Internal Cue Reliance Scale

Development and validation of the measurement of a new perspective on food regulation.

S.A.M de Veth
Wageningen University
July, 2016

Internal Cue Reliance Scale

Development and validation of the measurement of a new perspective on food regulation.

Master thesis Marketing & Consumer Behaviour

Student: S.A.M. (Saskia) de Veth
Student number: 920911887090

Thesis code: MCB 80433
Date: July, 2016

Master Management, Economics and Consumer Studies
Marketing and Consumer Behaviour Group
Wageningen University

Supervisor Wageningen University: dr.ir. PW (Ellen) van Kleef

Examiners Wageningen University: dr.ir. PW (Ellen) van Kleef
prof.dr.ir. JCM (Hans) van Trijp

Preface

Before you lies the thesis "Internal Cue Reliance Scale: Development and validation of the measurement of a new perspective on food regulation". This thesis has been written as part of the study programme of the master Management, Econimics, and Consumer Studies, with the specialization Marketing & Consumer Behaviour at Wageningen University. The thesis was written during the period January to July 2016.

I have chosen the subject Internal Cue Reliance because I am interested in the consumption behaviour of consumers and especially the perspectives on healthy consumption. Mindfulness and mindful eating were my first concepts of interest, when further investigating these concepts the construct Internal Cue Reliance drew my attention. I am aware that this study is just the beginning in exploring and evaluating this construct. Nevertheless, I believe that investigating this construct can help in creating healthier food patterns for consumer.

The thesis subject and aim of the study were formulated together with my supervisor, Ellen van Kleef. It was difficult to develop a new scale for a relatively new construct, but eventually after extensive research and conducting multiple ways of analysing, I succeeded to complete the study. Fortunately, Ellen van Kleef, Hans van Trijp, and other professors at the university were always willing to help and to answer my questions.
I would like to thank these professors for their help and support during the process of writing the thesis. Furthermore, I want to thank Ad Denissen for his excellent help with the difficult analysis part of the study.

I hope you enjoy your reading and that you will get inspired to think about and perhaps improve your own consumption behaviour.

Saskia de Veth
Wageningen, July 2, 2016.

Executive Summary

Objective: Although reliance on internal physiological hunger and satiety cues appears to be an important new principle in existing literate about mindfulness and intuitive eating, the construct has not been investigated extensively. An instrument that assesses the key items of internal cue reliance does not exist. The aim of this research is to close the knowledge gap in literature by developing a new scale that specifically measures reliance on internal physiological hunger and satiety cues.

Methodology: This paper consists of two studies. In the first study focusses on developing the scale measuring internal cue reliance. The literature study and investigation of existing scales concluded in a large item pool of 38 items divided in four factors. The four mechanisms forming internal cue reliance according to the literature study are; 1. The recognition of internal cues, 2. trust put on internal cues to determine food regulation, 3. recognition of external cues, and 4. disentanglement of these cues for the process. By conducting both exploratory and confirmatory factor analysis, the factor structure of the initial item pool is evaluated and adjusted to the outcomes of the analysis. The second study consists of a validation of the developed scale. The factor scores of the scale are tested on their correlation with certain healthy behavioural items. In this way the predictive value of the scale is tested. Next to age, gender, and BMI, weight fluctuation is added to the scale as a health indicator.

Results: The results of the first study show that the expected four factors are present in the scale. The exploratory and confirmatory factor analysis results in a model with total of 18 items that together form the internal cue reliance scale and. This total model shows good fit to the data. The second study reveals that internal cue reliance correlates to the total set of behavioural items. Internal cue reliance appears to have no significant relationship with age and gender. The construct does show a negative relationship with the health indicators BMI and weight fluctuation.

Conclusion: The total study is a first step in developing a scale that measures internal cue reliance. It concludes in a four factor scale measuring the construct that has a positive effect on healthy behaviour and health indicators and therefor predicts a healthier lifestyle.

Keywords: consumption, internal cues of hunger and satiety, food regulation, food intake, scale development.

Table of Content

1. Introduction

Obesity is a major health problem that has increased tremendously in many countries in the past decades (Ng et al., 2014). In 2014, the proportion of the global population that was overweight was estimated at 39%. Between 1980 and 2014 the obesity numbers have nearly doubled. 11% of adult men and 15% of adult women were classed as obese in 2014 (BMI >25), which means that more than half a billion adults were extremely overweight (World Health Organization, 2014).

The current obesogenic environment has been seen as the leading cause for this growing health problem. The overload of food related cues in the environment remind people of palatable, unhealthy, and energy-dense food. Unhealthy food cues such as food advisements and large portion sizes, are seen as persuaders that lead to overconsumption (Cairns, Angus, Hastings & Caraher, 2013; Folkvord, Anschütz, Wiers & Buijzen, 2015; Watson, Wiers, Hommel & de Wit, 2014). Wansink (2004) states that the ambient factors related to consumption and the way food is provided and presented have influence on consumers and their eating behaviour. The consumption environment can be divided into the food environment and the eating environment. Both the food related cues in the food environment (food salience, packaging, structure) and the food independent cues in the eating environment (atmospherics, social interactions, distractions) contribute to the amount of food consumed (Wansink, 2004).

Based on this knowledge many dietary ideas are formed around the idea that the environment needs to be adapted to prevent overconsumption (Corsica & Hood, 2011; Osei-Assibey et al., 2012; Wansink, 2010). The underlying assumption that is made in this perspective is that people eat mindlessly and primary use external cues as indicators to decide what, when and how much to eat (Wansink, 2010).

A relatively new and contrasting perspective that is gaining interest in this context is the theory around the reliance on internal physiological hunger and satiety cues. Whereas the previous mentioned theory is based on a deficit model and tends to focus on deficiencies in people's behaviour, this latter paradigm takes a more positive perspective and leads to adaptive forms of eating (Tylka & Wilcox, 2006). Two similar concepts that incorporate this perspective are intuitive eating and mindful eating. Intuitive eating concisely means relying on internal cues to decide when, what and how much to eat (Herbert, Blechert, Hautzinger, Matthias & Herbert, 2013; Tylka, 2006). Framson et al. (2009) describe mindful eating as "non-judgmental awareness of physical and emotional sensations while eating or in a food-related environment", with listening to internal cues of the body as the main principle of this eating form. Mindful eating follows the same general idea as intuitive eating but is complementary to the concept mainly due to the fact that it incorporates mediation as necessary and basic element (Mathieu, 2009).

This paradigm undermines the former idea that the focus of research and diets should be on human deficits and the bad influence of the environment. The assumption that forms the basis of this theory is that people can learn to listen to their body and are able to ignore or disregard external food cues from the environment (Kristeller & Hallett, 1999). Tylka (2013), argues that intuitive eating is positively related to concepts such as body appreciation and self-esteem and she found a negative relationship between intuitive eating and Body Mass Index

(BMI). Due to this paradigm shift in approaching eating behaviour and weight control, alternative forms of dietary ideas arise. The health at every size approach for example stimulates people to accept their current weight and rely on their internal cues to regulate their food intake and body weight (Berman, Morton & Hegel, 2015).

Research on the concepts of intuitive eating and mindful eating is still in its nascent stage. Although reliance on internal physiological hunger and satiety cues appears to be the main principle in their definition, this concept is merely seen as one of the elements when measuring the concepts. Scale development to measure internal reliance related concepts is limited and is never specified to exclusively measure internal reliance. Not only intuitive eating and mindful eating scales incorporate items that relate to this concept. Other scales, as for example the Power of Food Scale (Cappelleri et al., 2009) and The Eating Motivation Survey (Renner, Sproesser, Strohbach, & Schupp, 2012), also include a small number of items that could relate to internal cue reliance.

Up to now, an instrument that assesses the key items of internal cue reliance does not exist. The aim of this research is to close the knowledge gap in literature by developing a new scale that specifically measures reliance on internal physiological hunger and satiety cues.

To close this knowledge gap, this research consists of both the development of the new scale (Study 1) and a preliminary validation of the scale (Study 2). Refinement of the construct 'reliance on internal physiological hunger and satiety cues' is the starting point of this paper. A literature review is used to provide information about internal cue reliance and related concepts. Furthermore, existing scales and the items that relate to the construct are investigated and evaluated. This leads to an item-pool that will be implemented as first part of the study. The method, results and conclusion of this inquiry are discussed. The second phase of this paper (Study 2) describes the study that tests the predictive value of the scale. It is tested whether the scale is related to certain healthy behavioural outcomes. The complete method and results of Study 2 are described. Finally, the conclusion includes both the theoretical and empirical research outcomes to aim at closing the knowledge gap and the discussion part provides a critical reflection on the study.

2. Theoretical background

2.1 Promising Effects of Internal Cue Reliance

Obesity has increased tremendously in many countries in the past decades and is seen as one of the largest health problems of this time (Ng et al., 2014). The basic key element of dieting or regulation of healthy weight, is to control the energy intake by not consuming more energy than is dissipated by the body (Due, Karhunen, Saarela & Lyly, 2009). In practice, it however is not that simple for a large part of the population to control their food intake. Many researchers see the current obesogenic environment, where (unhealthy) food is largely promoted and the palatability of food is high, as the main instigator of this obesity problem (Cairns, Angus, Hastings & Caraher, 2013; Folkvord, Anschütz, Wiers & Buijzen, 2015; Watson, Wiers, Hommel & De Wit, 2014). However, relatively new theories are built around the idea that people are capable of learning to listen to their internal cues of hunger and satiety, instead of letting the environmental cues regulate a large part of the food intake (Tylka & Wilcox, 2006). The prevalence of reliance on internal cues could protect consumers from the overload of unhealthy food-related cues in the environment and therefor leads to a healthier body. Internal cue reliance has never been measured separately but results from studies that investigate the relationship between overarching concepts (i.e. intuitive eating) of internal cue reliance and Body Mass Index show that people who listen to their internal cues have a lower BMI (Framson et al., 2009; Gagnon-Girouard, 2010; Hawks, Merrill & Madanat, 2004; Tylka, 2013; Tylka & Kroon Van Diest, 2013). In cross-sectional survey studies, the negative relationship between internal cue reliance and BMI is generally confirmed. There are also some contradicting results in literature about this relationship (Van Dyke & Drinkwater, 2014). The clinical studies that use an intervention programme to investigate this topic find little evidence for the cause-effect relationship. However, some of these studies do find a relationship between internal cue reliance and weight maintenance (Bacon, Stern, Van Loan & Keim, 2005; Hawley et al, 2008; Leblanc et al., 2012)

Besides a healthy body, research also shows positive correlations with mental health indicators, such as self-esteem, body image, optimism and satisfaction with life in general (Augustus-Horvath & Tylka, 2011; Tylka, 2006; Tylka & Wilcox, 2006). These outcomes provide a promising base for the research about measurement of internal cue reliance specifically and its relation to the various health indicators to help fight the obesity problem.

2.2 Defining Internal Cues of Hunger and Satiety

To be able to construe a scale that measures the construct ‘reliance on internal cues’, the meaning of this construct needs to be specified. The term ‘internal cues’ is used in the context of this paper to refer to the bodily signals that indicate both the feelings of hunger and feelings of satiation and satiety. The full construct can be described as reliance on internal cues of hunger and satiety and satiation, in this paper frequently concisely referred to as internal cue reliance.

Blundell, Lawton, Cotton & Macdiarmid (1996) define hunger as a subjective feeling of emptiness of the stomach that leads to the desire of wanting to eat and has the biological

function of reminding people that the body needs food. Hunger is determined by two factors, namely the physiological need for food from the body and the amount of food required to fulfil this need (Blundell, Lawton, Cotton & Macdiarmid, 1996). The sensation of hunger occurs when the glycogen level of the liver reaches the point of being below a certain limit, which leads to an unpleasant feeling (Due, Karhunen, Saarela & Lyly, 2009). Satiation on the other hand occurs when hunger is reduced while consuming food and eventually terminates the consumption moment. Satiety differs from satiation as it is the state that follows after the intake of food. Its intensity level can be defined using the length of the period in which hunger is supressed after the consumption moment (Blundell, Lawton, Cotton & Macdiarmid, 1996; Green, Delargy, Joanes & Blundell, 1997)

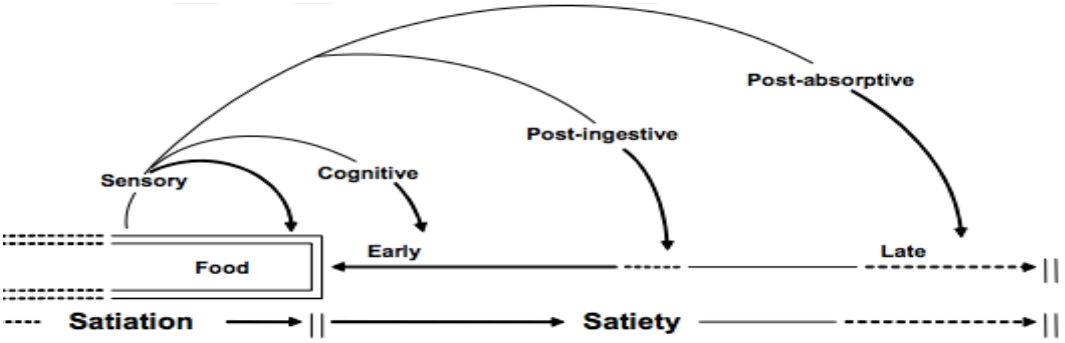

Figure 1: Mechanisms influencing food intake. Modified from Satiety Cascade Blundell, Rogers & Hill, 1987.

Satiety and satiation are influenced by different factors. Blundell (1991) mentions four mechanisms that influence hunger, satiety and satiation; sensory, cognitive, pre-absorptive and post-absorptive determinants. Figure 1, based on the satiety cascade of Blundell, Rogers & Hill (1987), illustrates the difference between satiation and satiety and shows the position of the four influencing mechanisms.

Sensory characteristics of the food can influence the perceived satiation and early satiety in many ways. For example, textural cues as the thickness, hardness and creaminess of a product have a positive relationship with perceived satiety (McCrickerd & Forde, 2015; Yeomans, 2015). Furthermore, variety of food is an important sensory factor that influences satiation. When the variety of flavour and texture in a meal or diet increases, the food intake also increases (Raynor & Epstein, 2001). The related mechanism that explains the variety effect is called 'sensory-specific satiety' and refers to the decrease in liking a specific food after eating it, while the liking of other foods that are not eaten does not change (Havermans, 2012). This means that when a great variety of food is accessible during a meal or diet, as it is in the current food environment, satiation feelings are inhibited and a greater food intake is caused (Raynor & Epstein, 2001).

The second mechanism, cognitive-enhanced satiety, occurs when expectations of how filling the product will be alters the feeling of satiation and early satiety. The label or textual information on the packaging of the product can influence the beliefs held about the saturating value of the product and thereby influence the actual satiety and satiation (Yeomans, 2015).

Yeomans (2015) explains the difference between pre-absorptive and post-absorptive effects emphasizing the fact that the first mentioned occur before absorption in the gastrointestinal tract and the latter effects emerge from absorption of metabolites in the bloodstream. Gastric distention and the effort and time needed for chewing the food are

examples of pre-absorptive effects that influence satiation. The more time and energy it takes to chew on a product, the more saliva and gastric juice is secreted, which leads to enlargement of the stomach and thereby increases satiety (Slavin & Green, 2007). The nutritional content of the food consumed is also an important factor in satiety and satiation. Protein appears to have the most satiating effect of the macronutrients, whereas fat is the least satiating, and carbohydrates are in between (Stubbs, Ferres & Horgan, 2000). The interacting four mechanisms in the satiety cascade together determine how much, how long and how often people consume and thus determine the intensity and length of feelings of satiety and satiation.

An other important factor that is not included in the satiety cascade but does influence food intake of consumers, are external cues in the environment. The internal cues of hunger and satiety are often overruled by ambient factors in the environment and the presentation and provision of food (Wansink, 2004). External cues that influence feelings of hunger and satiety can occur in both the direct food environment as in the food independent eating environment. An example of an important cue in the food environment is portion or package size. Research shows that larger portion sizes lead to more food intake, which implies that satiation feelings are disturbed by this external cue (Fisher & Kral, 2008; Rolls, Roe, Kral, Meengs, & Wall, 2004; Wansink, 2004). Furthermore, distractions in the eating environment divert people's attention to other things than their internal feelings. For example, watching television or interacting with others while eating are examples of distractions in the environment that can influence satiation and satiety (Braude & Stevenson, 2014; Herman, 2005). Evidently, successful reliance on internal hunger and satiety cues is dependent of two factors. Firstly, people need to be able to recognize and act upon their internal cues. Secondly, people need the capability to identify external cues and disentangle these latter cues from influencing regulation of food intake.

Accordingly, reliance on internal cues can be defined as recognition of bodily cues of hunger, satiation and satiety and trusting these cues to regulate food intake, while recognizing and disentangling external cues from this process.

The figure below (Figure 2) shows the process that flows from the definition of internal cue reliance. First, the internal cue of hunger, satiety or satiation is generated in the body as a cause of fluctuations in hormone levels or stomach digestion. The next step is the detection and recognition of the cue by an individual. The individual has to evaluate the internal cue, decide what the cue means and determine to put trust in the cue or not.

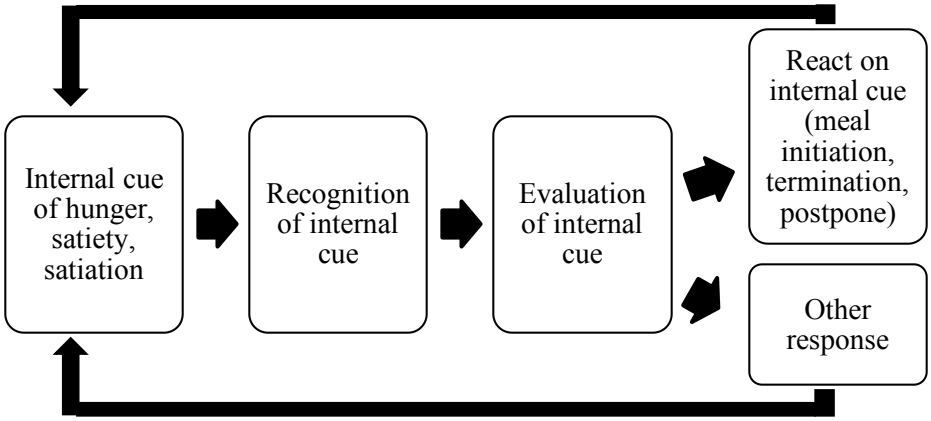

Figure 2: Internal Cue Process

The last step is the response behaviour, either acting upon the cue by meal initiation or termination or determining to chose other response and neglect the internal cue. When acting upon the internal cue, depending on the nature of the cue, the behaviour can be either meal initiation (hunger), meal termination (satiation), or postponement of the next meal (satiety). Other response can be continuing to eat while full, delaying eating while hungry (i.e. when dieting) or start to eat while still satiated. Dependent of this response choice, after a certain period in time a new internal cue will arise.

2.3 Reliance on internal cues, short-term regulation of food intake

To be able to rely on internal cues of hunger and satiety, people need to be aware of them. The underlying assumption that goes along with the theory around internal cue reliance is that people are able to detect their bodily cues and and have the capability to translate these signals into the right behaviour (Kristeller & Hallett, 1999). Authors that follow the externality perspective believe that people are not capable of listening to internal body cues (Wansink, 2010). Birch, Johnson, Andresen, Petersen, & Schulte (1991) however show in their study that young children (age 2-5) have an internal mechanism that they can use to regulate their food intake. Although the calorie intake per eating moment differs significantly, the total daily intake of young children is relatively consistent. Parents see the variable intake as a sign that children cannot regulate their food intake themselves and take over the control of their children's eating pattern. This leads to a disconnection between children and the innate quality to listen to internal hunger and satiety cues and results in empowerment of external cues as regulators of food intake (Birch et al., 1991; Birch & Fisher, 2000). This intrinsic knowledge of the body to identify the right type and amount of food to maintain health is also referred to as body wisdom (Gast & Hawks, 1998). According to authors that follow the intuitive eating paradigm, the disconnection between this body wisdom and decision making can be restored by training with the right instructions and putting effort in the performance of the principles that come along with the theory (Tribole & Resch, 1996).

How does this work? De Graaf, Blom, Smeets, Stafleu, and Hendriks (2004) make a difference between the use of internal cues for meal initiation (hunger) and the use of these cues for meal termination (satiation). Self-reported main reasons for meal termination are fullness, absence of hunger and a decrease of tastiness of the food (sensory-specific satiety) (Mook & Votaw, 1992; Tuomisto, Tuomisto, Hetherington & Lappalainen, 1998). Stomach distention and gut hormones are the internal processes that signal fullness and are used to decide meal termination. The feeling of being sated does not follow right after swallowing. The food and nutrients need to be digested and absorbed in the body before a person is able to detect the impact of it on the feeling of satiation. Therefor, the eating rate needs to be reduced to be able to feel sated on time and to prevent overeating.

For initiation of a meal the main reason appears not to come from internal cues, but is for most people regulated by external cues. In the study of Tuomisto, Tuomisto, Hetherington and Lappalainen (1998), only one out of five respondents report hunger as sign to start eating, while cues in the environment such as mealtime are mentioned as main trigger for meal initiation. According to these results, people mostly rely for meal termination on their internal cues, whereas for meal initiation environmental and cognitions factors are more influential.

People who rely on their internal cues of hunger and satiety are able to ignore the external cues and use for both initiation and termination of their meals their bodily signals.

2.3.1 Hunger, satiety and satiation signals

The increase and decrease of various hormones, gastronomical distention, and other physiological changes are accompanied by physical reactions of the body that can be detected by people. A decrease in satiety and thereby the feeling of hunger that in most cases leads to meal initiation, can be detected by a rumbling stomach. An empty stomach and a drop in the glucose level in the blood causes the brain to send out signals that make the stomach contract and consequently to make 'grumbling' noises (Hermann, Viard & Rogers, 2014). The phase of low blood sugar that is caused by decreased satiety also causes other physical discomforts that people can recognize as hunger signals that make them start eating. Also dizziness, muscle weakness, light-headedness, sweating, feeling confused and nervous, and lack of energy are symptoms people can experience when the blood sugar level is low and the body reports the need for food (ADA., 2014). Rather longer term effects of hunger are loss of concentration and an extraordinary focus on food (Polivy, 1996).

Feeling full is an abstract feeling caused by expansion of the stomach and the response of various GI hormones in the body (Woods, & D'Alessio, 2008). The bodily signs people can experience are a heavy or full feeling of the stomach, fatigue and rejection of eating any more.

2.3.2 The nature of hunger

When relying on internal cues, people need to be able to recognize the nature of the 'hunger-feeling'. The difference between physiological hunger, when the body needs food, and psychological desire to eat, when there is a craving for food for emotional, external directed or for social reasons, has to be detected. Smeets, Erkner & De Graaf (2010) focus in their study on cephalic phase responses (CPRs). CPRs are innate physical responses of the body to sensory cues and can be triggered by merely the sight or thought of food. The body responds to this cues by preparing itself for optimal consumption by increasing salivation, secretion of gastric acid, or the release of insulin (Smeets, Erkner & De Graaf, 2010). In this way, external cues can induce the internal signals. It needs to emphasized that people who rely on their internal cues, at the same time need to be capable of recognizing the nature of the cues and exclude external influences from their food intake regulation process.

Research furthermore emphasizes the difference between wanting and liking. The experience or pleasure around the eating moment is referred to as 'liking'. On the other hand, 'wanting' refers to the intrinsic desire to eat (Mela, 2006). When relying on internal cues, it is necessary to be able to detect if the source of the craving either is one of the above mentioned concepts or if it is real hunger that drives the need for food.

Furthermore, the boundary model of Herman and Polivy (1984) emphasizes an important characteristic of the food regulation of dieters that describes a behavioural pattern that is in contrast with how internal cue reliance should work. This model suggests that food intake is regulated within boundaries; on the left side the boundary for hunger, on the right the boundary for satiety, and in-between an area of 'biological indifference' (Rees, 1996). When situated in the left and right hunger and satiety boundary the body signals to initiate or terminate eating, whereas in the middle area cognitive and social factors take over the influence. Dieters

have a larger middle range as they hold on to food deprivation longer before accepting feelings of hunger and on the other hand in some circumstances eat a lot more that needed, which stretches the right boundary (Herman and Polivy, 1984). On the contrary, when relying on internal cues to regulate food intake, the middle boundary is a tighter. There is less room for external factors to take of food regulation and biological factors determine food intake.

2.4 Measurement of hunger, satiety and satiation

There are various ways to measure hunger, satiety and satiation. These three appetite related constructs are subjective and therefor have to be measured indirectly. The most common measurement methods are briefly described.

According to the review of Mattes, Hollis, Hayes, and Stunkard (2005), hunger and satiety are mentioned interchangeably and can be measured using multiple methods; using observations, biomarker measurements or questionnaires. The first way is to observe the volume of food intake as indicator of hunger or satiety (measuring the length of the non-eating interval). When a respondent relies solely on their internal cues to determine the volume of their intake, this could be a valid way to measure the constructs. This is however not the case is most situations, other variables as palatability and availability influence food intake (Yeomans, Blundell & Leshem, 2004).

The second way to measure hunger and satiety is to examine the levels of biomarkers in the body. Research about biomarkers that are related to the concepts of interest is still ongoing and has contradicting results. Biomarkers that claim to relate to hunger and satiety are for instance the glucose level in the bloodstream, presence of various gut peptides, and stomach distention (Mattes, Hollis, Hayes, and Stunkard, 2005).

Thirdly, hunger and satiety can be measured using the introspective quality of respondents in questionnaires. Visual analogue scales (VAS), where people have to indicate the hunger or fullness level by marking a point on a line, are often used (Flint, Raben, Blundell & Astrup, 2000). These scales come in various forms. Holt, Brand Miller, Petocz and Farmakalidis (1995), developed a 7-point scale and found that this scale gives more valid results than VAS to measure satiety (Figue 3).

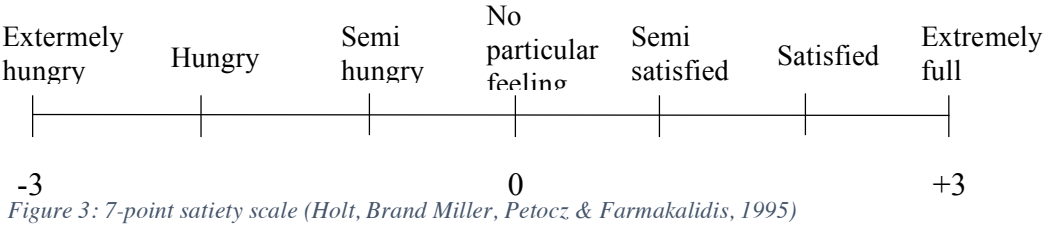

Figure 3: 7-point satiety scale (Holt, Brand Miller, Petocz & Farmakalidis, 1995)

Other ways to use scales to measure hunger or satiety are triangle scales, where the coloured area indicated satiety (Porrini, Crovetti, Riso, Santangelo & Testolin, 1995) and, especially for children, silhouettes with different stomach sizes tot chose from that indicate satiety (Faith, Kermanshah, Kissileff, 2002).

Another way to measure hunger and satiety via questionnaires is by using category scales. Instead of marking a point on a line as in VAS, respondents need to choose a category that corresponds with their hunger or satiety feeling (e.g. 'How hungry are you?', 1=not hungry

at all, 9=extremely full). Limitations are, same as for VAS, that people tend to avoid extremes and the difference between each category can be inconsistent (Benelam, 2009).

The Satiety Labelled Intensity Magnitude (SLIM) Scale of Cardello, Schutz, Lesher & Merril (2005) is found to be more reliable in measuring satiety. This vertical scale consists of eleven categories that contain hunger states that relate to how people perceive feelings of hunger and satiety. As illustrated in Figure 4, the intervals between the levels are unequal, indicating the inconsistency of gaps between the different stages as perceived by respondents (Merill, Cardello, Kramer, Lesher & Schutz, 2004).

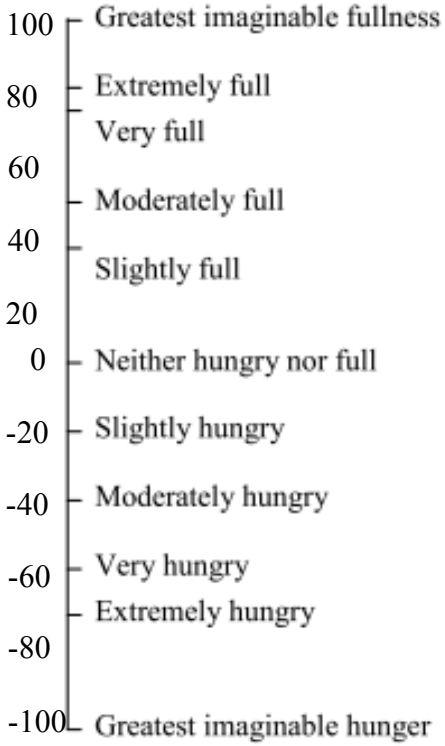

Figure 4: Satiety Labelled Intensity Magnitude. Modified from Merril, Cardello, Kramer, Lesher & Schutz, 2004)

The Grand Hunger Scale combines the measurement methods by asking four questions that together indicate the hunger level (Grand, 1968). The four indices of hunger included are:
1) time since last meal (estimated, rounded to closest interval of 15 minutes),
2) self-reported hunger rated on 7-point scale,
3) amount of favourite food respondent estimates to be able to eat, using a 6-point scale with ends 'none at all' and 'as much as I could get',
4) length of time until estimated next eating moment.

Measuring satiation is less complex and allows less variation in methods than the measurement of hunger and satiety. Benelam (2009) suggests respondents to be instructed to consume food *ad litbitum,* while their intake is examined to the point they stop eating and satiation is accomplished. To control for external variables that influence satiation, such as dietary restraint, palatability and variety, the best way to carry out this measurement is to use a laboratory setting in which these variables can be eliminated (Benelam, 2009).

2.5 Measurement of reliance on internal cues

There are multiple concepts that are related to the idea of eating with an internal focus. First, the concept of mindfulness will be reviewed and subsequently measurements of intuitive eating and external eating are discussed. These concepts and the measurement methods attached to the concepts are reviewed and their relevance for an internal reliance scale is assessed. Besides, the phase of the internal cue process (Figure 2) each method focusses on is pointed out.

2.5.1 Mindfulness

An overarching construct to this concept of internal cue reliance is mindfulness. This construct is can be described as non-judgmental awareness of the present and only focussing on the simple state of being at the present moment in a non-reactive and openhearted way (Kabat-Zinn, 2015). In the context of nutrition this idea is translated to mindful eating, which is described by Framson et al. (2009) as "non-judgmental awareness of physical and emotional sensations while eating or in a food-related environment", with listening to internal cues of the body as the main principle of this eating form. It can be seen as a counteract against the very common fast-paced lifestyles in the Western culture and it is gaining interest and popularity among medics (Monroe, 2015). To measure the presence of the trait mindful eating, Framsom (2009) developed the Mindful Eating Questionnaire (MEQ). This scale consists of twenty-eight items that are based on a combination of four existing eating behaviour questionnaires and six mindfulness-related questionnaires (Framson, 2009). The MEQ was distributed among seven convenience samples consisting of mostly white (90%) women (81%) with an average age of 42 years (range eighteen to eighty years). Five factors where found; disinhibition, distraction, awareness, emotional response, and external cues. The items within the factor labels 'disinhibition' and 'external cues' relate to the concept of internal cue reliance, as they measure respectively the tendency to overeat (e.g. "I stop eating when I'm full even when eating something I love") and the awareness of the influence of external cues (e.g. "I recognize when food advertisements make me want to eat"). The total MEQ scores showed a negative relationship with Body Mass Index and a positive relationship with intensity of yoga practice (Framson, 2009).

The items of the factor 'disinhibition' are mostly related to the last phase of the model, the response behaviour, as they ask questions about how people respond in a certain situation (i.e. when being in an all-you-can-eat restaurant or when eating something you love). The factor 'external cues' only includes items that refers to the evaluation phase in the model. The questions about the recognition of a cue in the environment as being misleading relates to the phase of evaluating the meaning of a certain cue.

2.5.2 Intuitive eating

Intuitive eating is similar to mindful eating as it also includes the principle of reliance on internal cues. This concept can be concisely defined as listening to, and relying on, internal physiological hunger and satiety cues to guide eating behaviour in deciding when, what and how much to eat (Herbert, Blechert, Hautzinger, Matthias & Herbert, 2013; Tylka, 2006). Although the focus in both the definition of mindful eating and intuitive eating is on reliance

on hunger and satiety cues, these eating forms also incorporate other principles. Tribole and Resh (1995) mention ten principles that are important to follow when practicing intuitive eating. These principles include for instance slowing down the pace of eating, reduction of portion sizes, using all senses, and no judgmental thoughts (i.e no 'good' or 'bad labels') about the food (Mathieu, 2009). Tylka and Kroon van Diest (2013) mention four main principles of intuitive eating. Next to 'Reliance on Hunger and Satiety Cues', they include the principles 'Eating for Physical Rather Than Emotional Reasons', 'Unconditional Permission to Eat', and 'Body–Food Choice Congruence'. In the article of Hawks, Merrill and Madanat (2004), intuitive eating is divided in the factors 'intrinsic eating', 'extrinsic eating', 'dieting', and 'self-care'.

Hawks, Merril and Madanat (2004), where the first to develop and publish a scale that measures intuitive eating (IES). The scale consists of twenty-seven items based on findings in literature about the subject and counselling of a panel of experts. When tested among 391 university students, scores showed positive associations with obesity, restrictive dieting and disordered eating (Hawks, Merril and Madanat, 2004). Of the four factors, that are mentioned above, the items under intrinsic eating and extrinsic eating show to be relevant for internal cue reliance. Items under these labels, such as "I seldom eat unless I notice that I am physically hungry" and "On social occasions, I feel pressure to eat the way those around me are eating—even if I am not hungry", could address to the level of reliance on internal cues.

The items that belong to the factors intrinsic and extrinsic eating of this scale are harder to classify as referring to one of the phases of the process model. However, it is safe to say that the focus in both the items of intrinsic and extrinsic is predominantly on response behaviour.

The Intuitive Eating Scale of Tylka (2006) is the most popular method to measure intuitive eating. This scale is based on the ten principles Tribole and Resch (1995) mention as being crucial to intuitive eating. The scale was tested among female university students and resulted to be negatively associated with BMI, dissatisfaction of the body, eating disorders, bad inner body awareness, adopting the thin ideal, and the pressure for being thin. Mental health indicators as overall well-being and self-esteem correlated negatively with the IES scores (Tylka, 2006). The first version of this scale consists of three factors; 'Unconditional Permission to Eat', 'Eating for Physical Rather Than Emotional Reasons', and 'Reliance on Hunger and Satiety Cues'. In 2013, Tylka and Kroon Van Diest improved the Intuitive Eating Scale (IES-2) by adding a fourth factor; 'Body– Food Choice Congruence', and by integrating seventeen new items. This scale was tested with a sample consisting both men and women and the IES-2 scores again show positive relations with various mental health indicators as self-esteem, satisfaction with life, appreciation of the body, and a negative relation with Body Mass Index (Tylka & Kroon Van Diest, 2013).

Evidently, the third factor 'Reliance on Hunger and Satiety Cues' contains items that could be integrated in the scale for internal cue reliance. This subscale consists of six items which focus on the reliance of internal cues to determine when, how much and what to eat. The items can be classified with certainty as focussing on the evaluation phase of the internal cue process. They answer to which extent an individual trusts its body, hunger and satiety cues to determine the food intake.

2.5.3 External eating

Internal cue reliance is earlier defined in this paper as *the recognition of bodily cues of hunger, satiation and satiety and trusting these cues to regulate food intake, while recognizing and disentangling external cues from this process.* Because this definition includes the importance of being able to detect and disentangle external cues, this construct also needs to be included in the measurement. To do so, the Dutch Eating Behaviour Questionnaire (DEBQ) of Van Strien (2010) can be integrated in the new scale. This questionnaire is divided in three subscales; 'Restraint Eating', 'Emotional Eating', and, most relevantly, 'External Eating'. This latter subscale consists of ten items that focus on questioning if an individual is sensitive to cues, such as smell of food or seeing others eating, in determining their own food intake. What is interesting, is that of the scores from the three factors, this subscale is the only one that does not relate to BMI (Van Strien, 2010).

The external cues mentioned in the questions can not be directly directed to the internal cue process model as it is about external instead of internal cues. If the model is seen in a broader perspective, the focus of the items in this subscale could be seen as being on the two last phases of the process. The questions contain both the evaluation of an external cue and the response behaviour that is generated by the evaluation of the cue.

The last scale that is reviewed is the scale developed by Wansink (2014). This scale uses only 6 items in total to address both internal and external reliance. What is interesting and unique in this scale, is that it focusses on merely on meal termination instead of a main focus on meal initiation, as the previous mentioned scales have. Meal termination and initiation are both important aspects of internal cue reliance. Therefor, this scale could be relevant to the development of the new scale in this paper. This scale's focus is on the behavioural phase.

The evaluation of these scales shows that although the scales identified in the literature touch upon the measurement of internal cue reliance, none of the measurements focusses solely on this concept and they do not comprehensively measure the theoretical constructs that it comprises. Hence, specific scale development for this concept is warranted. An overview of the items from existing scales that are used as input for the final the item pool can be found in Appendix 1: Input Existing Scales For Item Pool.

2.6 Key Constructs Internal Cue Reliance Scale

When summarizing the literature review, a few key constructs of the concept 'internal cue reliance' need to be emphasized. Firstly, the definition and the presented model illustrate different phases and factors of internal cues. From the definition four mechanisms appear to be important. The recognition of internal cues, the trust put on these cues to determine food regulation, the recognition of external cues, and the disentanglement of these cues for the process. These factors will be central in the scale development. The study of the definition of the concept thereby revealed the importance of three phases in the satiety cascade. Internal cues can refer to levels of hunger, satiety and satiation. It is important that this threefold is incorporated in a measurement scale for internal cue reliance. Furthermore, literature about the biomarkers for hunger, satiety and satiation highlight the difference between internal cues for meal initiation and meal termination. In the new scale, these two aspects both need to be

represented. This is the last key construct that needs to be accounted for in the new scale development.

3. Study 1: Scale development

In this chapter the first study is discussed. Firstly, the method that was used to conduct this study is described. Secondly, the further procedure and results are explained. Subsequently, a short interim conclusion is drawn that provides the base for the next study (Study 2: Validation).

3.1 Methodology

The structure of the methodology of the scale development is based on the review article of Worthington and Whittaker's (2006) who make recommendations that reflect best practices of scale development studies. The steps used in this study are 1) clear conceptual definition of the construct, 2), item pool generation, 3) measurement format choice, 4) experts review of items, 5) optimize scale length, 6) pre-test among small sample, and 7) inclusion choice of validation items. These steps result in the execution of the scale test (Study 1).

The first step about the defining of the construct is already dealt with in chapter 2, theoretical background. The second step, item pool generation, is also partly discussed in the previous chapter but is further elaborated in this chapter. The implementation of other steps is described below.

3.1.1 Item development

The four mechanisms that can be found in the definition of internal cue reliance – *recognition and trusting internal cues, recognition and disentanglement of external cues* – are leading in the further item pool creation. It is hypothesized that these four mechanisms form the four underlying factors in the scale. Items were added to match with each of the mechanisms to create a comprehensive pool of items. The review of existing scales in literature was conducted to determine whether items in these scales could be relevant for the internal cue reliance scale. Items from the scales that provided relevant input for one of the four factors were added to the item pool. From the Mindful Eating Scale (Framson, 2009), the Intuitive Eating Scale (Hawks, Merril and Madanat, 2004) and the Intuitive Eating Scale-2 (Tylka & Kroon Van Diest, 2013), items from the constructs 'disinhibition', 'intrinsic eating', 'extrinsic eating', and 'reliance on hunger and satiety cues' were used to create in the final item pool. Furthermore, the Dutch Eating Behaviour Questionnaire (Van Strien, 2012) provided items under the label 'external eating' cues' that were relevant for the item pool. The input from existing scales was combined with new items to form a comprehensive item pool that covered all of the four mechanisms.

The final Dutch item pool can be found in Appendix 2: Item Pool. The item pool consisted of 38 items. The four mechanisms; recognition of internal cues, trusting internal cues, recognition of external cues, and disentanglement of external cues contained respectively 9, 8, 9 and 12 items. The items were all described in the form of statements that can be answered using a 7-point Likert scale that ranged from *'never true to me'* to *'always true to me'*. The scale items were both negatively and positively written to reduce the response set bias and thereby increase validity.

Next to the items about the dimension of internal cue reliance, demographic questions about age, gender, weight, and length were added to the scale.

3.1.2 Experts review

Once developed, the items were spread out to a panel of experts in the area of adaptive eating, intuitive or mindful eating, healthy food intake and scale development. The experts evaluated the scale with its items and provided recommendations to improve the intelligibility and comprehensiveness of the scale. The experts made sure the scale encompassed all the aspects of internal cue reliance in an understandable way and that they conveyed the intended message.

3.1.3 Pre-test

To identify any unforeseen problems with the new measurement scale and to find possible solutions, a pre-test was conducted. The 38 items of the preliminary item pool were presented to a small group of respondents. The ten respondents reviewed each of the items on the clarity of the meaning and they gave their interpretation of the items and their opinion about them during a short interview. To be certain that items are comprehensible and unambiguous, the items were adjusted according to the feedback of the respondents.

3.1.4 Study population and procedure

The data for this study was collected in May 2016. The study is focussed on the Dutch population to exclude large cultural differences from this first measurement. Respondents were approached using an existing respondents mailing list of the chair group. Besides, the social network of the author was addressed.

The study was described as an investigation about the regulation of food intake. First, the respondents answered the questions about internal cue reliance. The demographic information, including information needed to calculate the BMI, was asked in the final section of the questionnaire. People are more likely to honestly answer these sensitive questions after being asked a list of other questions. The questionnaire was created in Qualtrics, an online programme that is used to create online surveys. All questions were written in Dutch, as the focus of this study is on the Dutch population.

A total of 243 respondents completed the questionnaire. The study sample consisted of 74 men and 169 women. The respondents ranged in age from 17 to 77 years (M = 29.30 years, SD = 11,12). The mean Body Mass Index (BMI) was 23,71 (calculated with the formula; weight / length * length) with a standard deviation of 4,23 and ranged from 17,01 to 52,83. A BMI score between 18,5 and 25 is seen as healthy.

3.1.5 Statistics

To asses the construct validity and gain insight in the dimensionality of the scale, exploratory factor analysis (EFA) was applied. In this analysis four factors were extracted in the EFA as this was the number of expected factors according to the literature. Furthermore, Cronbach's Alpha is used to measure to internal consistency reliability of the internal cue reliance items per factor. This number has to be >0.70 to ensure reliability. If removal of a certain item increases the reliability, this needs to be considered. To be able to use Cronbach's

Alpha correctly, the negatively written questions were reverse scored to ensure all high scores on a single item relate to a high score on the underlying construct. Then a confirmatory factor analysis was used to check whether the suggested model, that flowed from the previous EFA en reliability analysis, fits the data. Results of the CFA indicated whether the expected underlying subsets of the scale were present and provided information about the relation of the items to the factors and their usefulness and relevance for the scale. The CFA was conducted using the Lavaan package in the statistical programme R. Furthermore, R is used to asses the discriminant validity between the factors in the scale. For each factor-pair the change in chi-square score when the pair covariance is set to be 1 was tested for significance. To test if the demographic variables correlate with internal cue reliance, Pearson's R was used. This analysis indicated if variables as age and BMI show correlation with the level of internal cue reliance. To test if there are differences in gender means, an independent T-test was conducted. For these tests, the data was analysed using the statistical analysis software program SPSS.

3.2 Results

3.2.1 Exploratory Factor Analysis

The first step to gain insight in the factor structure of the scale was conducting an exploratory factor analysis (EFA) in the statistical programme SPSS. Because the literature study revealed that the scale consists four factors, the exploratory factor analysis was conducted for each of the factors separately. To evaluate the item fit to each of the factors, a factor analysis with Principal Axis Factoring was used. As correlated factors were not expected and the number of factors generated was supposed to be minimized into one general factor, Quartimax rotation was used as rotation type. The determine which items belonged to each factor, a cut-of value of a loading > 0.40 on the primary factor was used. To overcome cross-loading problems, only values < 0.32 on other factors than the primary factor were allowed (Tabachnick & Fidell, 1996). This method resulted in a total number of 21 items, with Factor 1 consisting of 4 items, Factor 2 consisting of 6 items, Factor 3 consisting of 6 items, and Factor 4 consisting of 5 items.

The next step was to evaluate the four factors on their reliability using Cronbach's Alpha. Factor 1 has a α=0.661. The other factors have a reliability indicator (α) of >0.70; Factor 2 α=0.811, Factor 3 α=0.774, and Factor 4 α=0.802. An overview of the Cronbach's Alpha scores can be found in Table 1: Cronbach's Alpha Reliabilty.

Table 1: Cronbach's Alpha Reliability

	Reliability Statistics		
Factor	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
Total scale	.761	.762	21
1. Recognize internal cues	.661	.663	4
2. Trust internal cues	.811	.812	6
3. Recognize external cues	.774	.774	6
4. Disentangle external cues	.802	.803	5

The exploratory factor analysis was again conducted over the new total item set of 21 items. The Kaiser–Meyer–Olkin measure of sampling adequacy (0.821) and the significance of Bartlett's test of sphericity (P-value <0.001) revealed that the items were suited to use for the factor analysis (Tabachnick & Fidell, 1996). To evaluate the structure of the scale, a factor analysis with Principal Axis Factoring was again used. As correlated factors were expected, Direct Oblimin was used as rotation type. To allow for a moderate correlation between factors, the delta weight was set at 0. To stay in line with the previous discussed theory around internal cue reliance, four factors were extracted from the total item set. The four factors had eigenvalues > 1.0. The cumulative percentage of variance accounted for by these factors together was 54,48%.

The pattern matrix was examined to determine if the total item set consisted of the four factors with the corresponding items per factor as the previous EFA per factor suggested. The EFA over the total item set revealed that the four factors were present. One item of Factor 4 (*It's hard to resist eating something good if it is around me, even if I'm not very hungry)* dropped out because it cross-loaded (with a loading of >0.32) on Factor 3. Also one item (*I recognize it when my body tells me to stop eating)* of Factor 1 was left out because it loaded solely on Factor 2, which is incongruent with the theory. This resulted in an item set with a total of 19 items, with each of the factor respectively containing 3, 6, 6, and 4 items.

3.2.2 Confirmatory Factor Analysis

To test the fit of the model with the four mechanisms as underlying factors in the scale, a confirmatory factor analysis (CFA) is conducted using Lavaan in the statistical programme R. The adequacy of the model fit was determined using three indices; the Comparative Fit Index (CFI); the Root Mean Square Error of Approximation (RMSEA); and the Standardized Root Mean Square Residual (SRMR) (Hu and Bentler, 1999). More specifically, CFI values of > 0.90, RMSEA values > 0.05 but < 0.08, and SRMR values < 0.08 indicate good fit of the model Kline (2010).

The first step in this analysis is to conduct CFA for each of the factors separately and for the total model. Table 2: Output CFA shows the outcomes of the three indices of fit of the analysis. The RMSEA score indicates the amount of misfit per degree of freedom (df). The small number of df in the analysis per factor bias this score. Therefor the other two indices (CFI and SRMR) are taken into account as leading indices of fit for this part of the analysis.

Table 2: Output CFA

	Confirmatory Factor Analysis		
Factor	CFI	RMSEA	SRMR
Total model	0.872	0.071	0.072
1. Recognize internal cues	0.993	0.045	0.025
2. Trust internal cues	0.941	0.136	0.060
3. Recognize external cues	0.885	0.139	0.062
4. Disentangle external cues	0.999	0.027	0.020

To further evaluate survey, the loadings of each of the items on the factors are taken into account. The items all appear to have significant P-values (<0.05).

The modification indices (MI's) that were retrieved in Lavaan provided further insight in the model fit. These indices show the level of covariance between two items and present the increase in the Chi-squared score if a certain pair is covariated or if one of the items is excluded from the item list. A cut-of value of >15 was used. This method revealed that deletion of one item of Factor 2 (*I trust my body to tell me when to eat*) would improve the Chi-squared and thereby the model fit as it showed high covariance with two items in the same factor. After deletion of this item the model fit indices of the total model improved; CFI = 0.897, RMSEA = 0.065, SRMR = 0.067. This resulted in an item set with a total of 18 items, with each of the factor respectively containing 3, 5, 6, and 4 items.

The modification indices also show the cross-loadings, which means that some items also appear to load on other factors than the factor they are supposed to load on. In confirmatory factor analysis, cross-loading is not a strict no-go but these items also need to be revised on their accuracy and usefulness with the underlying theory taken into account. According to the indices, no large (<15) cross-loading were present in the model. The new item set can be found in Appendix 3: Final Adjusted Item Pool.

3.2.3 Discriminant Validity

In this phase of the analysis the aim was to check whether the four factors were indeed four separate dimensions and were not correlated too high with each other. Again, Lavaan in R was used to conduct confirmatory factor analysis. The Chi-square score (χ^2) of the four (uncorrelated) factor model and the χ^2 of a model that suggests 2 factors have a covariance of 1 were compared. If the model fit decreased (i.e. χ^2 increased) when the covariance between each pair of factors is set at 1, it was shown that the factors were unique. To evaluate the significance of the increase in χ^2 score, the Critical Values of the Chi-square Distribution Table of Fields (2013) was used. The degrees of freedom increase each time with 1 as the covariance between two of the four factors is added. The table of Fields (2013) shows that for a change of 1 degree of freedom a critical value of >6.63 in the χ^2 score is significant (P <0.01). The χ^2 score of the four factor model was 261.43, the χ^2 score of covariated factor pairs increased significantly (χ^2 score ranged from 350 to 434). Furthermore, the Comparative Fit Index decreased when the covariance between factor pairs were set a 1.

3.2.4 Demographic variables correlation results

To have a first impression of the relation internal cue reliance has with the demographic variables, the output of Study 1 with only the data of the 18 items of the final adjusted model was used. The maximum result respondents could achieve on the 18 items is a total score of 126. The mean score of the respondents was 76.93 (SD = 10.96) and ranged from 44.00 to 103.00. Male respondents had a mean score of 76.36 (SD=11.33). Female respondents had a mean score of 77.17 (SD= 10.81). The results from the independent sample T-test show that this difference in mean score is not significant (P-value=0.605, CI=95%).

To test for correlation, Pearson's R is used. The results showed that internal cue reliance score is not significantly correlated with age (R= -0.065, P-value =0.313). Furthermore, the internal cue reliance score showed no correlation with BMI (R=-0.090, P-value=0.163).

3.3 Discussion Study 1

The goal of this research was to close the knowledge gap in literature about reliance on internal physiological hunger and satiety cues by developing a new scale that specifically measures this construct. This first study took a first step in developing this scale. The hypothesis that flowed from the literature was that the internal cue reliance consists of four underlying mechanisms; (1) recognition of internal cues, (2) trust put on these cues to determine food regulation, (3) recognition of external cues, (4) disentanglement of external cues from the process. Other key concepts for internal cue reliance appeared to be the three phases of hunger, satiety, and satiation and the difference in internal cues for meal initiation and meal termination.

The exploratory factor analysis showed that the four expected mechanisms that together form internal cue reliance, were present in the scale. This method provided a four factor scale with an item total of 19 items. The confirmatory factor analysis showed that this model has an adequate fit to the data. The modification indices of this method improved the model by suggesting deletion of one item, which made the study result in a four factor scale with each factor containing respectively 3, 5, 6, and 4 items. Furthermore, the discriminant validity test of the factors showed that the scale consists of four unique factors.

The correlation tests of internal cue reliance with the demographic variables age, gender, and BMI showed that internal cue reliance does not have a significant influence on these variables. Especially the last relation (internal cue reliance – BMI) was of interest as this relation is found in existing literature. However, this result is only an indication of this relationship as its based on partial data of the total study. In the second study this relation is revised. In the survey of the second study the health indicator ‘weight fluctuation’ is added, as the interest in health benefits internal cue reliance does relate to increased. Weight fluctuation is seen as a health outcome that relates negatively with internal cue reliance. Based on the Restraint Scale of Herman et al. (1978), three items were added to the survey to measure weight fluctuation of respondents. The three items together indicate the level of weight fluctuation of an individual.

4. Study 2: Validation

The second phase of the study consisted of the validation part. The scale measuring internal cue reliance was tested and at the same time the predictive value of the internal cue reliance scale was evaluated. The items in this scale slightly differ from the items the first study concluded with, as the analysis of the first study was adjusted in a later stage of the total study. The English and Dutch version of the items measuring internal cue reliance as presented to respondents for this study can be found in respectively Appendix 4 and Appendix 5: Item Pool Study 2. In this chapter the methodology and results of the second study are described.

4.1 Methodology

4.1.1 Validation

To measure the predictive value of the scale, a validation part was added to the study. With this validation the relation between the scale outcome and certain expected behaviour is tested. This part is thus meant to measure if the outcomes of the scale predict the behaviour it is supposed to be connected with. The validation part consisted of 16 behaviour items each referring to one of the four factors in the scale. The items are based on behavioural actions that according to literature should lead to a healthy lifestyle and on their fit to the theory around internal cue reliance. For example, Wansink (2010) suggests certain actions to overcome the temptation of external cues such as the sight of food or distraction during eating. Items added in the survey that relate to this theory and internal cue reliance for example are about storing away tempting food, eating in a calm pace and without distractions, and finishing portions. The total list with the behaviour items, each assigned a factor, can be found in both the Dutch and English version in Appendix 6 and Appendix 7: Behavioural items.

4.1.2 Study population and procedure

The data for this study was collected in June 2016. The study is focussed on the Dutch population to exclude large cultural differences from this first measurement. Respondents were again approached using an existing respondents mailing list of the chair group, different from the list in the first study.

The study was again described as an investigation about the regulation of food intake. First, the respondents answered the questions about internal cue reliance. After this, the behavioural items were presented to the respondents. The questionnaire concluded with questions about demographics. Besides age, gender, length, and weight, respondents answered 3 items to measure weight fluctuation. The questionnaire was created in Qualtrics, an online programme that is used to create online surveys. All questions were written in Dutch, as the focus of this study is on the Dutch population.

A total of 214 respondents completed the questionnaire. The study sample consisted of 52 men and 162 women. The respondents ranged in age from 18 to 68 years (M = 43.24 years, SD = 17.90). The mean Body Mass Index (BMI) was 24.21 (calculated with the formula; weight / length * length) with a standard deviation of 4.10 and ranged from 14.69 to 40.53. A BMI score between 18.5 and 25 is seen as healthy.

4.1.3 Statistics

To test the internal consistency reliability of the items in the four factors Cronbach's Alpha was used. The correlation of the scale with the demographic variables was tested conducting Pearson's R for age, BMI, and weight fluctuation and an independent T-test for gender. Cronbach's Alpha showed if the behavioural items per factor were reliable. Finally, to test if the behavioural items are predicted by the scale score, Pearson's R was again used for both the total score on behavioural items per factor and the behaviour items individually.

4.2 Results

4.2.1 Reliability

To measure the internal consistency reliability of the factors Cronbach's Alpha is used as indicator. Table 3: Reliability factors provides an overview of the outcomes of the total scale and per factor.

Table 3: Reliability factors

	Reliability Statistics		
Factor	Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
Total scale	.813	.817	19
Recognize internal cues	.698	.698	4
Trust internal cues	.820	.818	4
Recognize external cues	.846	.851	6
Disentangle external cues	.813	.805	5

The total scale, factor 2, factor 3, and factor 4 show to have a Cronbach's Alpha >0.70. Factor 1 did not reach this standard (α=0.698).

4.2.2 Demographic variables correlation results

The scores respondents could achieve has a range of 19 to 133. The mean score of the respondents was 86.28 (SD = 14.25) and ranged from 39.00 to 132.00. Male respondents had a mean score of 84.30 (SD=15.50). Female respondents had a mean score of 86.91 (SD= 13.82). The results from the independent sample T-test show that this difference in mean score is not significant (P-value=0.282, CI=95%).

Pearson's R is used to test for correlation between age and internal cue reliance score. The results showed that internal cue reliance score is not significantly correlated with age (R= 0.041, P-value =0.556). However, the internal cue reliance score did show a slight negative correlation with BMI (R=-0.268, P-value=0.001). To measure weight fluctuation, three items

were added. When adding the scores on these items and testing on the correlation with internal cue reliance, a significant negative correlation was found (R=-0.208, P-value=0.002). According to the Cronbach's Alpha of the weight fluctuation scale the scale is not reliable (α=0.673). When the first item (*What is the maximum amount of weight you have ever lost within 1 month?*) was deleted, the scale was reliable (α=0.750). Therefor, the correlation with each of the items was measured separately. The first item showed to have no correlation with internal cue reliance (R=-0.013, P-value=0.846). The second (*What is the maximum amount of weight gain within a week?*) and third item (*In a typical week, how much does your weight fluctuate?)* did show negative correlation (resp. R=-0.209, P-value=0.002 and R=-0.254, P-value=0.00).

4.2.3 Validation behavioural items

To test whether the behavioural items per factor together form a reliable scale, the Cronbach's Alpha for each of the factor behaviours was retrieved. The behavioural items corresponding to Factor 1 had α= 0.506, Factor 2 α=0.506, Factor 3 α=0.672, and the behavioural items of Factor 4 α=0.343. It appeared that non of these behaviour groups meets the reliability standard of $\alpha > 0.70$. The behavioural items of all factors together did meet the reliability standard with a $\alpha = 0.708$.

The next step was to test for correlation between the total score per factor and the total score of the corresponding behavioural items per factor. From the reliability analysis it appeared that the behavioural items per factor did not form reliable scales. Therefor, the correlation between the total factor scores and the behavioural items individually were also retrieved. To test for these correlations Pearson's Correlation is used. Table 4: Correlation matrix factor-behaviour shows the results of this test. The results that show significant (P-value <0.05) correlations between behaviour scores and the factor it corresponds with are indicated in bold.

All of the total behaviour item score per factor appeared to correlate significantly with the corresponding factor. The behavioural items individually however appeared to not all correlate significantly with the corresponding factor. The first behavioural item of Factor 1, the last two behavioural items of Factor 2, three of the behavioural items of Factor 3, and the third and last items of Factor 4 did not correlate with the factor they were supposed to relate to. The items almost all did show significant correlation with the total scale score. The last three items of the behaviours of Factor 4 did not correlate to the total score. Furthermore, most behavioural items correlated significantly (next to the corresponding factor) with other factors. Some high correlations between behaviour and the total scale score can be found in the table. For instance, the behavioural item "*I eat as much as my body tells me it needs*" appears to highly correlate with internal cue reliance. Also, items about eating quickly and the completion compulsion show high correlation scores with internal cue reliance.

The total score of the behavioural items of all the factors together appeared to correlate positively with all the factors and with the total scale score.

Table 4: Correlation matrix factor-behaviour

	Factor 1	*Factor 2*	*Factor 3*	*Factor 4*	*Total sore*
Total behaviour items Factor 1	**R= .331 Sig = .000**	R = .228 Sig =.001	R = .163 Sig = .017	R= .292 Sig = .000	R = .379 Sig = .000
I always eat at the table..	R = .094 Sig = .196	R = .076 Sig = .269	R = .112 Sig = .101	R = .101 Sig = .139	R = .155 Sig = .000
I take time for each meal..	**R = .332 Sig = .000**	R = .182 Sig = .008	R = .091 Sig = .183	R = .351 Sig = .000	R = .359 Sig = .000
After diner I wait..	**R = .256 Sig = .000**	R = .232 Sig = .001	R = .140 Sig = .041	R = .196 Sig = .004	R = .311 Sig = .000
Total behaviour items Factor 2	R= .401 Sig = .000	**R = .534 Sig = .000**	R = -.014 Sig = .843	R = .437 Sig = .000	R = .485 Sig = .000
I only eat when I am hungry	R = .309 Sig = .000	**R = .466 Sig = .000**	R = -.087 Sig = .204	R = .368 Sig = .000	R = .368 Sig = .000
I eat as much as my body..	R = .439 Sig = .000	**R = .573 Sig = .000**	R = .036 Sig = .598	R = .386 Sig = .000	R = .513 Sig = .000
After a meal, my stomach..	R = .164 Sig = .016	R = .110 Sig = .107	R = -085 Sig = .217	R = .432 Sig = .000	R = .232 Sig = .001
I regularly count calories..	R = .119 Sig = .184	R = .184 Sig = .007	R = .055 Sig = .427	R = .047 Sig = .491	R = .146 Sig = .032
Total behaviour items Factor 3	R = .391 Sig = .000	R = .202 Sig = .003	**R = .201 Sig = .003**	R = .339 Sig = .000	R = .460 Sig = .000
I am aware of temptations..	R = .315 Sig = .000	R = .076 Sig = .271	**R = .413 Sig = .000**	R = .032 Sig = .637	R = .340 Sig = .000
I eat quickly and do not..	R = .418 Sig = .000	R = .250 Sig = .000	R = -.029 Sig = .667	R = .515 Sig = .000	R = .418 Sig = .000
When food is offered..	R = .245 Sig = .000	R = .244 Sig = .000	R = .052 Sig = .447	R = .406 Sig = .000	R = .360 Sig = .000
On a party, I am aware of..	R = .171 Sig = .012	R = .024 Sig = .732	R = .147 Sig = .032	R = .193 Sig = .005	R = .216 Sig = .001
Total behaviour items Factor 4	R = .254 Sig = .000	R = .200 Sig = .003	R = .039 Sig = .569	**R = .400 Sig = .000**	R = .338 Sig = .000
I refuse food that other offer..	R = .283 Sig = .000	R = .302 Sig = .000	R = -.038 Sig = .581	**R = .476 Sig = .000**	R = .376 Sig = .000
When there is a small portion left..	R = .305 Sig = .000	R = .344 Sig = .000	R = -.155 Sig = .023	**R = .781 Sig = .000**	R = .471 Sig = .000
There is little variation..	R = -.058 Sig = .398	R = .029 Sig = .675	R = . 062 Sig = .370	R = -.105 Sig = .127	R = -.021 Sig = .761
I put external temptations..	R = .029 Sig = .674	R = -.145 Sig = .034	R = .183 Sig = .007	**R = -.139 Sig = .042**	R = -.010 Sig = .883
There is no difference in..	R = .116 Sig = .090	R = .036 Sig = .707	R = .042 Sig = .545	R = .058 Sig = .400	R = .088 Sig = .197
Total behavioural items all factors	R = .489 Sig = .000	R = .411 Sig = .000	R = .144 Sig = .035	R = .556 Sig = .000	R = .600 Sig = .000

4.3 Discussion Study 2

The aim of the second study was to validate the predictive value of the developed internal cue reliance scale. First, the reliability of the scale was shown as the reliability indicator (Cronbach's Alpha) provided high results on both the individual factors as the total scale.

The validation part was set up by attaching healthy behavioural items to each factor. From the analysis it appeared that the behavioural items should not to be divided according to the four factors. The indicators for this conclusion were that the behavioural items per factor did not appear to be reliable scales, and the individual behavioural items mostly correlated significantly to multiple factors. The behavioural items could not be grouped probably because the items all contained a different focus of healthy behaviour, for instance eating pace and behaviour at a party, made a too wide range of behavioural actions to capture them as one.

The behavioural items of all factors together did appear to be a reliable scale and the total behavioural item score also did correlate significantly with all the individual factors and the total factor score. Therefor, the behavioural items should be considered all together as being an outcome of healthy behaviour and a health indicator. With this assumption being made, it can be concluded that the internal cue reliance scale did predict healthy behaviour. In future research the behavioural items included need to be evaluated on their relevance for the total scale and their connection to each of the four factors.

In addition, Body Mass Index and items of weight fluctuation showed to have a slight negative relation with the internal cue reliance score. Thus, in line with the existing literature on similar constructs, internal cue reliance showed to have a positive influence on physical health indicators of people.

To conclude, according to the second study, people who rely more on their internal cues are healthier as they show healthier behaviour, have a lower BMI and their weight fluctuates less. The developed scale can be used as an information source in the research on how to create healthier lifestyles and thereby help in solving the obesity problem.

5. General Conclusion and Discussion

In the two studies, the development of a scale to measure reliance on internal cues of hunger and satiety and satiation was discussed, the factor structure was evaluated, and its reliability and predictive value were tested. Reliance on internal cues of hunger and satiety and satiation, referred to as internal cue reliance, consists of four main mechanisms: 1) the recognition of internal cues; 2) the trust put on these cues to determine food regulation; 3) the recognition of external cues; 4) and the disentanglement of these cues for the process.

The first study consisted of both an exploration and confirmation of factor structure of the scale. This study revealed that the four expected factors were present in the scale and a model formed by 18 items with good fit to the data. The second study consisted of a validation part and revealed that internal cue reliance has a positive effect on healthy behaviour and therefor predicts a healthier lifestyle. Furthermore, internal cue reliance appeared to have a positive influence on the physical health indicators BMI and weight fluctuation. These indicators of better health stress the importance of gaining insight in the construct internal cue reliance and the usefulness of a scale that measures it. Other existing scales, for instance on mindful eating and intuitive eating, measure more overarching constructs and do not extensively investigate and specify their main principle of relying on internal cues. This scale is totally new and is unique from the existing scales as it specifically measures reliance on bodily cues of hunger and satiety. This study did extensively investigate the construct and found four important underlying mechanisms that together form the construct.

A matter that needs to be pointed out, concerns a general limitation of scale development. Internal cue reliance is a personality trait which in theory needs to be measured by assessing the brain functioning. However, in practice the closest way to measure a trait is by investigating associated behaviour. By describing the questions as concrete as possible, it was attempted to reduce the bias of the possible difference between reported self-reporting behaviour and the trait.

This study furthermore relies on self-report methodology, which can also be a limitation as it assumes people are able to accurate report their behaviour. It could be that the perception of eating patterns may or may not reflect the actual behaviour. Besides, in the current study the validation part was questioned right after the scale was answered. Respondents might feel that they need to be consistent to their earlier answers. Future research should therefor focus on validating the scale outcomes and reveal the correlation between self-reported an actual eating behaviour. This could be done by using an experimental real-life setting - for example a completion compulsion test - which appears to be independent of the questionnaire.

In the first study the relationship between internal cue reliance and Body Mass Index (BMI) as suggested in existing literature, was not confirmed. In the second study, internal cue reliance however did show to have a negative relationship with both BMI and the added health indicator weight fluctuation. It has to be noted that the items in the questionnaire of Study 1 and Study 2 were slightly different. The difference in findings related to these physical health indicators can be a result of this difference in item set. Furthermore, although age has no significant influence on internal cue reliance, the large age difference in the samples between the two studies (approx. 15 years' difference in mean age) can be another reason for the results to differ. Future research should be aimed at further investigating this relationship.

In this study, the behavioural items could not be grouped according the four factors of the scale. The reason for this could be that the behavioural items were not specific enough in their focus on a certain area of behaviour. Future research could further investigate whether there is certain behaviour that solely corresponds to one of the factors.

Another note that has to be made is that in this study, the current health situation of respondents is not taken into account. Diet history, current dieting, eating disorders, and diseases could influence the score of internal cue reliance and its relationship and impact could be further investigated. Besides that, to further validate the influence of the scale, more health indicators could be tested on their relationship with internal cue reliance. Not only physical health indicators could be incorporated, but also more mental health indicators as body satisfaction, overall wellbeing, and activity level can be concepts of interest.

The last important implication for future research is the need to focus on determining the best way to steer or learn people to rely more on their internal cues and neglect external cues. It is now known that this could be beneficial to improve the health of people, and it should be possible to learn to rely on internal signals. The exact way to achieve this trait on a longer term needs to be investigated.

If future research further develops and confirms the validity and reliability of the internal cue reliance scale, the scale may be an important tool in the health industry. For instance, this scale might be used to investigate the improvement in adaptive eating behaviour after a certain treatment. To date, the focus in literature and practices around improvement of health is mainly on adjusting the environment and learning to repel unhealthy external signals. This study showed that the emphasis of research should shift to learning to rely on internal cues. The developed scale in this study was a first step in expanding the knowledge about this construct. It contributes to solving the obesity problem and thereby supports the movement towards a healthier society.

References

ADA. (2014). Good to Know - Hypoglycemia, *30*(1), 30.

Augustus-Horvath, C. L., & Tylka, T. L. (2011). The acceptance model of intuitive eating: a comparison of women in emerging adulthood, early adulthood, and middle adulthood. *Journal of Counseling Psychology*, *58*(1), 110–125. http://doi.org/10.1037/a0022129

Bacon, L., Stern, J. S., Van Loan, M. D., & Keim, N. L. (2005). Size Acceptance and Intuitive Eating Improve Health for Obese, Female Chronic Dieters. *Journal of the American Dietetic Association*, *105*(6), 929–936. http://doi.org/10.1016/j.jada.2005.03.011

Benelam, B. (2009). Satiation, satiety and their effects on eating behaviour. *Nutrition Bulletin*, *34*(2), 126–173. http://doi.org/10.1111/j.1467-3010.2009.01753.x

Berman, M. I., Morton, S. N., & Hegel, M. T. (2015). Health at Every Size and Acceptance and Commitment Therapy for Obese, Depressed Women: Treatment Development and Clinical Application. *Clinical Social Work Journal*. http://doi.org/10.1007/s10615-015-0565-y

Birch, L. L., Johnson, S. L., Andresen, G., Petersen, J. C., & Schulte, M. C. (1991). The variability of young children's energy intake. *New England Journal of Medicine*, 324, 232–235.

Birch, L. L., & Fisher, J. O. (2000). Mothers' child-feeding practices influence daughters' eating and weight. *American Journal of Clinical Nutrition,* 71, 1054–1061.

Blundell, J. E., Rogers, P. J., & Hill, A. J. (1987). Evaluating the satiating power of foods: implications for acceptance and consumption. In J. Colms, D. A. Booth, R. M. Pangborn, & O. Raunhardt (Eds.), *Food acceptance and nutrition*. (pp. 205 - 219)

Blundell, J. E. (1991). Pharmacology of appetite control. *Trends in Pharmacological Sciences*, 12, 147–157.

Blundell, J. E., Lawton, C. L., Cotton, J. R., & Macdiarmid, J. I. (1996). Control of human appetite: implications for the intake of dietary fat. *Annual Review of Nutrition*, *16*, 285–319. http://doi.org/10.1146/annurev.nutr.16.1.285

Braude, L., & Stevenson, R. J. (2014). Watching television while eating increases energy intake. Examining the mechanisms in female participants. *Appetite*, *76*, 9–16. http://doi.org/10.1016/j.appet.2014.01.005

Cairns, G., Angus, K., Hastings, G., & Caraher, M. (2013). Systematic reviews of the evidence on the nature, extent and effects of food marketing to children. A retrospective summary. *Appetite*, *62*, 209–15. doi:10.1016/j.appet.2012.04.017

Cappelleri, J. C., Bushmakin, a G., Gerber, R. a, Leidy, N. K., Sexton, C. C., Karlsson, J., & Lowe, M. R. (2009). Evaluating the Power of Food Scale in obese subjects and a general sample of individuals: development and measurement properties. *International Journal of Obesity (2005)*, *33*(8), 913–922. http://doi.org/10.1038/ijo.2009.107

Cardello, A. V., Schutz, H. G., Lesher, L. L., & Merrill, E. (2005). Development and testing of a labeled magnitude scale of perceived satiety. *Appetite*, *44*(1), 1–13. http://doi.org/10.1016/j.appet.2004.05.007

Corsica, J. a., & Hood, M. M. (2011). Eating disorders in an obesogenic environment. *Journal of the American Dietetic Association*, *111*(7), 996–1000. doi:10.1016/j.jada.2011.04.011

De Graaf, C., Blom, W. A. M., Smeets, P. A. M., Stafleu, A., & Hendriks, H. F. J. (2004). Biomarkers of satiation and satiety. *American Journal of Clinical Nutrition*, *79*(6), 946–961.

Due, A., Karhunen, L., Saarela, M., & Lyly, M. (2009). Satiety , weight management and foods. *Health (San Francisco)*, (January), 163.

Faith, M. S., Kermanshah, M., & Kissileff, H. R. (2002). Development and preliminary validation of a silhouette satiety scale for children. *Physiology and Behavior*, *76*(2), 173–178. http://doi.org/10.1016/S0031-9384(02)00702-3

Field, A. (2013). *Discovering statistics using IBM SPSS statistics* (pp. 898). Londen, England: Sage

Fisher, J. O., & Kral, T. V. E. (2008). Super-size me: Portion size effects on young children's eating. *Physiology and Behavior*, *94*(1), 39–47. http://doi.org/10.1016/j.physbeh.2007.11.015

Flint, A., Raben, A., Blundell, J. E., & Astrup, A. (2000). Reproducibility, power and validity of visual analogue scales in assessment of appetite sensations in single test meal studies. *International Journal of Obesity and Related Metabolic Disorders : Journal of the International Association for the Study of Obesity*, *24*(1), 38–48. http://doi.org/10.1038/sj.ijo.0801083

Folkvord, F., Anschütz, D. J., Wiers, R. W., & Buijzen, M. (2015). The role of attentional bias in the effect of food advertising on actual food intake among children. *Appetite*, *84*, 251–8. doi:10.1016/j.appet.2014.10.016

Framson, C., Kristal, A. R., Schenk, J. M., Littman, A. J., Zeliadt, S., & Benitez, D. (2009). Development and validation of the mindful eating questionnaire. *Journal of the American Dietetic Association*, *109*(8), 1439–44. http://doi.org/10.1016/j.jada.2009.05.006

Gagnon-Girouard, M. P., Bégin, C., Provencher, V., Tremblay, A., Mongeau, L., Boivin, S., & Lemieux, S. (2010). Psychological impact of a "health-at-every-size" intervention on weight-preoccupied overweight/obese women. *Journal of Obesity*, *2010*, 7–10. http://doi.org/10.1155/2010/928097

Gast, J. & Hawks, S.R. (1998). Weight loss education: the challenge of a new paradigm. *Health Education Behaviour,* 25, 464–473.

Grand, S. (1968). Color-Word Interference: an Investigation of the Role of Vocal Conflict and Hunger in Associative Priming. *Journal of Experimental Psychology*, *77*(1), 31–40. http://doi.org/10.1037/h0025759

Green, S. M., Delargy, H. J., Joanes, D., & Blundell, J. E. (1997). A satiety quotient: a formulation to assess the satiating effect of food. *Appetite*, *29*(3), 291–304. http://doi.org/06/appe.1997.0096

Havermans, R. (2012). Sensory-specific satiety and the variety effect. *Appetite*, *59*(2), 627. http://doi.org/10.1016/j.appet.2012.05.070

Hawks, S., Merrill, R. M., & Madanat, H. N. (2004). The Intuitive Eating Scale: Development and Preliminary Validation. *American Journal of Health Education*, *35*(2), 90–99. http://doi.org/10.1080/19325037.2004.10603615

Hawley, G., Horwath, C., Gray, A., Bradshaw, A., Katzer, L., Joyce, J., & O'Brien, S. (2008). Sustainability of health and lifestyle improvements following a non-dieting randomised

trial in overweight women. *Preventive Medicine*, *47*(6), 593–599. http://doi.org/10.1016/j.ypmed.2008.08.008

Herbert, B. M., Blechert, J., Hautzinger, M., Matthias, E., & Herbert, C. (2013). Intuitive eating is associated with interoceptive sensitivity. Effects on body mass index. *Appetite*, *70*, 22–30. doi:10.1016/j.appet.2013.06.082

Herman, C. P. (2015). The social facilitation of eating. A review. *Appetite*, *86*, 61–73. http://doi.org/10.1016/j.appet.2014.09.016

Herman, C., & Polivy, J. (1984). A boundary model for the regula- tion of eating. In A. Stunkard & E. Stellar (Eds.), *Eating and its disorders* (pp. 141-156). New York: Raven Press.

Hermann, G. E., Viard, E., & Rogers, R. C. (2014). Hindbrain glucoprivation effects on gastric vagal reflex circuits and gastric motility in the rat are suppressed by the astrocyte inhibitor fluorocitrate. *The Journal of Neuroscience : The Official Journal of the Society for Neuroscience*, *34*(32), 10488–96. http://doi.org/10.1523/JNEUROSCI.1406-14.2014

Holt, S., Brand Miller, J., Petocz, P., & Farmakalidis, E. (1995). A satiety index of common foods. *European Journal of Clinical Nutrition*, *49*, 675–690.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal*, *6*(1), 1–55. http://doi.org/10.1080/10705519909540118

Kabat-Zinn, J. (2015). Mindfulness. *Mindfulness*, *6*(6), 1481–1483. http://doi.org/10.1007/s12671-015-0456-x

Kline, R. B. (2010). *Principles and practice of structural equation modeling (3rd ed.)*. New York, New York: Guilford Press.

Kristeller, J. L., & Hallett, C. B. (1999). An Exploratory Study of a Meditation-based Intervention for Binge Eating Disorder. *Journal of Health Psychology*, *4*(3), 357–363. http://doi.org/10.1177/135910539900400305

Leblanc, V., Provencher, V., Begin, C., Corneau, L., Tremblay, A., & Lemieux, S. (2012). Impact of a Health-At-Every-Size intervention on changes in dietary intakes and eating patterns in premenopausal overweight women: Results of a randomized trial. *Clinical Nutrition*, *31*(4), 481–488. http://doi.org/10.1016/j.clnu.2011.12.013

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

MacCallum, R. C., Browne, M. W., & Sugawara, H. M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychological Methods*, *1*(2), 130–149. http://doi.org/10.1016/S1726-4901(09)70399-5

Mathieu, J. (2009). What Should You Know about Mindful and Intuitive Eating? *Journal of the American Dietetic Association*, *109*(12), 1982–1987. http://doi.org/10.1016/j.jada.2009.10.023

Mattes, R. D., Hollis, J., Hayes, D., & Stunkard, A. J. (2005). Appetite: Measurement and manipulation misgivings. *Journal of the American Dietetic Association*, *105*(5 SUPPL.), 87–97. http://doi.org/10.1016/j.jada.2005.02.029

Mccrickerd, K., & Forde, C. G. (2015). Sensory influences on food intake control: Moving beyond palatability. *Obesity Reviews*. http://doi.org/10.1111/obr.12340

Merrill, E. P., Cardello, A. V., Kramer, F. M., Lesher, L. L., & Schutz, H. G. (2004). The development of a perceived satiety index for military rations. *Food Quality and Preference*, *15*(7-8 SPEC.ISS.), 859–870. http://doi.org/10.1016/j.foodqual.2004.04.001

Monroe, J. T. (2015). Mindful Eating : Principles and Practice, *XX*(X), 1–4. http://doi.org/10.1177/1559827615569682.

Mook, D. G., & Votaw, M. C. (1992). How important is hedonism? Reasons given by college students for ending a meal. *Appetite*, *18*(1), 69–75. http://doi.org/10.1016/0195-6663(92)90211-N

Osei-Assibey, G., Dick, S., Macdiarmid, J., Semple, S., Reilly, J. J., Ellaway, A., … McNeill, G. (2012). The influence of the food environment on overweight and obesity in young children: a systematic review. *BMJ Open*, *2*(6), e001538–. doi:10.1136/bmjopen-2012-001538

Passamonti, L., Rowe, J. B., Schwarzbauer, C., Ewbank, M. P., Von Dem Hagen, E., & Calder, A. J. (2009). Behavioral/Systems/Cognitive Personality Predicts the Brain's Response to Viewing Appetizing Foods: The Neural Basis of a Risk Factor for Overeating, *29*(1), 43–51. doi:10.1523/JNEUROSCI.4966-08.2009

Polivy, J. (1996). Psychological consequences of food restriction. *Journal of the American Dietetic Association*. http://doi.org/10.1016/S0002-8223(96)00161-7

Porrini, M., Crovetti, R., Riso, P., Santangelo, A., & Testolin, G. (1995). Effects of physical and chemical characteristics of food on specific and general satiety. *Physiology and Behavior*, *57*(3), 461–468. http://doi.org/10.1016/0031-9384(94)00242-W

Raynor, H. A., & Epstein, L. H. (2001). Dietary variety, energy regulation, and obesity. *Psychological Bulletin*, *127*(3), 325–341. http://doi.org/10.1037//0033-2909.127.3.325

Rees, K. B. (1996). A feminist therapy application of the boundary model with obese female binge eaters, *116*, 111–116.

Renner, B., Sproesser, G., Strohbach, S., & Schupp, H. T. (2012). Why we eat what we eat. The Eating Motivation Survey (TEMS). *Appetite*, *59*(1), 117–28. http://doi.org/10.1016/j.appet.2012.04.004

Rolls, B. J., Roe, L. S., Kral, T. V. E., Meengs, J. S., & Wall, D. E. (2004). Increasing the portion size of a packaged snack increases energy intake in men and women. *Appetite*, *42*(1), 63–69. http://doi.org/10.1016/S0195-6663(03)00117-X

Schachter, S. (1971). Some extraordinary facts about obese humans and rats. *The American Psychologist*, *26*(2), 129–144. doi:10.1037/h0030817

Slavin, J., & Green, H. (2007). Dietary fibre and satiety. *Nutrition Bulletin*, *32*(SUPPL.1), 32–42. http://doi.org/10.1111/j.1467-3010.2007.00603.x

Smeets, P. A. M., Erkner, A., & De Graaf, C. (2010). Cephalic phase responses and appetite. *Nutrition Reviews*, *68*(11), 643–655. http://doi.org/10.1111/j.1753-4887.2010.00334.x

Stubbs, J., Ferres, S., & Horgan, G. (2000). *Energy density of foods: Effects on energy intake*. *Critical Reviews in Food Science and Nutrition* (Vol. 40). http://doi.org/10.1080/10408690091189248

Tabachnick, B. G.,& Fidell, L. S. (1996). Using multivariate statistics (3rd ed.). New York: HarperCollins.

Tribole, E. & Resch, E. (1995). *Intuitive Eating: A Revolutionary Program that Works*. New York, NY: St. Martin's Press.

Tuomisto, T., Tuomisto, M. T., Hetherington, M., & Lappalainen, R. (1998). Reasons for initiation and cessation of eating in obese men and women and the affective consequences of eating in everyday situations. *Appetite*, *30*(2), 211–222. http://doi.org/S0195666397901422

Tylka, T. L. (2006). Development and psychometric evaluation of a measure of intuitive eating. *Journal of Counseling Psychology*, *53*(2), 226–240. doi:10.1037/0022-0167.53.2.226

Tylka, T. L., & Kroon Van Diest, A. M. (2013). The Intuitive Eating Scale–2: Item refinement and psychometric evaluation with college women and men. *Journal of Counseling Psychology*, *60*(1), 137–153. http://doi.org/10.1037/a0030893

Tylka, T. L., & Wilcox, J. a. (2006). Are intuitive eating and eating disorder symptomatology opposite poles of the same construct? *Journal of Counseling Psychology*, *53*(4), 474–485. http://doi.org/10.1037/0022-0167.53.4.474

Van Dyke, N., & Drinkwater, E. J. (2014). Review Article Relationships between intuitive eating and health indicators: literature review. *Public Health Nutrition*, *17*(08), 1757–1766. http://doi.org/10.1017/S1368980013002139

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. (2010). From mindless eating to mindlessly eating better. *Physiology & Behavior*, *100*(5), 454–463. doi:10.1016/j.physbeh.2010.05.003

Watson, P., Wiers, R. W., Hommel, B., & de Wit, S. (2014). Working for food you don't desire. Cues interfere with goal-directed food-seeking. *Appetite*, *79*, 139–148. doi:10.1016/j.appet.2014.04.005

Woods, S. C., & D'Alessio, D. A. (2008). Central Control of Body Weight and Appetite. *The Journal of Clinical Endocrinology and Metabolism*, *93*(11 Suppl 1), S37–S50. http://doi.org/10.1210/jc.2008-1630

Worthington, R. L., & Whittaker, T. a. (2006). Scale development research: A content analysis and recommendations for best practices. *The Counseling Psychologist*, *34*(6), 806–838. http://doi.org/10.1177/0011000006288127

World Health Organization. (2014). *Global status report on noncommunicable diseases 2014*. Retrieved from http://www.who.int/nmh/publications/ncd-status-report-2014/en/

Yeomans, M. R., Blundell, J. E., & Leshem, M. (2004). Palatability: response to nutritional need or need-free stimulation of appetite? *The British Journal of Nutrition*, *92 Suppl 1*, S3–S14. http://doi.org/10.1079/BJN20041134

Yeomans, M. R. (2015). Cued satiety: How consumer expectations modify responses to ingested nutrients. *Nutrition Bulletin*, *40*(2), 100–103. http://doi.org/10.1111/nbu.12139

Appendix 1: Input Existing Scales For Item Pool

STUDY	RELEVANT ITEMS
FRAMSON (2009)	**Disinhibition**
	I stop eating when I'm full even when eating something I love.
	When a restaurant portion is too large, I stop eating when I'm full
	When I eat at "all you can eat" buffets, I tend to overeat.
	If there are leftovers that I like, I take a second helping even though I'm full.
	If there's good food at a party, I'll continue eating even after I'm full.
	When I'm eating one of my favorite foods, I don't recognize when I've had enough.
	If it doesn't cost much more, I get the larger size food or drink regardless of how hungry I feel.
	When I'm at a restaurant, I can tell when the portion I've been served is too large for me.
	External cues
	I recognize when food advertisements make me want to eat.
	I notice when I'm eating from a dish of candy just because it's there.
	I recognize when I'm eating and not hungry.
	I notice when just going into a movie theater makes me want to eat candy or popcorn.
	When I eat a big meal, I notice if it makes me feel heavy or sluggish.
	At a party where there is a lot of good food, I notice when it makes me want to eat more food than I should.
HAWKS ET AL. (2004)	**Intrinsic Eating**
	Without really trying, I naturally select the right types and amounts of food to be healthy.
	I seldom eat unless I notice that I am physically hungry.
	I consciously try to eat whatever kind of food I think will satisfy my hunger the best.
	Extrinsic Eating
	I often turn to food when I feel sad, anxious, lonely, or stressed out.
	After eating, I often realize that I am fuller than I would like to be.
	When I feel especially good or happy, I like to celebrate by eating.
	I often find myself looking for something to eat or making plans to eat—even when I am not really hungry.
	It's hard to resist eating something good if it is around me, even if I'm not very hungry.
	On social occasions, I feel pressure to eat the way those around me are eating—even if I am not hungry.
TYLKA & KROON VAN DIEST (**2013)**	**Reliance on Hunger and Satiety Cues**
	I trust my body to tell me when to eat.
	I trust my body to tell me what to eat.
	I trust my body to tell me how much to eat.
	I rely on my hunger signals to tell me when to eat.
	I rely on my fullness (satiety) signals to tell me when to stop eating.
	I trust my body to tell me when to stop eating.
VAN STRIEN (2012)	**External Eating**

	If food tastes good to you, do you eat more than usual?
	If food smells and looks good, do you eat more than usual?
	If you see or smell something delicious, do you have a desire to eat it?
	If you have something delicious to eat, do you eat it straight away?
	If you walk past the baker do you have the desire to buy something delicious?
	If you walk past a snackbar or a cafe, do you have the desire to buy something delicious?
	If you see others eating, do you also have the desire to eat?
	Can you resist eating delicious foods?
	Do you eat more than usual, when you see others eating?
	When preparing a meal are you inclined to eat something?
WANSINK (2012)	**External vs Internal Meal Cessation**
	Internal cues
	I usually stop eating when I start feeling full.
	I usually stop eating when I want to leave room for dessert.
	If it doesn't taste good, I'll still eat it if I am hungry.
	External cue items
	I usually stop eating when I've eaten what most think is normal.
	I usually stop eating when I run out of a beverage.
	I usually stop eating when the TV show I'm watching is over

Appendix 2: Item Pool (Dutch) – 38 items

DIMENSIE	GEEF AAN IN HOEVERRE DE VOLGENDE STELLINGEN VAN TOEPASSING ZIJN OP JEZELF
HERKENNEN VAN INTERNE SIGNALEN	Ik ervaar dagelijks honger signalen, zoals het rommelen van mijn maag of duizeligheid (1)
	Ik besteed aandacht aan de eetlust signalen die mijn lichaam me geeft (2)
	Als ik een grote maaltijd heb gegeten, merk ik wanneer dit me een zwaar of traag gevoel geeft (3)
	Na het eten kan ik precies aangeven hoe vol ik zit (4)
	Ik kan het verschil aanduiden tussen wanneer mijn lichaam echt voedsel nodig heeft of wanneer ik slechts zin heb in eten (5)
	Ik merk wanneer mijn lichaam reageert op het zien, ruiken of denken aan eten - zelfs als ik niet echt honger heb (6)
	Ik herken het verschil tussen honger signalen van mijn lichaam die veroorzaakt worden door externe factoren (bijv. het ruiken of zien van voedsel) en honger signalen veroorzaakt door de fysieke noodzaak om te eten (7)
	Ik merk wanneer mijn lichaam signalen geeft die me vertellen te eten (8)
	Ik merk wanneer mijn lichaam signalen geeft die me vertellen te stoppen met eten (9)
VERTROUWEN OP INTERNE SIGNALEN	Ik eet alleen wanneer ik merk dat ik lichamelijk honger heb (1)
	Ik ben regelmatig op zoek naar eten terwijl ik niet echt hongerig ben (2)
	Ik vertrouw erop dat mijn lichaam me vertelt wanneer te eten (3)
	Ik vertrouw erop dat mijn lichaam me vertelt hoe veel te eten (4)
	Ik gebruik mijn honger signalen om me te vertellen wanneer te eten (5)
	Ik gebruik de verzadigingssignalen van mijn lichaam om te vertellen wanneer ik moet stoppen met eten (6)
	Ik vertrouw op mijn lichaam om me te vertellen te stoppen met eten (7)
	Ik stop met eten wanneer ik me vol begin te voelen. (8)
HERKENNIN EXTERNE SIGNALEN	Ik merk wanneer voedselreclames me aanmoedigen om te eten (1)
	Ik merk wanneer ik snoep of snacks eet enkel omdat het voor het grijpen staat (2)
	Ik merk wanneer ik eet terwijl ik eigenlijk geen honger heb (3)
	Ik merk wanneer het gaan naar een bioscoop me verleidt om snoep, chips of popcorn te eten (4)
	Als er op een feestje veel lekker eten is, merk ik wanneer dit ervoor zorgt dat ik meer eet dan ik zou moeten doen (5)
	Ik herken het wanneer ik eet alleen maar omdat anderen ook aan het eten zijn. (6)
	Ik merk het wanneer ik zin krijg om te eten alleen omdat anderen traktaties aanbieden (7)
	Wanneer ik een van mijn favoriete gerechten of producten eet kan ik niet stoppen met eten (8)
	Als het niet veel duurder is kies ik voor de grotere versie van het eten of drinken, ongeacht hoe veel honger ik heb (9)
UITSLUITEN VAN EXTERNE SIGNALEN	Ik eet altijd mijn bord leeg wanneer ik in een restaurant ben (1)
	Ik eet iedere dag op exact dezelfde vastgestelde tijden. (2)
	Ook al zit ik vol, een verpakking of portie eet ik op (3)
	Als ik vol zit, wijs ik traktaties of snacks die anderen me aanbieden af (4)
	Ik stop met eten als ik vol zit, ook al is het iets wat ik heel erg lekker vind (5)
	Wanneer ik eet bij “all you can eat” restaurants, heb ik de neiging om te veel te eten (6)
	Ik kan de drang om te eten wanneer ik eten zie of ruik negeren (7)

	Als er lekker eten is op een feestje eet ik door terwijl ik vol zit (8)
	Ik kan lekker eten om me heen niet weerstaan, ook al heb ik niet echt honger. (9)
	Bij sociale gelegenheden, zoals een diner in een restaurant, voel ik de druk om hetzelfde te eten als de anderen, ook al heb ik geen honger (10)
	Wanneer er nog een beetje eten over is eet ik het op, ook al zit ik vol (11)
	Ik stop met eten wanneer ik denk dat ik op heb wat ik 'normaal' ook eet. (12)

Appendix 3: Final Adjusted Item Pool – 18 items

DIMENSIE	GEEF AAN IN HOEVERRE DE VOLGENDE STELLINGEN VAN TOEPASSING ZIJN OP JEZELF
RECOGNIZE INTERNAL SIGNALS	After dinner I can precisely tell how full I am.
	I can tell the difference between the moment when my body really needs food or when I am just craving for it.
	I recognize the difference between hunger signals caused by external cues (e.g the smell or sight of food) and the hunger signals caused by the physical need for food.
TRUST INTERNAL SIGNALS	I trust my body to tell me how much to eat.
	I rely on the hunger signals of my body to tell me when to eat.
	I rely on the satiety signals of my body to tell me when to stop eating.
	I trust my body to tell me when to stop eating.
	I stop eating when I start feeling full.
RECOGNIZE EXTERNAL SIGNALS	I recognize when food advertisements make me want to eat.
	I notice when I'm eating from a dish of candy just because it's there.
	I recognize when I'm eating and not hungry.
	At a party where there is a lot of good food, I notice when it makes me want to eat more food than I should.
	I notice when I am eating because others are eating.
	I notice when I want to eat just because others offer me treats.
DISENTANGLE EXTERNAL SIGNALS	When I am full, I reject treats or snacks other offer me.
	I stop eating when I'm full even when eating something I love.
	I can resist the urge to eat when I see or smell food.
	If there's good food at a party, I'll continue eating even after I'm full (reversed).

Appendix 4: Item Pool Study 2 – 19 items

DIMENSIE	GEEF AAN IN HOEVERRE DE VOLGENDE STELLINGEN VAN TOEPASSING ZIJN OP JEZELF
RECOGNIZE INTERNAL SIGNALS	I pay attention to the appetite signals that my body sends me.
	After dinner I can precisely tell how full I am.
	I can tell the difference between the moment when my body really needs food or when I am just craving for it.
	I recognize the difference between hunger signals caused by external cues (e.g the smell or sight of food) and the hunger signals caused by the physical need for food.
TRUST INTERNAL SIGNALS	I trust my body to tell me how much to eat.
	I rely on the hunger signals of my body to tell me when to eat.
	I rely on the satiety signals of my body to tell me when to stop eating.
	I trust my body to tell me when to stop eating.
RECOGNIZE EXTERNAL SIGNALS	I notice when I'm eating from a dish of candy just because it's there
	I recognize when I'm eating and not hungry.
	I notice when just going into a movie theater makes me want to eat candy or popcorn.
	At a party where there is a lot of good food, I notice when it makes me want to eat more food than I should.
	I notice when I am eating because others are eating.
	I notice when I want to eat just because others offer me treats.
DISENTANGLE EXTERNAL SIGNALS	I stop eating when I'm full even when eating something I love.
	When I eat at "all you can eat" buffets, I tend to overeat.
	If there's good food at a party, I'll continue eating even after I'm full.
	At social occasions such as dining in a restaurant, I feel pressure to eat to same as others.
	When there is a small left-over I eat it, even if I'm full.

Appendix 5: Item Pool Study 2 (Dutch) – 19 items

DIMENSIE	GEEF AAN IN HOEVERRE DE VOLGENDE STELLINGEN VAN TOEPASSING ZIJN OP JEZELF
HERKENNEN VAN INTERNE SIGNALEN	Ik besteed aandacht aan de eetlust signalen die mijn lichaam me geeft (2)
	Na het eten kan ik precies aangeven hoe vol ik zit (4)
	Ik kan het verschil aanduiden tussen wanneer mijn lichaam echt voedsel nodig heeft of wanneer ik slechts zin heb in eten (5)
	Ik herken het verschil tussen honger signalen van mijn lichaam die veroorzaakt worden door externe factoren (bijv. het ruiken of zien van voedsel) en honger signalen veroorzaakt door de fysieke noodzaak om te eten (7)
VERTROUWEN OP INTERNE SIGNALEN	Ik vertrouw erop dat mijn lichaam me vertelt hoe veel te eten (4)
	Ik gebruik mijn honger signalen om me te vertellen wanneer te eten (5)
	Ik gebruik de verzadigingssignalen van mijn lichaam om te vertellen wanneer ik moet stoppen met eten (6)
	Ik vertrouw op mijn lichaam om me te vertellen te stoppen met eten (7)
HERKENNIN EXTERNE SIGNALEN	Ik merk wanneer ik snoep of snacks eet enkel omdat het voor het grijpen staat (2)
	Ik merk wanneer ik eet terwijl ik eigenlijk geen honger heb (3)
	Ik merk wanneer het gaan naar een bioscoop me verleidt om snoep, chips of popcorn te eten (4)
	Als er op een feestje veel lekker eten is, merk ik wanneer dit ervoor zorgt dat ik meer eet dan ik zou moeten doen (5)
	Ik herken het wanneer ik eet alleen maar omdat anderen ook aan het eten zijn (6)
	Ik merk het wanneer ik zin krijg om te eten alleen omdat anderen traktaties aanbieden (7)
UITSLUITEN VAN EXTERNE SIGNALEN	Ik stop met eten als ik vol zit, ook al is het iets wat ik heel erg lekker vind (5)
	Wanneer ik eet bij “all you can eat” restaurants, heb ik de neiging om te veel te eten (6)
	Als er lekker eten is op een feestje eet ik door terwijl ik vol zit (8)
	Bij sociale gelegenheden, zoals een diner in een restaurant, voel ik de druk om hetzelfde te eten als de anderen, ook al heb ik geen honger (10)
	Wanneer er nog een beetje eten over is eet ik het op, ook al zit ik vol (11)

Appendix 6: Behavioural items Dutch – 16 items

1. Herkennen intern

- Ik eet altijd aan tafel zonder afleidingen zoals televisie, radio of telefoon.
- Ik neem voor elke maaltijd ruim de tijd en eet in een rustig tempo.
- Na het eten van het hoofdgerecht wacht ik even voordat ik besluit of ik een toetje neem.

2. Vertrouwen intern

- Ik eet alleen wanneer ik honger heb.
- Ik eet zoveel als mijn lichaam aangeeft nodig te hebben.
- Na de maaltijd heb ik buikpijn, omdat ik te veel gegeten heb (R).
- Ik tel of schat regelmatig de calorieën ik heb ingenomen (R).

3. Herkennen extern

- Ik ben me bewust van de verleidingen in de omgeving.
- Ik eet haastig en denk niet na over wat ik eet (R).
- Als eten wordt aangeboden door anderen bedenk ik eerst of ik honger heb voordat ik het aanneem.
- Op een feestje ben ik bewust bezig met mijn honger- en verzadigingssignalen.

4. Uitsluiten extern

- Ik weiger eten of drinken wat anderen me aanbieden als ik geen honger heb.
- Als er een klein beetje eten of drinken over is eet ik dit op, ook al zit ik vol (R).
- Er zit weinig variatie in mijn voedselinname, ik eet veelal dezelfde producten.
- Externe verleidingen, zoals een snoeppot of geopende zak chips, leg ik uit mijn zicht.
- Er is geen verschil tussen mijn aankopen wanneer ik honger heb of wanneer ik vol zit tijdens het doen van boodschappen.

Appendix 7: Behavioural items (English) – 16 items

1. Recognize internal cues

- I always eat at the table without distraction of television, radio or telephone.
- I take the time for each meal and eat at a slow pace.
- After eating a main course, I wait a bit before I decide to take a dessert.

2. Trust internal cues to determine food intake

- I only eat when I am hungry.
- I eat as much as my body tells me it needs.
- After a meal I have stomach ach because I ate too much (R).
- I regularly count or estimate the calories I took (R).

3. Recognize external cues

- I am aware of the temptations in the environment.
- I eat quickly and do not think about what I am eating (R).
- When others offer food, I first evaluate if I am hungry before I accept it.
- On a party, I am consciously busy with paying attention to my feelings of hunger and satiety.

4. Disentangle external cues from intake process

- I refuse food others offer me when I am not hungry.
- When there is only a small portion left, I eat it, even when I am full (R).
- There is little variation in my food intake, I mostly eat the same products.
- External temptations, such as a candy jar of open bag of chips, I put them out of my sight.
- There is no difference between my purchases during grocery shopping when I am hungry or when I am full.