pay in everyday economic transactions. *The Journal of Neuroscience: The Official Journal of the Society for Neuroscience*, *27*(37), 9984–9988. doi:10.1523/JNEUROSCI.2131-07.2007

Polivy, J., & Herman, C. P. (1985). Dieting and binging: A causal analysis. *American Psychologist*, *40*(2), 193–201. doi:10.1037/0003-066X.40.2.193

Põltsam-Jürjo, I., Aas, D., & Kruuser, V. (2013). *Pidusöögist näljahädani: söömine-joomine keskaja Tallinnas [From Feast to Famine: Eating and Drinking in Medieval Tallinn]*. Tallinn: Hea Lugu.

Prentice, A. M., Hennig, B. J., & Fulford, A. J. (2008). Evolutionary origins of the obesity epidemic: natural selection of thrifty genes or genetic drift following predation release? *International Journal of Obesity*, *32*(11), 1607–1610. doi:10.1038/ijo.2008.147

Price, M., Higgs, S., & Lee, M. (2015). Self-reported eating traits: Underlying components of food responsivity and dietary restriction are positively related to BMI. *Appetite*, *95*, 203–210. doi:10.1016/j.appet.2015.07.006

Pursey, K., Burrows, T. L., Stanwell, P., & Collins, C. E. (2014). How Accurate is Web-Based Self-Reported Height, Weight, and Body Mass Index in Young Adults? *Journal of Medical Internet Research*, *16*(1), e4. doi:10.2196/jmir.2909

Pursey, K. M., Stanwell, P., Callister, R. J., Brain, K., Collins, C. E., & Burrows, T. L. (2014). Neural responses to visual food cues according to weight status: a systematic review of functional magnetic resonance imaging studies. *Eating Behavior*, *1*, 7. doi:10.3389/fnut.2014.00007

Rao, M., Afshin, A., Singh, G., & Mozaffarian, D. (2013). Do healthier foods and diet patterns cost more than less healthy options? A systematic review and meta-analysis. *BMJ Open*, *3*(12), e004277. doi:10.1136/bmjopen-2013-004277

Rauthmann, J. F., Gallardo-Pujol, D., Guillaume, E. M., Todd, E., Nave, C. S., Sherman, R. A., … Funder, D. C. (2014). The Situational Eight DIAMONDS: A Taxonomy of Major Dimensions of Situation Characteristics. *Journal of Personality and Social Psychology*. doi:10.1037/a0037250

Reinert, K. R. S., Po'e, E. K., & Barkin, S. L. (2013). The Relationship between Executive Function and Obesity in Children and Adolescents: A Systematic Literature Review. *Journal of Obesity*, *2013*, 1–10. doi:10.1155/2013/820956

Richard, F. D., Bond, C. F., & Stokes-Zoota, J. J. (2003). One Hundred Years of Social Psychology Quantitatively Described. *Review of General Psychology*, *7*(4), 331–363. doi:10.1037/1089-2680.7.4.331

Roberts, H. C., Denison, H. J., Martin, H. J., Patel, H. P., Syddall, H., Cooper, C., & Sayer, A. A. (2011). A review of the measurement of grip strength in clinical and epidemiological studies: towards a standardised approach. *Age and Ageing*, *40*(4), 423–429. doi:10.1093/ageing/afr051

Robinson, E., Aveyard, P., Daley, A., Jolly, K., Lewis, A., Lycett, D., & Higgs, S. (2013). Eating attentively: a systematic review and meta-analysis of the effect of food intake memory and awareness on eating. *The American Journal of Clinical Nutrition*, *97*(4), 728–742. doi:10.3945/ajcn.112.045245

Rodriguez, M. L., Mischel, W., & Shoda, Y. (1989). Cognitive person variables in the delay of gratification of older children at risk. *Journal of Personality and Social Psychology*, *57*(2), 358–367. doi:10.1037/0022-3514.57.2.358

Rollins, B. Y., Loken, E., Savage, J. S., & Birch, L. L. (2014). Measurement of food reinforcement in preschool children. Associations with food intake, BMI, and reward sensitivity. *Appetite*, *72*, 21–27. doi:10.1016/j.appet.2013.09.018

Rose, D., Bodor, J. N., Swalm, C., Rice, J. C., Farley, T., & Hutchinson, P. (2009). Deserts in New Orleans? Illustrations of urban food access and implications for policy. *Ann Arbor, MI: University of Michigan National Poverty Center/USDA Economic Research Service Research*. Retrieved from https://web.archive.org/web/20150828064805/http://www.npc.umich.edu/news/events/food-access/

Ruhm, C. J. (2000). Are Recessions Good for Your Health? *The Quarterly Journal of Economics*, *115*(2), 617–650. doi:10.1162/003355300554872

Saelens, B. E., & Epstein, L. H. (1996). Reinforcing value of food in obese and non-obese women. *Appetite*, *27*(1), 41–50. doi:10.1006/appe.1996.0032

Sarlio-Lähteenkorva, S., & Winkler, J. T. (2015). Could a sugar tax help combat obesity? *The BMJ*, *351*, h4047. doi:10.1136/bmj.h4047

Saunders, B. T., & Robinson, T. E. (2010). A Cocaine Cue Acts as an Incentive Stimulus in Some but not Others: Implications for Addiction. *Biological Psychiatry*, *67*(8), 730–736. doi:10.1016/j.biopsych.2009.11.015

Schmeichel, B. J., Volokhov, R. N., & Demaree, H. A. (2008). Working memory capacity and the self-regulation of emotional expression and experience. *Journal of Personality and Social Psychology*, *95*(6), 1526–1540. doi:10.1037/a0013345

Schönbrodt, F. D., & Perugini, M. (2013). At what sample size do correlations stabilize? *Journal of Research in Personality*, *47*(5), 609–612. doi:10.1016/j.jrp.2013.05.009

Schultz, W. (2007). Behavioral dopamine signals. *Trends in Neurosciences*, *30*(5), 203–210. doi:10.1016/j.tins.2007.03.007

Schwarz, N., & Oyserman, D. (2001). Asking questions about behavior: Cognition, communication, and questionnaire construction. *American Journal of Evaluation*, *22*(2), 127–160.

Sharma, L., Markon, K. E., & Clark, L. A. (2014). Toward a theory of distinct types of "impulsive" behaviors: A meta-analysis of self-report and behavioral measures. *Psychological Bulletin*, *140*(2), 374–408. doi:10.1037/a0034418

Sheppes, G., Scheibe, S., Suri, G., & Gross, J. J. (2011). Emotion-Regulation Choice. *Psychological Science*, *22*(11), 1391–1396. doi:10.1177/0956797611418350

Siep, N., Roefs, A., Roebroeck, A., Havermans, R., Bonte, M., & Jansen, A. (2012). Fighting food temptations: The modulating effects of short-term cognitive reappraisal, suppression and up-regulation on mesocorticolimbic activity related to appetitive motivation. *NeuroImage*, *60*(1), 213–220. doi:10.1016/j.neuroimage.2011.12.067

Skorka-Brown, J., Andrade, J., & May, J. (2014). Playing "Tetris" reduces the strength, frequency and vividness of naturally occurring cravings. *Appetite*, *76*, 161–165. doi:10.1016/j.appet.2014.01.073

Smith, E., Hay, P., Campbell, L., & Trollor, J. (2011). A review of the association between obesity and cognitive function across the lifespan: Implications for novel approaches to prevention and treatment. *Obesity Reviews*, *12*(9), 740–755.

Spearman, C. (1904). "General Intelligence," Objectively Determined and Measured. *The American Journal of Psychology*, *15*(2), 201–292. doi:10.2307/1412107

Spearman, C. (1927). *The Abilities Of Man*. Macmillan And Company., Limited. Retrieved from http://archive.org/details/abilitiesofman031969mbp

Stager, S. F. (1981). Externality, Environment, and Obesity in Children. *Journal of General Psychology*, *105*(1), 141.

Statistics Estonia. (2015). Statistical database. Retrieved August 28, 2015, from https://web.archive.org/web/20150828052335/http://pub.stat.ee/px-web.2001/Dialog/varval.asp?ma=PA661&ti=PALGA-+JA+TARBIJAHINNAINDEKSI+SUHE%2C+II+KVARTAL+2001+%3D+100+%282001-2014%2C+KVARTALID%29&path=../Database/Majandus/12Palk_ja_toojeukulu/01Palk/04Luhiajastatistika/&lang=2

Stice, E., Yokum, S., Burger, K., Rohde, P., Shaw, H., & Gau, J. M. (2015). A pilot randomized trial of a cognitive reappraisal obesity prevention program. *Physiology & Behavior*. doi:10.1016/j.physbeh.2014.10.022

Stunkard, A. J., & Messick, S. (1985). The Three-Factor Eating Questionnaire to measure dietary restraint, disinhibition and hunger. *Journal of Psychosomatic Research*, *29*(1), 71–83.

Sullivan, N., Hutcherson, C., Harris, A., & Rangel, A. (2015). Dietary Self-Control Is Related to the Speed With Which Attributes of Healthfulness and Tastiness Are

Processed. *Psychological Science*, *26*(2), 122–134. doi:10.1177/0956797614559543
Sultson, H. (2014). *Emotsionaalse söömise küsimustiku konstrueerimine ja valideerimine [Construction and validation of the Emotional Eating Scale]*. University of Tartu, Tartu.
Sutin, A. R., Costa, P. T., Jr, Chan, W., Milaneschi, Y., Eaton, W. W., Zonderman, A. B., … Terracciano, A. (2013). I Know Not To, but I Can't Help It: Weight Gain and Changes in Impulsivity-Related Personality Traits. *Psychological Science*, *24*(7), 1323–1328. doi:10.1177/0956797612469212
Sutin, A. R., Ferrucci, L., Zonderman, A. B., & Terracciano, A. (2011). Personality and obesity across the adult life span. *Journal of Personality and Social Psychology*, *101*(3), 579–592.
Sutin, A. R., & Terracciano, A. (2015). Personality Traits and Body Mass Index: Modifiers and Mechanisms. *Psychology & Health*, *0*(ja), 1–31. doi:10.1080/08870446.2015.1082561
Swinburn, B., Kraak, V., Rutter, H., Vandevijvere, S., Lobstein, T., Sacks, G., … Magnusson, R. (2015). Strengthening of accountability systems to create healthy food environments and reduce global obesity. *The Lancet*.
Swinburn, B., Sacks, G., & Ravussin, E. (2009). Increased food energy supply is more than sufficient to explain the US epidemic of obesity. *The American Journal of Clinical Nutrition*, *90*(6), 1453–1456. doi:10.3945/ajcn.2009.28595
Tang, D. W., Fellows, L. K., & Dagher, A. (2014). Behavioral and Neural Valuation of Foods Is Driven by Implicit Knowledge of Caloric Content. *Psychological Science*, 0956797614552081. doi:10.1177/0956797614552081
Tang, D. W., Fellows, L. K., Small, D. M., & Dagher, A. (2012). Food and drug cues activate similar brain regions: A meta-analysis of functional MRI studies. *Physiology & Behavior*, *106*(3), 317–324. doi:10.1016/j.physbeh.2012.03.009
Tekkel, M., & Veideman, T. (2015). *Eesti täiskasvanud rahvastiku tervisekäitumise uuring, 2014 [Health Behavior among Estonian Adult Population, 2014]*. Tallinn: NIHD. Retrieved from https://web.archive.org/web/20150828065213/http://rahvatervis.ut.ee/handle/1/6049
Temple, J. L. (2014). Factors that influence the reinforcing value of foods and beverages. *Physiology & Behavior*, *136*, 97–103. doi:10.1016/j.physbeh.2014.04.037
Teper, R., Segal, Z. V., & Inzlicht, M. (2013). Inside the Mindful Mind How Mindfulness Enhances Emotion Regulation Through Improvements in Executive Control. *Current Directions in Psychological Science*, *22*(6), 449–454. doi:10.1177/0963721413495869
The Automobile Knee. (1912). *The Boston Medical and Surgical Journal*, *167*(23), 816–821. doi:10.1056/NEJM191212051672309
Thiruchselvam, R., Blechert, J., Sheppes, G., Rydstrom, A., & Gross, J. J. (2011). The temporal dynamics of emotion regulation: An EEG study of distraction and reappraisal. *Biological Psychology*, *87*(1), 84–92. doi:10.1016/j.biopsycho.2011.02.009
Thorndike, E. L. (1904). *An Introduction to the Theory of Mental and Social Measurements*. The Science Press. Retrieved from https://archive.org/details/theoryofmentalso00thor
Tibboel, H., De Houwer, J., Spruyt, A., Field, M., Kemps, E., & Crombez, G. (2011). Testing the validity of implicit measures of wanting and liking. *Journal of Behavior*

Therapy and Experimental Psychiatry, *42*(3), 284–292. doi:10.1016/j.jbtep.2011.01.002

Toms, T. (2015). *Stopp-signaali ülesanne seostub kehamassiindeksiga, kuid ei mõjuta šokolaaditungi reguleerimisvõimet [Stop-signal task correlates with Body Mass Index, but doesn't affect regulation of chocolate craving]* (Thesis). University of Tartu.

Tsuchida, A., & Fellows, L. K. (2009). Lesion evidence that two distinct regions within prefrontal cortex are critical for n-back performance in humans. *Journal of Cognitive Neuroscience*, *21*(12), 2263–2275. doi:10.1162/jocn.2008.21172

Tsuchida, A., & Fellows, L. K. (2013). Are core component processes of executive function dissociable within the frontal lobes? Evidence from humans with focal prefrontal damage. *Cortex*, *49*(7), 1790–1800. doi:10.1016/j.cortex.2012.10.014

Tsukayama, E., Duckworth, A. L., & Kim, B. (2012). Resisting everything except temptation: Evidence and an explanation for domain-specific impulsivity. *European Journal of Personality*, *26*(3), 318–334. doi:10.1002/per.841

Uusberg, H., Uusberg, A., Talpsep, T., & Paaver, M. (2015). *Mechanisms of mindfulness: dynamics of affective adaptation during open monitoring*.

Vainik, U., Dubé, L., Lu, J., & Fellows, L. K. (2015). Personality and situation predictors of consistent eating patterns. *Submitted for Publication*.

Val-Laillet, D., Aarts, E., Weber, B., Ferrari, M., Quaresima, V., Stoeckel, L. E., … Stice, E. (2015). Neuroimaging and neuromodulation approaches to study eating behavior and prevent and treat eating disorders and obesity. *NeuroImage: Clinical*, *8*, 1–31. doi:10.1016/j.nicl.2015.03.016

van den Bos, R., & de Ridder, D. (2006). Evolved to satisfy our immediate needs: Self-control and the rewarding properties of food. *Appetite*, *47*(1), 24–29.

van der Laan, L. N., de Ridder, D. T. D., Viergever, M. A., & Smeets, P. A. M. (2011). The first taste is always with the eyes: A meta-analysis on the neural correlates of processing visual food cues. *NeuroImage*, *55*(1), 296–303. doi:10.1016/j.neuroimage.2010.11.055

van der Laan, L. N., & Smeets, P. A. (2015). You are what you eat: a neuroscience perspective on consumers' personality characteristics as determinants of eating behavior. *Current Opinion in Food Science*, *3*, 11–18. doi:10.1016/j.cofs.2014.11.001

Van Dillen, L. F., & Koole, S. L. (2007). Clearing the mind: A working memory model of distraction from negative mood. *Emotion*, *7*(4), 715–723. doi:10.1037/1528-3542.7.4.715

Van Dillen, L. F., Papies, E. K., & Hofmann, W. (2013). Turning a blind eye to temptation: How cognitive load can facilitate self-regulation. *Journal of Personality and Social Psychology*, *104*(3), 427–443. doi:10.1037/a0031262

Verbruggen, F., Chambers, C. D., & Logan, G. D. (2013). Fictitious Inhibitory Differences: How Skewness and Slowing Distort the Estimation of Stopping Latencies. *Psychological Science*, *24*(3), 352–362. doi:10.1177/0956797612457390

Verburgh, L., Königs, M., Scherder, E. J. A., & Oosterlaan, J. (2013). Physical exercise and executive functions in preadolescent children, adolescents and young adults: a meta-analysis. *British Journal of Sports Medicine*, bjsports–2012–091441. doi:10.1136/bjsports-2012-091441

Voltaire. (1838). *Dictionnaire philosophique [1901: The Works of Voltaire, A Contemporary Version, A Critique and Biography by John Morley, notes by Tobias Smollett, trans. William F. Fleming]*. Cosse et Gaultier-Laguionie / New York: E.R. DuMont. Retrieved from

https://web.archive.org/web/20150828070142/https://ebooks.adelaide.edu.au/v/voltaire/dictionary/
Wansink, B. (2004). Environmental factors that increase the food intake and consumption volume of unknowing consumers. *Annual Review of Nutrition*, *24*(1), 455–479. doi:10.1146/annurev.nutr.24.012003.132140
Wansink, B. (2014). *Slim by Design: Mindless Eating Solutions for Everyday Life* (1 edition.). New York, NY: William Morrow.
Wansink, B., & Chandon, P. (2014). Slim by design: Redirecting the accidental drivers of mindless overeating. *Journal of Consumer Psychology*, *24*(3), 413–431. doi:10.1016/j.jcps.2014.03.006
Weafer, J., Baggott, M. J., & de Wit, H. (2013). Test-retest reliability of behavioral measures of impulsive choice, impulsive action, and inattention. *Experimental and Clinical Psychopharmacology*, *21*(6), 475–481. doi:10.1037/a0033659
Weir, K. (2012, October). Overcoming temptation. Retrieved July 7, 2015, from https://web.archive.org/web/20150828070240/http://www.apa.org/monitor/2012/10/temptation.aspx
Werthmann, J., Jansen, A., & Roefs, A. (2015). Worry or craving? A selective review of evidence for food-related attention biases in obese individuals, eating-disorder patients, restrained eaters and healthy samples. *Proceedings of the Nutrition Society*, *74*(02), 99–114. doi:10.1017/S0029665114001451
Whiteside, S. P., & Lynam, D. R. (2001). The Five Factor Model and impulsivity: Using a structural model of personality to understand impulsivity. *Personality and Individual Differences*, *30*(4), 669–689.
Yates, K. F., Sweat, V., Yau, P. L., Turchiano, M. M., & Convit, A. (2012). Impact of Metabolic Syndrome on Cognition and Brain A Selected Review of the Literature. *Arteriosclerosis, Thrombosis, and Vascular Biology*, *32*(9), 2060–2067. doi:10.1161/ATVBAHA.112.252759
Ziauddeen, H., & Fletcher, P. C. (2013). Is food addiction a valid and useful concept? *Obesity Reviews*, *14*(1), 19–28. doi:10.1111/j.1467-789X.2012.01046.x
Ziauddeen, H., Subramaniam, N., Cambridge, V. C., Medic, N., Farooqi, I. S., & Fletcher, P. C. (2014). Studying Food Reward and Motivation in Humans. *Journal of Visualized Experiments*, (85). doi:10.3791/51281
Ziauddeen, H., Subramaniam, N., Gaillard, R., Burke, L. K., Farooqi, I. S., & Fletcher, P. C. (2012). Food images engage subliminal motivation to seek food. *International Journal of Obesity*, *36*(9), 1245–1247. doi:10.1038/ijo.2011.239

SUMMARY IN ESTONIAN

Ülekaalu ja ülesöömisega seotud psühholoogilised mehhanismid: mitmekülgse raamistiku loomine

Tänu viimase aja tehnoloogilisele arengule on inimkond uudses etapis, kus toitu saab kätte aastaringselt ja suures koguses. Nii ajaloolised kui ka kaasaegsed andmed näitavad, et parem kättesaadavus suurendab riski toiduga liialdamiseks ja ülekaalu tekkeks. Ometi kõik inimesed ei reageeri keskkonnale samamoodi – mõnel õnnestub jääda saledaks. Käesolev doktoritöö annab süstemaatilise ülevaate sellest, kuidas ülekaal ja ülesöömine seostuvad teatud psühholoogiliste mehhanismidega. Seejärel lahatakse meetodeid, kuidas neid mehhanisme kõige paremini mõõta. Lisaks tutvustatakse ka söömist mõjutavaid situatsioone ning antakse soovitusi, kuidas psühholoogilisi mehhanisme teades kõige sobivamat toidutungi reguleerimise meetodit valida.

Uuring I-s tehtud süstemaatiline kirjanduse ülevaade näitas, et vaatamata 66-le erinevale käitumuslikule testile pakuvad vaid 8 testi robustseid seoseid kehamassiindeksi ja ülesöömisega. Need 8 testi mõõdavad kahte peamist mehhanismi – kognitiivne kontroll ja toidutung. Toidutung tähistab, kui väga väärtustab inimene toidu stiimulit võrreldes teiste keskkonna stiimulitega. Kognitiivne kontroll seevastu tähistab pikemaajaliste eesmärkide integreerimist käitumisse, võimaldades muuhulgas toidutungi maha surumist. Toidukäitumisküsimustikke analüüsides järeldati, et vaatamata mitmekesistele nimedele võivad küsimustikud peegeldada neidsamu kahte peamist mehhanismi. Ülevaade toob välja kõige perspektiivikamad mõõdikud ning oletab, et nii käitumuslikud testid kui ka küsimustikud võivad peegeldada kognitiivse kontrolli ja toidutungi taga olevaid ajumehhanisme.

Küsimustikega mõõtmisel võib tekkida kaks probleemi – ülemääratus kui mitmed erineva nimega küsimustikud mõõdavad sama iseloomuomadust, või siis alamääratus, kus üks küsimustik mõõdab mitut loomuomadust korraga. Kui selliste probleemidega küsimustikke seostada ülekaaluga, siis pole täpselt selge, millise psühholoogilise mehhanismiga ülekaal seostub. Alamääratuse tarvis töötas Uuring II välja väidete välistamise lähenemise, millega saab vaadata, kas küsimustiku-väljundi seos sõltub üksikutest väidetest. Uurides selle meetodiga impulsiivsuse ja kehamassiindeksi (KMI) seoseid, selgus et impulsiivsuse ja KMI seost veavad kaks söömise spetsiifilist väidet. Seega pole KMI-ga seotud mitte ilmtingimata impulsiivsus vaid selle söögispetsiifiline vorm.

Mitmeid söömisega seotud küsimustikke saab samuti süüdistada ülemääratuses. Näiteks vihjavad nii varasemalt publitseeritud küsimustike vahelised korrelatsioonid kui ka küsimustike definitsioonid, et need instrumendid mõõdavad sarnast konstrukti, mida võiks nimetada kontrollimatu söömine (*Uncontrolled Eating*). Uuringus III tehtud sturktuurvõrrandite analüüs kahe valimi peal kinnitas seda muljet. Pea kõik küsimustikud jagasid ühist konstrukti, mis seostus ka KMI-ga. Samas oli mõnel küsimustikul ka väike unikaalne komponent, millel oli iseseisev seos KMI-ga. Seega mõnel juhul võib küsimustiku spetsiifilisus olla põhjendatud, kuid tulevikus peaks seda unikaalsust eraldi demonstreerima, mitte vaikimisi eeldama. Lisaks erinesid küsimustikud ka oma raskuse poolest – mõned küsimustikud keskendusid kontrollimatu söömise kergematele vormidele ja teised raskematel vormidele. See tulemus näitab veelgi küsimustike mitmekesisust. Lisaks pakkus Uuring III esimest korda empiirilist tuge teoreetilisele mudelile, mille järgi kaotavad inimesed toidu üle kontrolli järk-järgult (Davis, 2013).

Ka KMI ise on teatud mõttes alamääratud – inimestel võivad olla erinevad põhjused, miks nad on ülekaalus. See võib seletada, miks näiteks isiksuse – KMI seosed kipuvad olema üsna väikesed. Uuring IV keskendub ühele võimalikule ülekaalu vältivale tegurile nimega söömisstabiilsus – kas inimene sööb erinevates situatsioonides sarnaselt või on ta toiduvalik väliste tegurite poolt mõjutatav. Söömisstabiilsuse uurimiseks analüüsiti naiste kogemuse väljavõtte andmeid, et välja selgitada isiksusejoonte ja erinevate situatsioonide mõju. Tulemused näitasid, et isiksuslik enesekontroll mõjub stabiilsusele positiivselt, samas kui mitmed situatsioonid vähendavad stabiilsust – kodust väljas söömine, teistega koos söömine, alkoholi tarbimine ja füüsiline aktiivsus. Uuring näitas, et konkreetsele käitumisele keskendumine võib olla tulemuslikum kui üldise KMI uurimine. Lisaks demonstreeris analüüs, et käitumise (söömisstabiilsuse) seletamiseks tasub mõõta nii inimest ennast kui ka situatsioone, mida inimene kogeb.

Uuringud II ja III näitasid, et toidu üle kontrolli kadu on keskne tunne, mida inimesed raporteerivad ja teadlased uurivad. Seega paistab, et paljud inimesed on hädas tõhusate tungi reguleerimise meetodite leidmisel. Viies peatükk annab kiire ülevaate erinevatest populaarsetest tungi regulatsiooni meetoditest, toetudes Grossi (1998, 2015) emotsiooniregulatsiooni mudelile. Samuti hinnatakse kognitiivse kontrolli rolli iga meetodi juures. Selle põhjal on näha, et tavapärane dieedi pidamine / piiramine on sageli vähetulemuslik, kuna ta ei arvesta toidutungiga ja vajab tugevat kognitiivset kontrolli. Samas on olemas ka teised meetodid, mis on vähem sõltuvad tugevast kognitiivsest kontrollist. Võimalik, et nende meetodite abiga saaksid rohkem inimesi taastada kontrolli tunde oma söömise üle.

Kokkuvõttes on inimese toidukäitumise mõistmiseks tehtud väga palju tööd. Käesolev doktoritööd teeb süstematiseeritud ülevaate sellest, mis on tehtud, ning pakub välja mitmesuguseid võimalusi, kuidas edasi minna. Loodetavasti võimaldab tehtud töö tulevikus nautida enneolematut toiduküllust, ilma et peaks muretsema kontrolli kao üle.

PUBLICATIONS

CURRICULUM VITAE

Name:	Uku Vainik
Date and of birth:	31.05.1985 (Tallinn, Estonia)
Citizenship:	Estonian
E-mail:	uku.vainik@gmail.com
Languages:	Estonian, English (TOEFL 114), German, (French, Spanish, Russian)

Field of research:
Health psychology, personality psychology, cognitive psychology

Research techniques:
Web studies, experimental manipulations, electroencephalography, Structural Equation Modelling, Multi-Level Modelling, epidemiological data analysis.

Education

2011–2015	Doctoral studies, Department of Psychology, University of Tartu Includes a year at Montreal Neurological Institute, McGill University, Canada
2009–2011	Master of Arts, Department of Psychology, University of Tartu Includes an exchange year at University of Toronto, Canada
2004–2008	Bachelor of Arts, Department of Psychology, University of Tartu ÜlikoolIncludes an exchange year at University of Konstanz, Germany
1992–2004	Tallinn English College, silver medalist

Employment

2013–…	Research assistant, Allik Lab of Experimental Psychology, University of Tartu
2011–2012	Research assistant, Fellows Decision Making Lab, Montreal Neurological Institute
2011–2011	Research assistant, Tannock ADHD Lab, University of Toronto, Canada
2009–2010	Research assistant, Allik Lab of Experimental Psychology, University of Tartu.

ELULOOKIRJELDUS

Nimi:	Uku Vainik
Sünniaeg:	31.05.1985 (Tallinn, Estonia)
Kodakonsus:	Eestlane
E-mail:	uku.vainik@gmail.com
Keeled:	Eesti, inglise (TOEFL 114), saksa, (prantsuse, hispaania, vene)

Uurimistöö põhisuunad:
Tervisepsühholoogia, isiksus, kognitiivpsühholoogia

Uurimistehnikad:
Veebiuuringud, eksperimentaalsed manipulatsioonid, elektroentsegalograafia, struktuurvõrrandid, mitmetasandilised mudelid, epidemioloogilised tehnikad.

Haridus

2011–2015	Doktorantuur, psühholoogia instituut, Tartu ülikool Sisaldab aastat Montreali neuroloogilises instituudis McGilli ülikoolis Kanadas
2009–2011	Magistrikraad (MA), psühholoogia instituut, Tartu ülikool Sisaldab vahetusaastat Toronto Ülikoolis Kanadas
2004–2008	Bakalaureuse kraad (BA), psühholoogia instituut, Tartu ülikool Sisaldab vahetusaastat Konstanzi ülikoolis Saksamaal
1992–2004	Tallinna Inglise Kolledž, lõpetanud hõbemedaliga

Töökäik

2013–…	Laborant, ekspertimentaalpsühholoogia labor, Tartu ülikool
2011–2012	Uurimisassistent, Lesley Fellowsi otsustetegemise labor, Montreali Neuroloogiline Instituut, Kanada
2011–2011	Uurimisassistent, Rosemary Tannocki Hüperaktiivsuse- ja tähelepanuhäire labor, Toronto Ülikool, Kanada
2009–2010	Laborant, ekspertimentaalpsühholoogia labor, Tartu ülikool

DISSERTATIONES PSYCHOLOGICAE UNIVERSITATIS TARTUENSIS

1. **Jüri Kruusvall.** Environmental and social influence on human activity. Tartu, 1994, 135 p.
2. **Dagmar Kutsar.** Transformation in Estonia as reflected in families: Insight into social stress and poverty. Tartu, 1995, 171 p.
3. **Aleksander Pulver.** Measurement of elementary movement vectors in human visual system. Tartu, 1995, 123 p.
4. **Ritva Fagerström.** The correlations between psychological factors and vision in aged cataract operation patients. Tartu, 1996, 145 p.
5. **Eve Kikas.** Conceptual development in school-aged children: The impact of teaching. Tartu, 1997, 112 p.
6. **Anu Realo.** Individualism and collectivism: An exploration of individual and cultural differences. Tartu, 1999, 164 p.
7. **Aaro Toomela.** Cultural-historical psychology: three levels of analysis. Tartu, 2000, 171 p.
8. **Anneli Kolk.** Cognitive development of children with non-progressive unilateral brain lesion. Tartu 2001, 95 p.
9. **Aune Valk.** Two facets of ethnic identity: pride and differentiation. Tartu, 2001, 153 p.
10. **Anu Aluoja.** Depression in the population: assessment, prevalence and relationships with socio-demographic factors and cognitive aspect of social adjustment. Tartu 2002, 73 p.
11. **Talvi Kallasmaa.** Personality traits and ways of coping: their characteristics and interrelations. Tartu 2002, 119 p.
12. **Luule Mizera.** Socialization in Estonian families: attitudes and behavior in comparative perspective. Tartu 2003, 117 p.
13. **Kairi Kreegipuu.** Availability and accessibility of information in perception of moving stimuli. Tartu 2004, 97 p.
14. **Riina Häidkind.** Monoaminergic mechanisms in mood-associated behaviours and neurochemistry in rats. Tartu 2004, 123 p.
15. **Evelyn Kiive.** Studies on peripheral markers of central serotonergic activity and behaviour. Tartu, 2005, 113 p.
16. **Helle Pullmann.** The development of intelligence and personality traits among Estonian schoolchildren. Tartu, 2005, 112 p.
17. **Kenn Konstabel.** The structure and validity of self- and peer-reported personality traits. Tartu, 2006, 103 p.
18. **Toivo Aavik.** Lexical analysis of Estonian personal values vocabulary and relation to socially desirable responding and parenting practices. Tartu, 2006, 113 p.
19. **Margus Tõnissaar.** Stress and sociability: individual differences and their neurochemical substrate. Tartu, 2006, 161 p.

20. **Kaia Laidra.** Adolescent personality: Development, interrater agreement, and relation to academic achievement. Tartu, 2007, 117 p.
21. **Iiris Luiga.** Interaction of object perception and visual attentional selection processes. Tartu, 2007, 116 p.
22. **Marika Paaver.** Types of impulsivity, their behavioural expression, and association with the markers of vulnerability of serotonin system. Tartu, 2007, 140 p.
23. **Tanel Mällo.** Exploratory behaviour and 50-kHz ultrasonic vocalizations in rats: behavioural and neurochemical profiles of persistent inter-individual differences. Tartu, 2008, 216 p.
24. **Aet Alttoa.** Neurochemical regulation of rat exploratory behaviour: focus on dopaminergic and noradrenergic neurotransmission. Tartu, 2008, 166 p.
25. **René Mõttus.** Universal and specific features of personality traits in their various representations. Tartu, 2009, 170 p.
26. **Kirsti Akkermann.** Serotonin-related biomarkers and symptoms of eating disorders. Tartu, 2010, 120 p.
27. **Iris Podar.** Eating disorders, personality, and cultural differences. Tartu, 2010, 130 p.
28. **Denis Matrov.** Cerebral oxidative metabolism and effects of chronic variable stress in animal models of human affective styles. Tartu, 2010. 208 p.
29. **Kadri Kõiv**. Studies on monoaminergic regulation of inter-individual differences in exploratory behaviour and the activating and rewarding effects of psychostimulants in rats. Tartu, 2010, 132 p.
30. **Triin Hannust.** Children's knowledge about the Earth and gravity and its change in the course of development and learning. Tartu, 2011, 108 p.
31. **Kersti Luuk.** Antecedents and concomitants of adult psychological distress. Tartu, 2011, 132 p.
32. **Margus Kanarik**. Inter-individual differences in vulnerability to depression: regional brain energy metabolism, serotonergic function and behaviour in animal models. Tartu, 2011, 239 p.
33. **Aire Raidvee.** Pooling of elementary motion, colour, and orientation signals into global perception. Tartu, 2012, 105 p.
34. **Liisi Kööts-Ausmees.** Emotional experience: relations to personality, subjective well-being, recollection, and external influences. Tartu, 2012, 137 p.
35. **Pirko Tõugu.** "Where did we go last weekend?" Socialization of children through past-event reminiscing in various cultural contexts. Tartu, 2012, 132 p.
36. **Triin Kurrikoff.** Interpersonal relationships and behaviour: moderation by functional gene variants. Tartu, 2012, 126 p.
37. **Karin Täht**. The cross-cultural view on students' motivation to learn. Tartu, 2012, 137 p.

38. **Henrik Dobewall.** Human values and subjective well-being: An exploration of individual and cultural differences, change across life span, and self-other agreement. Tartu, 2013, 157 p.
39. **Carolina Murd.** Mechanisms of processing visual motion information: Psychophysical, bioelectrical and transcranial magnetic stimulation investigations. Tartu, 2014, 120 p.
40. **Andero Uusberg.** Electroencephalographic insights into affective attention. Tartu, 2014, 122 p.
41. **Kariina Laas.** Neuropeptide S and mental health: A functional receptor gene variant and environment shaping traits and contributing to psychiatric disorders. Tartu, 2014, 144 p.
42. **Maria Tamm**. Psychological and physiological implications of time perception. Tartu, 2014, 154 p.
43. **Inga Karton**. Deceptive communication: the effects of transcranial magnetic stimulation and the signatures of electroencephalography. Tartu, 2014, 94 p.
44. **Kelli Lehto.** Depression- and anxiety-related gene variants: effects on personality traits and health-related behaviour. Tartu, 2015, 104 p.
45. **Anni Tamm.** Conflicts and their management in early childhood and adolescence. Tartu, 2015, 161 p.
46. **Renate Rutiku.** Refining the methodology for investigating the neural correlates of consciousness. Tartu, 2015, 166 p.