Consuming media, consuming food?
Reactivity to palatable food cues in television content
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CHAPTER 1

General introduction
After coming home from a long day at work, you cook yourself a meal, settle down on the couch and enjoy dinner in front of the TV. When finished, you decide to have a cup of tea, which obviously tastes much better with a cookie on the side. And as the evening continues while watching your favorite shows, likely interrupted by several commercial blocks that advertise crunchy pizzas or salted caramel ice cream, you may find yourself going to the kitchen to get a bag of potato chips that satisfies your late-night cravings. Before going to sleep, you try to convince yourself that tomorrow, you will do things differently and start to eat healthier.

Media use, and particularly watching TV, is considered an important contributor to the development of overweight and obesity (e.g., Boulos, Vikre, Oppenheimer, Chang, & Kanarek, 2012). Studies have consistently shown a positive association between the amount of TV viewing (e.g., the number of hours per day) and body mass index (BMI; Cameron et al., 2004; Hu, Li, Colditz, Willett, & Manson, 2003; Salmon, Bauman, Crawford, Timperio, & Owen, 2000). For example, a longitudinal study found that for every 2-hour increase of time spent watching TV per day, there was a 23% higher risk of developing obesity in the next six years (Hu et al., 2003). Because of its health consequences for cardiovascular diseases, diabetes, musculoskeletal disorders, and several types of cancers, obesity is perceived as one of the most important and challenging current health issues, affecting almost every region of the world (World Health Organization, 2020). This also holds for the Netherlands, where currently 35.4% of adults is overweight (BMI ≥ 25) and another 14.7% obese (BMI ≥ 30; RIVM, 2020). It is therefore crucial to gain a good understanding of how watching TV may contribute to this growing health issue.

Although several explanations for the relationship between TV viewing and obesity have been proposed (Boulos et al., 2012; Chaput, Klingenber, Astrup, & Sjödin, 2011), the positive association remains after controlling for physical activity levels (Cameron et al., 2003; Hu et al., 2003; Salmon et al., 2000). Rather than ascribing this relationship to TV viewing as a replacement of other, more physical activities, it is more likely the result of increased energy intake (Boulos et al., 2012; Cleland, Schmidt, Dwyer, & Venn, 2008). One plausible and often proposed reason for this may be that the frequent exposure to palatable (i.e., tasty, yet often unhealthy) food cues embedded in TV content triggers the consumption of food (Boulos et al., 2012; Boyce, 2007; Foster, Gore, & West, 2006). Food cues are widely portrayed in TV content and conveyed in various ways (Dickinson, 2000). Perhaps the most common form is food advertising. Approximately a third of all TV commercials is food-related (Chapman, Nicholas, & Supramaniam, 2006), and the vast majority of the advertised products are for unhealthy food (i.e., food with poor nutritional value and high in calories, added fat, sugar, and/or salt; Chapman et al., 2006; Warren, Wicks, Wicks, Fosu, & Chung, 2008).
Another type of TV content in which palatable food cues are continually visible is culinary content. Cooking shows and other food-related TV programs have massively increased in popularity, and a large variety of such programs is nowadays available (De Solier, 2005), ranging from cooking competitions (e.g., MasterChef, The Great British Bake Off, The Taste) to travel shows (e.g., Street Food), makeover shows (e.g., Gordon Ramsay Restaurant Makeover), and talk shows with cooking segments (e.g., The Rachael Ray Show). Even though most of these shows have some instructional aspects, they primarily focus on entertainment and eating for pleasure, showing its viewers how to make mouth-watering and beautifully presented – yet often unhealthy – dishes (Boulos et al., 2012; Jones, Freeth, Hennessy-Priest, & Costa, 2013).

In addition to TV content in which food plays a central role, food cues are also present in more subtle ways, for instance when characters in movies or sitcoms are eating. This can be in the form of covert advertising (i.e., product placement) or merely as part of the narrative. Again, these foods are often unhealthy snacks, rather than healthy meals (Eisenberg, Larson, Gollust, & Neumark-Sztainer, 2016).

Exposure to the abundance of palatable food cues in our environment, such as in TV content, is thought to trigger food intake even in the absence of physical hunger (Pinel, Assanand, & Lehman, 2000). Thus, rather than responding to internal signals of the body indicating energy deficits, these external food cues may be a drive to eat for pleasure – also called hedonic eating (Lowe & Butryn, 2007). Empirical evidence for the influence of seeing palatable food cues in TV content on eating behavior (i.e., food choices and intake) is, however, surprisingly scarce, especially in adult populations. There has been some experimental research aimed at testing the causal relationship between exposure to food cues embedded in TV content and eating behavior, but this has produced mixed findings. Several studies found that participants who watched TV content containing palatable food cues (i.e., in commercials or a cooking show) consumed more food compared to those exposed to non-food related TV content (Bodenlos & Wormuth, 2013; Harris, Bargh, & Brownell, 2009). However, in other studies no such effect was found (Bellisle, Dalix, Airinei, Hercberg, & Péneau, 2009; Boyland, Burgon, & Hardman, 2017; Martin, Coulon, Markward, Greenway, & Anton, 2009). Additionally, other research found mixed results within studies, often showing effects only for subgroups of participants based on individual characteristics (Anschutz, Engels, Van der Zwaluw, & Van Strien, 2011; Kidd & Loxton, 2018; Van Nee, Larsen, & Fisher, 2016; Van Strien, Herman, & Anschutz, 2012; Wonderlich-Tierney, Wenzel, Vander Wal, & Wang-Hall, 2013; Zimmerman & Shimoga, 2014).

Thus, although it is often argued that exposure to food cues in TV content triggers food intake (Boulos et al., 2012; Boyce, 2007; Foster et al., 2006), further research is required to
understand this relationship (French, Story, & Jeffery, 2001; Robinson et al., 2017; Scully, Dixon, & Wakefield, 2016). First, to gain more insight into why exposure to food cues in TV content may result in food intake it is important to investigate the underlying processes that may explain this relationship (Harris et al., 2009). However, in the literature to date, research into these processes is lacking (Boyland et al., 2017; Folkvord, Anschütz, Boyland, Kelly, & Buijzen, 2016). Second, it has been suggested that individual differences likely play a role in effects of food cues in TV content (Boyland et al., 2016; Mills, Tanner, & Adams, 2013; Vukmirovic, 2015). This points to the need for more research on the influence of individual differences, which could potentially explain mixed findings of food cues in TV content. Previous research shows that particularly people who are chronically dieting (i.e., restrained eaters) but are relatively unsuccessful in their dieting attempts (i.e., have low perceived self-regulatory success) are sensitive to palatable food cues (e.g., words representing food; Fishbach, Friedman, & Kruglanski, 2003; Papies, Stroebe, & Aarts, 2008a). It remains to be tested whether differences in restrained eating and dieting success could also explain effects of food cues embedded in TV content. Third, research on effects of food on TV on eating behavior has almost exclusively focused on one type of content: food commercials (for an exception, see Bodenlos & Wormuth, 2013). However, as discussed earlier, palatable food cues are frequently presented in other types of TV content as well. The food cues embedded in these different types of content may differ in salience, and the different content types may in general have different aims (e.g., entertainment vs. persuasion), which might both influence how food cues are processed and in turn, their effects (Folkvord et al., 2016; Van Nee et al., 2016). To be able to draw sound conclusions about the processes involved and behavioral reactivity to food on TV, more research on other types of TV content is therefore required. Fourth, existing literature on the relation between exposure to food cues in TV content and eating behavior has largely relied on experimental studies in laboratory settings, often among (predominantly female) student samples. In order to get a more comprehensive view of this relationship in daily life, this should be complemented with research in naturalistic settings among the general population of adults. Guided by these four gaps in the current literature, this dissertation aims to investigate to what extent and for whom exposure to food cues in (various types of) TV content may result in eating behavior, and through what processes this likely occurs.
Potential Processes Explaining Behavioral Reactivity to Palatable Food on TV

To gain a better understanding of the potential effects of palatable food cues in TV content on food intake it is crucial to also understand the processes that may underlie this relationship. So far, only little research has been conducted on these potential processes in media content specifically (Boyland et al., 2017; Folkvord et al., 2016). To identify what processes may play a role when exposed to food on TV, it is useful to consider existing research that used other types of external visual food cues, for instance food pictures or real food.

A large body of literature has focused on investigating why exposure to external food cues may lead to food intake. This may occur through an interplay of several processes, in which learned associations based on classical conditioning are considered to play an important role (Berridge & Robinson, 1998; Jansen, 1998; Morris, Beilharz, Maniam, Reichelt, & Westbrook, 2015). According to cue reactivity theory, because the sight of food (e.g., a cooked meal on a plate) often signals actual food intake, over time a learned association between food cues and food intake may develop. As a consequence of this association, merely seeing food may elicit a range of psychological and physiological responses that prepare the body for expected food intake and support eating initiation (Jansen, 1998; Nederkoorn, Smulders, & Jansen, 2000). This relationship is intensified by the naturally rewarding effects of the intake of palatable food, enhancing the incentive value of food (Berridge, 2009; Berridge & Robinson, 1998). Food cues may therefore also elicit other psychological and physiological processes (e.g., increased attention to food and approach behavior) to increase the likelihood that the food will be obtained and consumed. Importantly, as shown by a meta-analysis, people are not only reactive to seeing real food, but also to other types of visual food cues, such as pictures (Boswell & Kober, 2016). In a similar vein, the mere sight of food cues embedded in TV content may lead to a range of psychological and physiological processes that facilitate food intake (Folkvord et al., 2016).

A substantial amount of research has examined the psychological and physiological responses elicited by the sight of palatable food cues, for instance self-reported appetite (Ferriday & Brunstrom, 2008), visual attention (Werthmann et al., 2013), cognitive performance (Cunningham & Egeth, 2018), and salivation (Nederkoorn & Jansen, 2002), yet no systematic review of evidence on these investigated responses is available. Such a review is important as it provides detailed insight into what is known about the potential processes through which visual food cues may increase food intake, and can be used to further explore how food cues embedded in TV content may result in increased food intake. The current dissertation therefore commences with such a review, and subsequently investigates two processes (i.e., goal accessibility and visual attention) in relation to food cues in TV content specifically.
Individual Differences in Reactivity to Palatable Food Cues

Not all people may be equally susceptible to seeing external food cues, such as food on TV (Mills et al., 2013; Polivy, Herman, & Coelho, 2008). Over the past few decades, large bodies of literature have focused on explaining differential reactivity to food cues depending on differences in individual characteristics, and much of this research has examined the role of eating restraint (for a recent overview, see Polivy & Herman, 2017). Restrained eaters are people who are chronically concerned with their body weight and with dieting. Typically, restrained eaters are expected to be more sensitive to palatable food cues compared to unrestrained eaters (i.e., non-dieters). An explanation for this has been provided by the goal conflict model of eating (Stroebe, Mensink, Aarts, Schut, & Kruglanski, 2008; Stroebe, Van Koningsbruggen, Papis, & Aarts, 2013). According to this model, eating behavior of restrained eaters is characterized by a conflict between two generally incompatible goals: a short-term hedonic eating goal and a long-term dieting goal. On the one hand, restrained eaters want to enjoy palatable (but often unhealthy) food, but on the other hand, they want to lose or at least not gain weight. Under normal circumstances, the long-term dieting goal is highly accessible in the mind of restrained eaters. As goal accessibility is strongly associated with behavior in concordance with attaining an activated goal (Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trötschel, 2001; Förster, Liberman, & Friedman, 2007), restrained eaters may usually restrict their food intake (Stroebe et al., 2013). However, exposure to palatable food cues may automatically activate the hedonic eating goal, and thereby override the dieting goal, which may subsequently result in food intake. As unrestrained eaters generally do not have a dieting goal, they do not experience such a goal conflict and are thought to be relatively insensitive to external food cues. Instead, they possibly focus more on informational aspects of food cues, such as nutritional value (Stroebe, Papis, & Aarts, 2008).

Although a substantial amount of empirical research corroborates with the idea that restrained eaters are more sensitive to food cues compared to unrestrained eaters (e.g., Fedoroff, Polivy, & Herman, 2003; Papis, Stroebe, & Aarts, 2007; Wang et al., 2016), other studies found no differences between restrained and unrestrained eaters regarding their reactivity to food cues (e.g., Meule, 2016; Van Nee et al., 2016) or even found that restrained eaters are less reactive to palatable food compared to their unrestrained counterparts (e.g., Ferriday & Brunstrom, 2008; Nederkoorn & Jansen, 2002). These latter findings appear to be more consistent with counteractive control theory, which posits that after repeatedly engaging in self-regulatory efforts in response to tempting cues, such cues may result in activation rather than inhibition of the long-term goal (Fishbach et al., 2003; Trope & Fishbach, 2000). Integrating counteractive control theory with the goal conflict model of eating has led researchers to propose that the group of restrained eaters likely consists of both successful
and unsuccessful dieters (e.g., Stroebe et al., 2013), who differ in self-regulatory success 
(generally measured with the perceived self-regulatory success [PSRS] scale; Fishbach et al., 
2003). As a result of repeatedly exerting self-control in response to palatable food cues in the 
past, successful restrained eaters have likely developed strong facilitative links between food 
cues and the automatic activation of dieting goals. Unsuccessful restrained eaters, on the 
other hand, have not developed such strong links and for them, food cue exposure may easily 
activate their hedonic eating goal (Fishbach et al., 2003; Stroebe et al., 2013). These notions 
are supported by empirical research showing that exposure to palatable food cues (i.e., 
words representing food) activated successful restrained eaters’ dieting goal, but inhibited 
this goal among unsuccessful restrained eaters (Fishbach et al., 2003; Papies et al., 2008a). 
Furthermore, in line with these goals, palatable food words increased unsuccessful restrained 
eaters’ effort to obtain high-calorie food, while successful restrained eaters showed more 
effort to obtain low-calorie food (Van Koningsbruggen, Stroebe, & Aarts, 2013b). This likely 
occurs via attentional mechanisms: the activation of a goal steers attention to goal-relevant 
cues, which subsequently increases motivation towards these cues (Moskowitz, 2002; Papies, 

Existing research on successful and unsuccessful restrained and unrestrained eaters’ 
differential reactivity to visual food cues largely relies on exposure to isolated food cues, or 
more specifically, to food words presented as part of a computerized task. It remains to be 
tested whether the same applies to food cues embedded in TV content, as these cues are 
part of a larger context (i.e., a narrative) and often serve a specific goal (e.g., to persuade in 
TV commercials, to entertain and/or inform in culinary content). These differences between 
isolated food cues and food cues embedded in TV content could potentially influence how food 
cues are processed (e.g., how attentively) and therefore, it should be investigated whether 
differences in eating restraint and PSRS also explain reactivity to food cues embedded in TV 
content. If so, it may provide an explanation for why previous findings on effects of food cues 
in TV content on eating behavior are mixed. The present dissertation therefore examines to 
what extent successful and unsuccessful restrained eaters and unrestrained eaters respond 
differentially to food cues in TV content with respect to hedonic eating goal accessibility, 
visual attention, and eating behavior.

**Type of TV Content**

The vast majority of existing research on effects of food cues embedded in TV content 
is based on food commercials, but food cues are also frequently conveyed through other 
types of TV content (Boulos et al., 2012; Dickinson, 2000). Depending on the TV content in 
which food cues appear, the cues may differ in salience and serve different goals. In culinary
content, food cues are usually prominently depicted, similar to commercials, but exposure is likely longer and therefore food cues may be more salient to the viewer. Furthermore, unlike commercials, in which the food cues serve to persuade viewers to buy the promoted product, culinary content rather aims to entertain and/or inform viewers (De Solier, 2005). Food cues appearing in TV shows or movies, for instance in a scene depicting characters having a dinner party, are generally less salient than those in commercials and culinary content, as they are usually not central to the content. These more subtle food cues may in some cases serve to persuade viewers (e.g., product placement), but are often a more natural part of the narrative (Boulos et al., 2012).

As differences in the way food cues are presented, or how they are viewed, could potentially influence effects of these cues (Folkvord et al., 2016; Van Nee et al., 2016), it is relevant to investigate other types of TV content in addition to commercials to achieve a more comprehensive picture of effects of food on TV. The current dissertation therefore examines reactivity to food cues in various types of TV content (i.e., commercials, culinary content, and TV shows that subtly depict food cues).

Exposure to Food Cues in TV Content and Eating Behavior in Daily Life

The current literature on the relationship between exposure to food cues in TV content and eating behavior is dominated by experimental research conducted in laboratory settings. This type of research provides useful insights, as it allows for testing causal relations and potential underlying processes while controlling for external influences. Yet, for a more complete understanding of how food cues in TV content may influence eating behavior, it is necessary to also study this relationship in a naturalistic setting, where people behave following their usual viewing and eating patterns. Studying exposure to food cues and eating behavior in daily life will therefore provide a more ecologically valid account of these relationships. There has been some research in naturalistic settings that provides some evidence for an association between the amount of food cue exposure on TV and increased food intake (De Backer & Hudders, 2016; Scully et al., 2016; Thomson, Spence, Raine, & Laing, 2008), however, these studies investigated overall food intake across the day. Studying eating behavior during exposure to food cues in TV content would provide more direct evidence on whether food cues in media content may trigger the consumption of food.

Related to this, the vast majority of research in this domain has been conducted among highly educated, young, and predominantly female samples. To get a more comprehensive view of the relationship between food cues in TV content and eating behavior, it is important to conduct research among the general population of adults, particularly because it has been suggested that demographic variables may play a potential role in effects of food cues on TV
This dissertation therefore concludes with research on the relationship between exposure to food cues in TV content in a naturalistic setting among a sample of the general population of adults in the Netherlands. Additionally, this final study also explores eating behavior in relation to the activity of TV viewing in general, thereby moving beyond food cues in TV content as explanation for the relationship between TV viewing and eating behavior.

Summary of Aims and Contributions of this Dissertation

Even though it has often been proposed that the omnipresence of food cues on TV may trigger food intake and thereby contributes to overweight and obesity (e.g., Boulos et al., 2012), the inconsistency in evidence on the causal relationship between exposure to food cues embedded in TV content and eating behavior in adults calls for further investigation of this topic. This dissertation therefore aims to answer the following research question: To what extent, for whom, and through what processes may exposure to palatable food cues embedded in TV content result in unhealthy food choices and increased food intake? It thereby fills four relevant gaps in the literature. First, the processes explaining how exposure to food on TV may affect food choices and intake are largely unknown, but are crucial in understanding the potential causal relationship. Second, even though individual differences likely play an important role in reactivity to food cues (Mills et al., 2013; Stroebe et al., 2013), there is not much research on whether and how such individual differences may influence effects of exposure to food cues embedded in TV content. Third, food cues are embedded in TV content in multiple ways, but research on effects of food on TV is almost solely based on food commercials. Fourth, existing literature on the relationship between exposure to food cues in TV content and eating behavior heavily relies on laboratory studies among specific adult samples, which limits the ability to draw conclusions about this relationship in daily life among the general population of adults. By addressing these gaps, this dissertation advances our understanding of how the current media environment, in which people are continually exposed to palatable food cues, may potentially contribute to food intake. This knowledge is important in order to reduce food intake, and subsequent obesity, associated with TV use.

Dissertation Outline

The remainder of this dissertation consists of six chapters. A schematic overview of the dissertation outline can be found in Figure 1.1. Chapter 2 provides a detailed overview of previous research investigating psychological and physiological responses to food cues that may potentially function as processes underlying the effect of food cue exposure on food intake. More specifically, the chapter reports a systematic review of the literature based on
55 experimental studies testing psychological and physiological responses to high-calorie, visual food cues (vs. non-food cues) in healthy adults. As research on such responses to food cues embedded in media content is very scarce, evidence based on other types of visual food cues was also included (i.e., pictures of food, food words, and real food). This way, the chapter serves as a useful starting point for exploring potential processes that may underlie the relationship between food cues in TV content and food intake.

In Chapters 3 through 5, participants' psychological (Chapters 3 and 5) and/or behavioral reactivity (Chapters 4 and 5) to food cues in TV content is examined in laboratory settings, thereby investigating two potential processes that were identified in Chapter 2 (i.e., goal accessibility and visual attention). Additionally, Chapters 3 through 5 all investigate whether individual differences in eating restraint and PSRS influence reactivity to these food cues.

With three experiments, Chapter 3 investigates whether watching TV content with food cues affects mental accessibility of a hedonic eating goal. In the first (student sample, \( n = 111 \)) and second experiments (community sample, \( n = 69 \)), participants either viewed food commercials or non-food commercials. In the third experiment (student sample, \( n = 102 \)), participants watched a cooking segment or a non-food related segment of a TV show. Hedonic eating goal accessibility was measured afterwards by assessing participants' reaction times to words representing this goal (e.g., tasty, appetizing) in a lexical decision task.

Chapter 4 focuses on behavioral effects of watching TV content with food cues. As increased goal accessibility has found to result in behavior in line with pursuit of this goal (Bargh et al., 2001; Förster et al., 2007), an experiment was conducted (\( n = 112 \)) to test whether watching a cooking segment vs. a non-food related segment of a TV show affected unhealthy food choices.

Accessible goals may influence behavior via attention towards goal-congruent cues (Moskowitz, 2002; Papies et al., 2008b; Van der Laan et al., 2017). To gain further insight into this process, Chapter 5 examines visual attention to food cues embedded in TV content and the extent to which this predicts subsequent unhealthy food intake. The chapter describes a study in which participants (\( n = 62 \)) watched a segment of a TV show with subtly presented food cues. Visual attention to the food cues was measured directly, by using eye-tracking technology allowing for the investigation of different components of visual attention (i.e., initial orientation of visual attention and attention duration). Participants' food intake was assessed after watching the TV show.

Complementing research in the previous chapters conducted in laboratory settings, Chapter 6 investigates whether exposure to food cues in TV content is associated with eating behavior in a naturalistic setting. The chapter presents secondary data analysis of
a seven-day diary study conducted among a sample of the general population of adults in the Netherlands (n = 2292). In addition to investigating the time spent on food intake while watching culinary TV content (i.e., programs focused on food and cooking) vs. non-food related TV content, the study also examined food intake in relation to the activity of TV viewing in general (vs. food intake without concurrent media use). This chapter thereby moves beyond food cues in TV content as explanation for the association between TV viewing and food intake. Moreover, this chapter explores the potential role of individual differences in demographic variables in relation to food intake while watching TV.

Chapter 7 presents a general discussion and conclusions of the findings throughout the different chapters. The key findings of this dissertation are presented and discussed in light of previous literature. Furthermore, potential directions for future research are provided, as well as implications of the findings for practice.

**FIGURE 1.1.** Schematic overview of the dissertation outline.