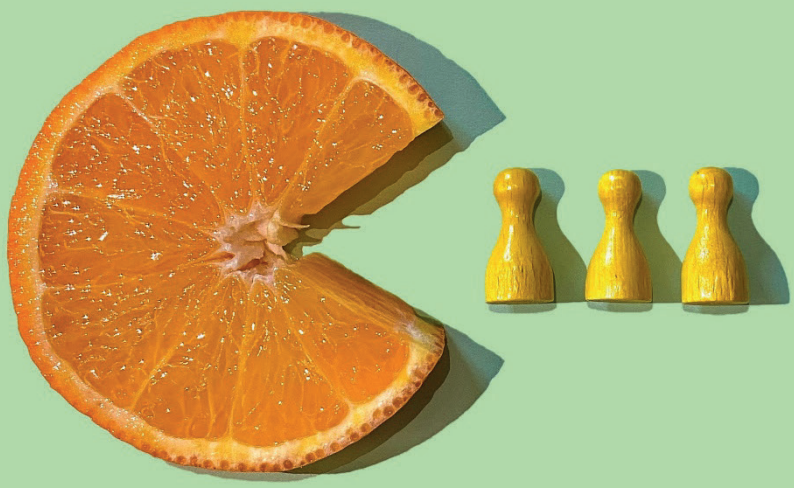
How physical cues in micro food environments influence consumption:

A social norm account



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Thesis

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Chapter 1

General introduction

"Our societies are complex and interrelated. Health cannot be separated from other goals. The inextricable links between people and their environment constitute the basis for a socioecological approach to health…"

– The Ottawa Charter for Health Promotion, World Health Organization (1986) p. 2

1.1. Introduction

We are continuously exposed to artificial food environments created for our consumption and made possible by our natural environment – such as supermarkets, roadside shops, and vending machines at the workplace. Our physical food environments are largely shaped and defined by people and reflect the common norms and practices of the nation in which people live. The organization of physical food environments is rather complex, as they include many aspects including food availability and accessibility (Lake & Townshend, 2006). In an ideal world, these food environments can typically be characterized by the presence of easily accessible healthy foods (low in calories, fat, salt, and/or sugar) produced by sustainable food systems (entailing food production, processing, distribution, preparation, and consumption) and created to support the health of our (growing) population and our planet (Willett et al., 2019). In large parts of the Western world however, the opposite may be true nowadays: People navigate through (live and function in) a range of food environments that may be characterized by some, or a set of, aspects within these environments that presumably encourage undesired dietary decisions; for example, aspects such as the abundance, easy accessibility, or strong promotion of relatively less healthy and less sustainable foods (Egger & Swinburn, 1997; Lakerveld & Mackenbach, 2017; Rutter et al., 2017; Swinburn, Egger, & Raza, 1999; Swinburn et al., 2011). To illustrate, portion sizes of commercially available (high-caloric) foods have increased considerably in recent decades (Ledikwe, Ello-Martin, & Rolls, 2005; Schwartz & Byrd-Bredbenner, 2006; Steenhuis, Leeuwis, & Vermeer, 2010; Young & Nestle, 2012).

The large number of people in Western society suffering from (preventable) diet-related chronic diseases (such as obesity, type 2 diabetes, or cardiovascular diseases) and proven diet-related environmental damage (such as greenhouse gas emissions, freshwater use, or land use) give cause for concern (Swinburn et al., 2019; Willett et al., 2019; World Health Organization, 2020). To illustrate, in the Netherlands, half of the adult population are currently overweight (35.4%, BMI = 25–30) or obese (14.7%, BMI ≥ 30) (RIVM, 2020). Furthermore, food production systems are globally associated with up to 30% of greenhouse gas emissions, 70% of freshwater use, and 40% of land use (Willett et al., 2019). There are indications that the obesity epidemic

has developed in parallel with changes in food environments (Lakerveld, Mackenbach, Rutter, & Brug, 2018) – such as the abovementioned increases in the portion size of various foods. Consequently, the currently observed consumption patterns in the Netherlands, which deviate from national and global dietary guidelines, are often described as a normal response to an abnormal environment (Egger & Swinburn, 1997; Kromhout, Spaaij, De Goede, & Weggemans, 2016; Lakerveld et al., 2018; Springmann et al., 2020; Willett et al., 2019). It has been well established that the way in which food environments are arranged may have a considerable impact on our dietary decisions at different environmental levels (Ball, Timperio, & Crawford, 2006; Egger & Swinburn, 1997; Lakerveld et al., 2018; Swinburn et al., 1999; Swinburn et al., 2011). To illustrate, on the level of the built environment, food store availability and accessibility have been identified as (important) determinants of food store choice, although evidence at this level relating to dietary intake and health outcomes is mixed/inconsistent (e.g., see reviews by Black, Moon, & Baird (2014); Caspi, Sorensen, Subramanian, & Kawachi (2012); Pitt, Gallegos, Comans, Cameron, & Thornton (2017); Story, Kaphingst, Robinson-O'Brien, & Glanz (2008)). Within these food store environments (settings level), food availability has been indicated as a (key) driver of in-store food selection (e.g., see reviews by Pitt et al. (2017); Story et al. (2008)). Interestingly, some people *do* succeed in making healthy and sustainable food choices in these rather adverse food environments, but large groups of consumers seem to need some help in making such (rather 'abnormal') food choices – especially as it is often assumed that many food-related decisions are made without deliberation (Clary, Matthews, & Kestens, 2017). Therefore, calls to 'renormalize' our current food environments (for example by restricting the presence of unhealthy food stores) are rising, stepping away from putting *all* responsibility regarding (un)healthy eating on individuals themselves (see for instance Clary et al. (2017)). However, it remains poorly understood *how* physical aspects in these food environments actually contribute to our dietary decisions (e.g., Lakerveld et al. (2018); Marteau, Fletcher, Hollands, & Munafò (2020); Szaszi, Palinkas, Palfi, Szollosi, & Aczel (2018)). This lack of insight into the mechanisms underlying the causal relationship between the arrangement of food environments and consumption hampers progress in creating effective initiatives encouraging healthy and sustainable dietary decisions.

The interaction between people and the physical food environments surrounding them has been researched by many correlational studies addressing associations rather than causal relationships between the arrangement of physical food environments (for example the type and number of food stores available in local food environments) and consumption or obesity (see for instance Pitt et al. (2017); Story et

al. (2008); Townshend & Lake (2017)). In these correlational studies, the examination of pathways that may explain these associations is often neglected, although it has been proposed that we need to acknowledge that the relationship between physical food environments and consumption is not direct, but mediated through a set of different factors, such as perceptions of the environment, self-regulatory skills, or motivation (Caspi et al., 2012; Fleischhacker, Evenson, Rodriguez, & Ammerman, 2011; Giskes, Van Lenthe, Avendano-Pabon, & Brug, 2011; Lakerveld et al., 2018; Lytle & Sokol, 2017). To facilitate the examination of causal relationships, over the past decades, numerous small-scale empirical investigations have been performed to understand whether various targeted physical cues – physical aspects of environments (Pechey & Marteau, 2018) such as the relative physical distance at which a food is placed – *do* have an impact on our dietary decisions (see for example the Cochrane systematic review by Hollands et al. (2019)). Some of these small-scale experiments also attempted to investigate the potential mechanisms underlying the effect of physical cues in food environments on eating behavior. The dominant view in these first studies is that perceptions of salience of the foods (e.g., visibility of the foods) and the effort required to obtain these foods are the key mechanisms that potentially explain the link between physical cues in food environments and consumption, although their mediating effect is unknown (e.g., Hunter, Hollands, Couturier, & Marteau (2018); Knowles, Brown, & Aldrovandi (2019); Knowles, Brown, & Aldrovandi (2020); Maas, De Ridder, De Vet, & De Wit (2012)). We consider this view to be myopic and incomplete. From a socioecological perspective, people's dietary decisions are directly affected by physical aspects (such as food availability and accessibility) and social aspects (such as family, friends, and peers) of food environments, and, concurrently, people alter the organization of food environments by their individual and collective actions in these environments (Stokols, 1992; Story et al., 2008). As yet, the physical and the social food environment have generally been studied in isolation, treating both influences as separate forces impacting our dietary decisions (see for example the ANGELO framework (analysis grid for environments linked to obesity) as developed by Swinburn et al. (1999)).

In this dissertation, we posit that physical and social aspects of food environments are intertwined, particularly by proposing that social processes are physically embedded in food environments. To illustrate, previous experiments demonstrated that consumers tended to consume more snacks when they were exposed to snack bowls surrounded by empty snack wrappers (Burger et al., 2010; Prinsen, De Ridder, & De Vet, 2013). The salience of the snacks and the effort needed to obtain the snacks were similar when the wrappers were both present and absent.

The empty snack wrappers may have given the impression that other people had previously consumed some of these snacks – we consider this as an example of a social process that is physically embedded in food environments. We further argue, in line with suggestions by Burger et al. (2010), De Ridder, De Vet, Stok, Adriaanse, & De Wit (2013) and Prinsen et al. (2013), that such physical cues provide hints about what is normal and/or appropriate to consume according to other people in that situation – also referred to as *social norms*: implicit codes of conduct providing a guide for appropriate behavior (Higgs, 2015). Social norms can be either descriptive, i.e., *de*scribing what others have done in identical situations and thereby signaling what is considered 'normal' behavior (referred to as descriptive norms), or prescriptive, i.e., *pre*scribing how one should behave and thereby signaling what behavior others approve or disapprove of (referred to as injunctive norms) (Cialdini, Reno, & Kallgren, 1990). It has been substantially proven that social norms are powerful in guiding both what we consume and how much we consume, as for example shown in systematic reviews by Robinson, Thomas, Aveyard, & Higgs (2014) and Stok, De Vet, De Ridder, & De Wit (2016). It is easily assumed that, for instance, the empty snack wrappers as outlined above exemplify a (descriptive) social norm communicating that others had previously consumed snacks in that situation. However, to date it remains empirically underexamined whether social norms are conveyed by, or connected to, available foods, because an empirical investigation is lacking about whether people interpret physical cues in food environments as such a social norm. Going one step further, we consider the social norm interpretation of physical cues as an overlooked potential explanatory mechanism for the relationship between physical food environments and food consumption, contesting the dominant notion that the wide availability and easy accessibility of (unhealthy) foods exclusively determine our consumption (e.g., Pitt et al. (2017); Story et al. (2008); Townshend & Lake (2017)). This is the main focus of this dissertation. Relevant alternative explanations proposed and/or examined in the literature are also investigated (for example, perceptions of effort and salience), as we aim to gain a full understanding of the interaction between people and the physical food environments surrounding them. Insight into such a knowledge gap may elucidate the causal mechanisms explaining why we eat food that is available in physical micro food environments, and this may improve (or optimize) the development (i.e., the design and implementation) of effective intervention strategies encouraging healthy and sustainable diets (Marteau et al., 2020; Szaszi et al., 2018).

In the remainder of this general introduction, we discuss the current state of evidence by means of a modified version of the socioecological model (Bronfenbrenner, 1992; Centers for Disease Control and Prevention, n.d.; U.S.

Department of Health and Human Services, 2005). The socioecological model was specifically adapted by Story et al. (2008), depicting the multiple interrelated influences on our consumption (Figure 1.1.). This dissertation is particularly focused on the threefold interaction between the individual (the core of the model), the social food environment, and the physical food environment. However, we acknowledge that our dietary decisions are also impacted by more superordinate (macro) levels of influence operating within the larger society (sectors), including factors such as food marketing, food production, economic price structures, laws, and policies (macro level environments). This research needs to be understood mainly in a Dutch cultural context (e.g., with its own collective norms). We first outline the current state of evidence regarding the influence of physical food environments (specifically physical cues) on dietary behavior (Section 1.2), after which the influence of social food environments (specifically social norms) on consumption will be described (Section 1.3). We then focus on the interplay between these two environmental forces on our consumption behavior (Section 1.4), followed by the general aim of this dissertation and an outline of the empirical chapters (Section 1.5).

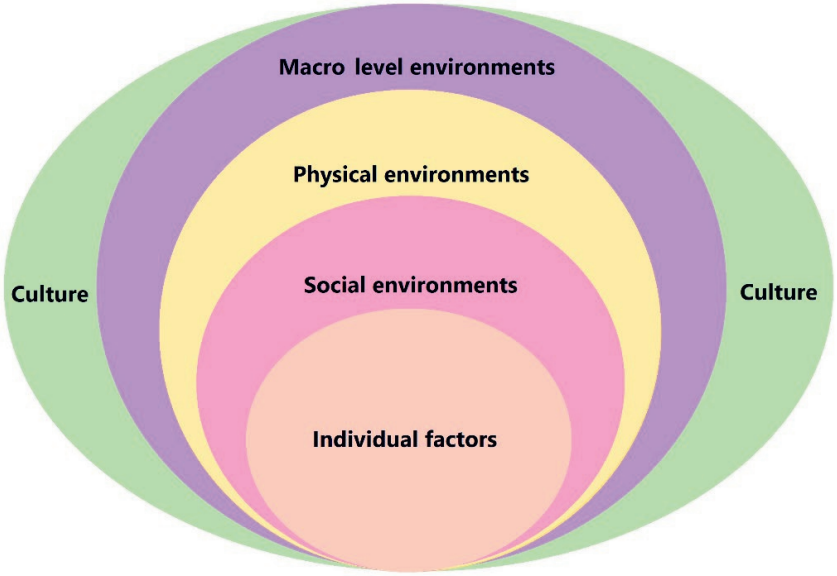

Figure 1.1. Story et al.'s (2008) adapted socioecological model, simplified to explain the structure of this general introduction.

1.2. The physical food environment

The idea that the environments through which we navigate have an impact on our consumption is not new. The influence of our surroundings on our health outcomes was formally recognized with the Ottawa Charter in 1986, among other things advocating for the creation of supportive environments to promote health (World Health Organization, 1986). After this charter for action, various sophisticated socioecological models were developed, attempting to explain the interaction between individuals and their environment (e.g., Bronfenbrenner (1992); Centers for Disease Control and Prevention (n.d.); Story et al. (2008); Swinburn et al. (1999); U.S. Department of Health and Human Services (2005)). This dissertation is specifically focused on the influence of micro (rather than macro) food environments on our dietary decisions, including specific settings such as schools, workplaces, food retailers, and food service outlets in which people interact directly with stimuli and objects within those environments (Hollands et al., 2017; Story et al., 2008; Swinburn et al., 1999). According to the ANGELO framework, four distinct environmental types can be identified within these micro food environments – all able to influence our dietary decisions (Swinburn et al., 1999). These environmental types include physical environments (referring to what is available), economic environments (referring to the costs), political environments (referring to the rules), and sociocultural environments (referring to attitudes, beliefs, and values) (Swinburn et al., 1999). The current dissertation aims to improve our understanding of the physical aspect of the micro food environment, particularly by investigating how specific physical aspects (i.e., physical cues) in those environments affect our eating behavior enacted in that same environment.

1.2.1. Physical cues in micro food environments

Ample empirical studies have been performed to understand whether there has been an impact of a variety of physical cues (in different situations) on behavior over the past decades (Szaszi et al., 2018). The focus on such an *is* question may be considered as the first generation of research questions in this (emerging) research domain – given the three typical research generations as distinguished by Zanna & Fazio (1982). For example, in a recent Cochrane systematic review by Hollands et al. (2019), it was reported that changes in the number of available food options or in the position of particular foods – in the setting to which people are exposed – may potentially influence food selection and consumption. To illustrate, it has been shown that the provision of a proportionally larger (versus a smaller) number of different vegetarian meal options (i.e., doubling vegetarian availability from 25 to 50%) in college cafeterias increased their vegetarian sales (and decreased the sales of animal source meals) (Garnett,

Balmford, Sandbrook, Pilling, & Marteau, 2019). Such effects on food consumption (and selection) have also been observed with changes in the size of food portions, packaging and tableware, with exposure to larger (versus smaller) sizes resulting in an increased consumption amount (and selection of foods), as reported in an earlier Cochrane systematic review by Hollands et al. (2015). In an attempt to consistently describe and classify such environmental changes, a typology of interventions in proximal (i.e., sensorily perceptible) physical micro environments has been developed (referred to as TIPPME), outlining different strategies to change the properties either of stimuli or of objects themselves (e.g., food portion sizes) or the placement of these stimuli or objects (e.g., the availability or proximity of food) within those micro environments to which people are exposed (Hollands et al., 2017). These alterations in physical cues in micro food environments are not designed to be tailored (e.g., varying dependent on an individual's responses or characteristics) but are mainly standardized for all people exposed to that environment (focusing on shaping behavior at the population level rather than at the individual level) (Hollands et al., 2017). Our dietary decisions may thus be (partially) determined by the physical arrangement of the environment in which we navigate, and it may be reasoned that we are exposed to a wide range of such physical cues in food environments, regardless of whether those cues are intentionally implemented within micro food environments to elicit certain behaviors or whether they are unintentionally present within those environments created to enable our consumption.

1.2.2. The underlying mechanisms

As described in Section 1.1., to date, relatively few studies have aimed to understand what processes drive our consumption in response to such physical cues in micro food environments, meaning that it remains poorly understood *how* specific physical cues to which we are exposed influence our dietary decisions. The focus on such a *how* question may be considered as the third (or second) generation of research questions in this (emerging) research domain – with the second (or third) generation focusing on the circumstances (or conditions) under which physical cues may determine consumption (Zanna & Fazio, 1982). Such a *when* question is somewhat outside the explicit main scope of the current dissertation, although we acknowledge the importance of studies investigating the boundary conditions of the effectiveness of physical cues in guiding behavior (e.g., strong a priori preferences as studied by Venema (2020)). The predominant idea behind the influence of physical cues on dietary decisions is that human behavior can be affected in a predictable way by making changes in the spatial arrangement of food environments (Thaler & Sunstein, 2008).

For example, the relatively small change of increasing the physical distance between people and (less healthy) snacks (e.g., from 20 cm to 70 cm from armrest) has repeatedly been demonstrated to reduce the (likelihood of) consumption (Hunter et al., 2018; Hunter, Hollands, Pilling, & Marteau, 2019; Knowles et al., 2020; Maas et al., 2012). This may be a predictable outcome, as the snacks were automatically made less accessible by placing them further away from the individual, meaning that the snacks objectively required more effort to obtain and were made less salient (or visible) to the individual. In previous research, perceptions of effort and salience were indeed repeatedly indicated as the potential key mechanisms that may explain the proximity effect, with some studies explicitly measuring an individual's perception of the effort required to obtain the snacks, as well as their perception of how salient the snacks appeared (Hunter et al., 2018; Knowles et al., 2019, 2020; Maas et al., 2012). These former studies showed, in line with predictions, that individuals perceived that it required more effort to obtain the snacks when the snacks were located further away from (compared to closer to) the individual (Hunter et al., 2018; Knowles et al., 2019, 2020; Maas et al., 2012). However, those studies that further examined the role of perceived effort showed either that perceived effort did not moderate the effect of physical distance on consumption (Knowles et al., 2019) or that perceptions of effort did not influence consumption (Knowles et al., 2020). In relation to perceived salience, previous research (unexpectedly) demonstrated that the snacks were perceived as equally (visually) salient regardless of their relative physical position vis-à-vis the individual (Hunter et al., 2018; Knowles et al., 2019, 2020; Maas et al., 2012). A higher perceived salience of the snacks was, however, positively correlated with a higher consumption of those snacks; this observation may suggest that visual salience may be independent of the proximity effect and thus may affect consumption irrespective of their physical distance (Knowles et al., 2019, 2020). In Knowles et al.'s (2020) research, similar hypotheses were tested with a different physical cue, specifically the presence (versus the absence) of a layer of wrapping around the snacks, with its presence reducing their actual consumption. More interestingly, they did actually observe that exposure to wrapped (versus unwrapped) snacks may decrease an individual's perceived salience of the snacks, and their perceptions of effort required to obtain the snacks was also increased.

From the outlined studies, it may be suggested that perceptions of effort and salience play some role in understanding how the spatial arrangement of micro food environments influences consumption, although these studies are not conclusive in explaining their influence – specifically their mediating role was not tested in any of the studies. Further investigation into the potential underlying mechanisms is thus needed. We therefore propose to expand the dominant view as outlined in Section 1.1. by

suggesting that such a predictable behavior may also be elicited by social norms that are physically embedded in food environments. In the following section, we describe the role of the social food environment in guiding consumption, and we specifically provide a theoretical underpinning of such a social norm account.

1.3. The social food environment

Humans are social beings who live in social environments, with roots in evolutionary history (Griskevicius, Goldstein, Mortensen, Cialdini, & Kenrick, 2006; Griskevicius, Goldstein, & Redden, 2011; Neuberg, Kenrick, & Schaller, 2010; Sundie, Cialdini, Griskevicius, & Kenrick, 2006). Our behavior cannot be seen in isolation from our social environment, as we have an inner drive to be accepted by, and belong to, others, and we compare ourselves with others. Our susceptibility to social influences has been widely acknowledged in the literature, showing that social environments are powerful in affecting perceptions and behaviors (Asch, 1951; Bond & Smith, 1996; Cialdini & Goldstein, 2004; Fiske, 2010; Hammerl, Dorner, Foscht, & Brandstätter, 2016; Nolan, Schultz, Cialdini, Goldstein, & Griskevicius, 2008), including our dietary decisions about what and how much we choose to eat (e.g., Higgs & Ruddock (2020); Higgs & Thomas (2016)). Other people in our social contexts may affect our dietary decisions in various ways. Three main areas of research in this domain outline that people may (a) use the eating behavior of others as a guide for themselves to determine what and how much to eat (referred to as modelling of eating), (b) use their dietary decisions to portray a certain (favorable) impression of themselves to other people (referred to as impression management), or (c) show a tendency to eat more when they eat with friends or family compared to when they eat alone (referred to as social facilitation of eating) (Higgs & Ruddock, 2020; Higgs & Thomas, 2016). One explanation for such an impact of social influences on consumption is that our social environment provides a guide for normal and/or appropriate behavior in a given situation, i.e., our social food environments signal *social norms* about what and how much is normal and/or appropriate to eat in that environment (Higgs, 2015; Higgs & Thomas, 2016). It may thus be reasoned that we use such social norms to determine our dietary decisions, and, concurrently, our actions influence others in making their decisions by signaling a certain norm. Several scholars have indeed demonstrated the power of social norms in affecting our eating behavior (e.g., as described in systematic reviews by Robinson, Thomas, et al. (2014); Stok et al. (2016)). Conformity with such social norms presumably has its roots in evolutionary history, as the following of social consumption norms in a particular situation tends to increase the likelihood of our eating safe foods and facilitates food sharing (thus enhancing evolutionary fitness) (Higgs, 2015). In this section, the concept

of social norms is described more extensively (Section 1.3.1) and their role in determining eating behavior is discussed (Section 1.3.2).

1.3.1. Social norms

Across disciplines (e.g., social psychology, sociology, economics, law, philosophy, and public health), there are different perspectives on how social norms are defined, formed, and exert an influence on behavior (Cislaghi & Heise, 2019; Mackie, Moneti, Denny, & Shakya, 2015). For example, Ajzen & Fishbein (1980) call this a subjective norm, whereas others refer to a perceived norm (e.g., Lapinski & Rimal (2005)) or social expectations (Bicchieri, 2006). These different definitions tend to have in common that social norms are constructed by one's beliefs (or perceptions) about what (relevant) other people do or think one should do (social norms are thus socially shaped) – these relevant others (to whom one refers) are referred to as the reference group. A further commonality is the idea that social norms are informal, contingent on the situation, and held in place by social influence, i.e., maintained by social approval (such as positive sanctions by the reference group) or social disapproval (such as negative sanctions by the reference group) (Mackie et al., 2015). This dissertation follows a social-psychological approach to social norms, adopting the *focus theory of normative conduct* developed by Cialdini and his colleagues as a theoretical underpinning (Cialdini, Kallgren, & Reno, 1991; Cialdini et al., 1990). The following subsections discuss two important premises as outlined by this theory: the distinction between descriptive and injunctive norms (Section 1.3.1.1.) and the importance of norm salience (Section 1.3.1.2.).

1.3.1.1. Descriptive and injunctive norms

Empirical work by Cialdini et al. (1991) and Cialdini et al. (1990) has demonstrated the importance of distinguishing between *descriptive* norms (what other people do in a given situation) and *injunctive* norms (what should be done according to other people in a given situation). Descriptive and injunctive norms are thus two conceptually and motivationally distinct types of social norms, differing, among other things, in *how* they affect behavior: influence based on what others have done versus what others condone, respectively (Cialdini & Trost, 1998; Zanna & Fazio, 1982). Regarding descriptive norms, humans have the intrapersonal goal of behaving effectively, and, in attempts to maximize the effectiveness of their (social) behavior, people may rely on the descriptive norm operating in that situation (i.e., rely on social proof). Especially in novel, ambiguous, or uncertain situations in which appropriate behavior is unclear, people tend to follow the behavior of others around them providing information about what is normal in that situation, and this may shape their interpretation of, and response to,

that particular situation (presumably saving time and cognitive effort) (Cialdini & Trost, 1998; Jacobson, Mortensen, & Cialdini, 2011). Regarding injunctive norms, humans have the interpersonal goal of maintaining and building social relationships with others (accurate decision making is then presumably less important). In attempts to gain social approval or acceptance by others (or to avoid social disapproval), people may be motivated to follow injunctive norms that are constructed from their perceptions about what other people approve or disapprove of in that situation (Cialdini et al., 1991; Cialdini & Trost, 1998; Jacobson et al., 2011).

1.3.1.2. Norm salience

Further, the focus theory of normative conduct emphasizes the importance of making the norm salient (i.e., focal in attention) in order to exert an influence on behavior (Cialdini et al., 1991; Cialdini et al., 1990). This research stream examining the conditions under what social norms are more likely to dictate behavior thus indicates that people tend to follow social norms only *when* the norm is salient at the point of behavior (Kallgren, Reno, & Cialdini, 2000; Zanna & Fazio, 1982). It is reasoned that when different (or even conflicting) norms are present in a similar situation, the norm more activated at the time of behavior is most likely to be followed in that situation (Cialdini et al., 1991; Cialdini et al., 1990). To illustrate one of their classical studies (among their other work), Cialdini and colleagues showed that a person's decision to litter a handbill in a particular environment was dependent on the dictates of the more salient norm. Specifically, making people concentrate on an injunctive norm against littering by showing an antilittering message on a handbill (compared to providing a nonnormative message) decreased littering behavior, regardless of the environmental state, as the naturally occurring litter in that environment was left unaffected – this may be considered as a conflicting descriptive norm promoting littering in that environment (Cialdini et al., 1991; Cialdini et al., 1990). Therefore, it seems crucial to distinguish between descriptive and injunctive norms, as both types may be present in an environment at the same time, dictating either congruent or contradictory conduct (Cialdini et al., 1991; Cialdini et al., 1990).

1.3.2. Social norms and food consumption

Social norm theory developed by Cialdini et al. (1991) and Cialdini et al. (1990) has been applied widely in studies investigating the influence of social norms on eating behavior (e.g., see reviews by Higgs (2015); Robinson, Thomas, et al. (2014); Stok et al. (2016)), demonstrating that both descriptive and injunctive norms may shape our dietary decisions (such as the quantity and type of food we choose (to consume)). Social norms

are therefore indicated as a potential tool for improving people's eating behavior. This previous work further indicated the importance of distinguishing between descriptive and injunctive norms, as they seem to work under different conditions in an eating context (for a brief discussion see Section 1.3.2.1.), and this is important to take into consideration in developing social norm interventions in such a food environment. Further, a range of methods can be used to influence perceptions of social norms in food environments, such as described in Section 1.3.2.2.

1.3.2.1. Factors affecting conformity with social norms in food environments

Several studies have attempted to increase our understanding of the factors that determine when social norms are followed in food environments (e.g., as described by Higgs (2015); Robinson, Thomas, et al. (2014); Stok et al. (2016)). For example, as described in Section 1.3.1.1., people are more likely to follow the lead of others when there is uncertainty about what constitutes appropriate consumption in that situation (Higgs, 2015). Further, among other proposed moderators (e.g., habitual consumption, food type, and individual characteristics such as sex), it was found that identification with the norm reference group moderated the relation between descriptive (but not injunctive) norms and (intended) consumption**.** Particularly, (young) people were more likely to adhere to descriptive norms when there was a greater shared identity with the norm reference group (e.g., a group of friends or students from the same university) (Higgs, 2015; Robinson, Thomas, et al., 2014; Stok et al., 2016). One may reason that norm following was used as a means to communicate their identity to such a social group, to promote affiliation, and to satisfy their desire to be liked (Higgs, 2015; Robinson, Thomas, et al., 2014; Stok et al., 2016). However, it was also shown that such descriptive norms could affect consumption when people ate alone in the absence of other people (thus without the possibility of directly communicating their identity to relevant groups). In the absence of such a direct social interaction, the norm in those studies referred to the behavior of previous participants (Higgs, 2015; Robinson, Thomas, et al., 2014), and it can be argued that norm adherence was then more motivated by a person's desire to behave correctly (according to the behavior of the reference group) (Higgs, 2015). Another potential moderator points to the forcefulness of the (communicated) injunctive norm, as a person may feel steered in a certain direction by this type of norm communication. Specifically, it was observed that strong 'ought' messages (i.e., a prescription) did not affect young people's consumption (or even showed adverse effects), whereas a more subtly communicated 'might' message (i.e., a suggestion) might result in desired dietary decisions in this target group (Stok et al., 2016). Such a boundary condition of the effectiveness of injunctive norms is

corroborated by other work by Stok, De Vet, De Wit, Renner, & De Ridder (2015), showing comparable results for the communication of restrictive versus suggestive eating-related rules.

1.3.2.2. Methods to communicate (or affect) social norms in food environments

Social norms are thus regarded as influencing consumption by our perceptions of what constitutes appropriate and/or normal eating in a given situation (Higgs, 2015). A range of methods can be used to influence such perceived social norms in food environments or to form such social norms (Robinson, Thomas, et al., 2014), although they of course may also occur naturally in food environments rather than being purposely communicated. To outline some methods, as described in Higgs's (2015) review, people may be exposed *directly* to social norms via actual behavior in a particular environment, such as the norms set by the consumption of other people present in that environment (e.g., Herman, Roth, & Polivy (2003)). The norm may also be set by remote (rather than actual) models exposing people to fictional accounts of the quantity of foods eaten by previous participants (Higgs, 2015) – for example by exposing people to information sheets of fictitious previous participants, as in Robinson, Benwell, & Higgs (2013). In what is presumably a more explicit method, social norms can be conveyed by text-based messages (Higgs, 2015), such as providing written information about the consumption behavior of other people (i.e., a descriptive norm) or about what other people think a person should consume (i.e., an injunctive norm), see for example Stok, De Ridder, De Vet, & De Wit (2014). Further, it has been proposed that people may be exposed *indirectly* to social norms via physical cues in a particular environment (De Ridder et al., 2013; Higgs, 2015), such as via the presence of empty food wrappers. These empty food wrappers may act as an embodiment (or evidence) of the previous consumption of other people in that situation, and it has been shown that a person's dietary decisions are influenced by the presence of such cues (Burger et al., 2010; Prinsen et al., 2013). These studies are further outlined in Section 1.4.1., as the current dissertation is focused on such an indirect communication of social norms via physical cues in micro food environments.

1.4 The interplay of physical and social food environments

This dissertation pertains to the interaction of physical and social environments and their influence on our dietary decisions. The idea of such an interplay between social and physical aspects is not new. For example, in the work of Cialdini et al. (1991) and Cialdini et al. (1990) as discussed in Section 1.3.1.2., the amount of litter present in an environment was used as an embodiment of descriptive norms. Specifically, it was

deemed that greater amounts of litter signaled (or proved) the littering behavior of other people, denoting that littering is 'popular' (or normal) in that environment – and it was shown that a person's likelihood of littering indeed increased when more litter was present. The scholars labeled the abundance of litter as a *descriptive norm cue* favoring littering in that environment. They also investigated the influence of an *injunctive norm cue*, assuming that a great amount of litter distributed across the environment signaled an approval cue to litter, whereas an environment with comparable amounts of litter, but swept into piles, was considered to signal a disapproval cue to litter. Such a pattern regarding littering behavior was indeed observed, but only when the norm was made salient by someone drawing attention to that environment by dropping litter in that environment (versus solely walking by) – again stressing the importance of norm salience in order to elicit behavior change (Cialdini et al., 1991; Cialdini et al., 1990). A few decades ago, it was thus already assumed that physical aspects in environments can signal social norms, and some preliminary evidence for such a social norm interpretation of physical cues has also been found in the context of eating behavior, as described in Section 1.4.1.

1.4.1. Physical cues in food environments potentially signaling social norms

The effect of empty food wrappers on dietary decisions have been mentioned several times in this introductory chapter, as this seems a clear example of a physical cue in food environments potentially being interpreted by people as a social norm, in ways comparable to the presence of litter influencing behavior. Particularly, previous experiments in laboratory and real-world settings demonstrated that, in situations where food availability and access were similar, a person's decision to take a snack was influenced by the presence or absence of empty snack wrappers – with its presence increasing snack intake (Burger et al., 2010; Prinsen et al., 2013). Also, people had a higher likelihood of choosing a 'healthy' (rather than an 'unhealthy') snack when they were led to believe that previous participants typically chose a healthy snack via the presence of empty wrappers. The scholars reasoned that the empty snack wrappers functioned as a physical cue communicating that others in that similar situation had previously consumed the snacks. They further reasoned that this exemplifies a descriptive norm communicated by the food environment, and they used the effect of the empty wrappers on consumption as evidence for this social norm account (Burger et al., 2010; Prinsen et al., 2013). However, in the illustrated examples (regarding littering and the empty snack wrappers), it remains unknown whether people actually interpreted such physical cues as a social norm, as people's perceptions of such physical cues were not measured in those studies.

The suggestion that social norms may explain (underlie) the effect of the arrangement of physical food environments on dietary decisions seems to appear more often in other literature streams, for example as outlined in research regarding food portion sizes and food availability. Ample studies have demonstrated that people tend to eat more when served larger portions (as described in Section 1.2.1. (Hollands et al., 2015)), and, in attempts to explain this effect, it has been proposed that portion sizes may function as a physical cue that signals the appropriate amount to consume in that situation (Herman, Polivy, Pliner, & Vartanian, 2015). Also, several experimental studies showed that being served a larger (rather than a smaller) portion on day 1 resulted in participants selecting and consuming more of that food one day later (24h later), and this increased their generic perceptions of what constitutes a 'normal-sized' portion (Robinson, Henderson, Keenan, & Kersbergen, 2019; Robinson & Kersbergen, 2018). This suggests that exposure to portion sizes may affect perceptions of a normal portion size, and it has been shown that these generic perceptions of portion size normality could mediate the effect of served portion sizes on later consumption (Robinson & Kersbergen, 2018). This previous work prompts further investigation of the role of social norms as a mechanism explaining the effect of portion size exposure on consumption, as the basis for the generic portion size normality judgment remains unclear in these studies (participants were asked to indicate what they think is a 'normal' portion of food to consume in a particular situation) (Robinson et al., 2019; Robinson & Kersbergen, 2018). Based on social norm theory by Cialdini et al. (1991) and Cialdini et al. (1990), one may propose that people believe that a given food portion is based on what other people in that environment (a) typically consume (a perceived descriptive norm) and/or (b) consider as the appropriate consumption amount for them (a perceived injunctive norm), influencing their consumption accordingly. Such a reasoning is corroborated by suggestions stating that people tend to assume that a served portion (determined by others) represents a judgement about what should be consumed in that context (Herman & Polivy, 2005). Regarding the relative availability of foods, as described in Section 1.2.1., increasing the proportion of particular foods may increase their selection and consumption (Hollands et al., 2019). In a comparable way as described with regard to portion sizes, it may be reasoned that the relative availability of foods may function as a physical cue implying a social norm, thereby affecting consumption; this is in line with suggestions by previous scholars such as Pechey, Cartwright, et al. (2019), Pechey, Hollands, Carter, & Marteau (2020), and Van Kleef, Otten, & Van Trijp (2012). Particularly, people may interpret a higher proportion of particular foods being available as a signal about what other people in that context (a) typically consume (perceiving the abundantly available products as being popular – a perceived

descriptive norm) and/or (b) consider as the appropriate choice for them (a perceived injunctive norm), eliciting norm-consistent behavior.

To our knowledge, studies empirically testing the role of social norms as an underlying mechanism of the effect of physical cues in food environments on consumption have largely been lacking, although several scholars have argued about such an interpretation of physical cues in food environments, as outlined in this section. Physical cues in micro (food) environments (e.g., the presence/absence of litter or empty snack wrappers) were mostly assumed to operationalize a social norm (e.g., a descriptive norm), rather than these social norm perceptions being explicitly disentangled (they were discussed mostly in hypothetical and theoretical terms), for example as in Burger et al. (2010), Cialdini et al. (1990), and Prinsen et al. (2013). To 'confirm' their assumptions, the arrangement of physical cues was often manipulated between conditions (e.g., varying the presence or absence of empty snack wrappers), and behavioral patterns were then measured to prove their assumptions – such as a person's likelihood of taking snacks. Also, some scholars attempted to measure more generic norm perceptions, such as perceptions of portion size normality, as in Robinson et al. (2019) and Robinson & Kersbergen (2018), rather than explicitly disentangling descriptive from injunctive norm perceptions. Previous scholars thus mostly attempted to either manipulate physical cues presumably exemplifying a social norm or measure more generic norm interpretations of physical cues in food environments, using varying (heterogenous) approaches to conceptualize, operationalize, and measure those norms. Measuring descriptive and injunctive norm interpretations of the material world is thus rather uncommon (and novel). It is therefore unknown whether perceived descriptive and injunctive norms are an (overlooked) potential explanatory mechanism of the relationship between physical food environments and food consumption.

1.5. General aim and chapter overview

The general aim of this dissertation is to improve the understanding of how physical cues in micro food environments determine dietary decisions. We therefore posit that physical and social aspects of food environments are intertwined. Specifically, we aim to demonstrate that social norms are indeed inferred from physical cues in food environments. We further aim to demonstrate that social norm interpretations indeed mediate the effect of food environment exposure on food consumption. The social norm interpretation is tested among a range of different physical cues, each chapter focusing on a specific physical cue (Chapters 3–5), thus testing similar hypotheses under different circumstances to validate the underlying theory. Specifically, the focus theory of normative conduct developed by Cialdini et al. (1991) and Cialdini et al. (1990) is used

as the theoretical premise in this dissertation, distinguishing between perceived *descriptive* norms (beliefs about what other people do in a given situation) and perceived *injunctive* norms (beliefs about what should be done according to other people in a given situation). We thereby attempt to measure perceptions of social norms across the different chapters, continuously fine-tuning (improving) social norm measures and adapting them to the specific physical cue under investigation. Further, relevant explanations alternative to the social norm account, known from the literature (such as perceived effort and salience), are also taken into consideration throughout the different chapters in this dissertation. Consequently, this dissertation contributes to the understanding of the causal mechanisms explaining the effect of physical cues in micro food environments on food consumption. Chapters 2–5, the empirical body of this dissertation, were written as standalone papers; therefore, our rationale that physical and social environments interact with each other may recur several times.

Chapter 2 provides a foundation for the experimental designs applied in Chapters 3–5. To do so, an inventory was created of physical cues in food environments potentially communicating social norms, mainly adopting an interpretative approach. First, a qualitative study was conducted in which we analyzed a set of photographs taken in different self-service food environments (e.g., worksite restaurants, roadside shops). The photographs were analyzed using strategies from photo documentation, semiology, and grounded theory to structurally link physical cues to both descriptive and injunctive norm connotations. Second, we cross-validated our findings among laypeople who completed an online questionnaire. Participants were exposed to two preselected photographs obtained from the qualitative study. They were asked to spontaneously identify physical cues in the photographs that could encourage or discourage people to obtain foods, and they rated a set of social norm statements – created on the basis of the descriptive and injunctive norm connotations formulated in the qualitative study – for a specific preselected physical cue in each photograph. From these studies, the causal effect of physical cues in food environments on perceived social norms and food consumption still remained unclear however. Therefore, we adopted an experimental approach and examined the effect of a set of three such identified physical cues on social norm interpretations and food consumption in subsequent studies – specifically, we tested the effect of a cover (Chapter 3), relative availability (Chapter 4), and portion sizes (Chapter 5).

Chapter 3 reports on two quasi-experimental field studies and a lab experiment disentangling the mechanisms underlying the effect of one specific physical cue connected to available foods on food consumption, namely, the presence or absence of a cover on snack bowls, presumably illustrating an injunctive norm (building on the

results from Chapter 2). Both direct and indirect pathways of the effect of physical cues on food consumption were tested. Regarding the indirect effect, three potential mediating factors were examined: (a) perceived social norms to take snacks, (b) perceived effort to obtain the snacks, and (c) perceived salience of the snacks. Also, direct effects of the manipulation on the proposed mediators were tested to assess how such cues are interpreted. The social norm measure used in these studies, however, precluded separating descriptive from injunctive norm interpretations, thus measuring social norms in generic terms.

Chapter 4 focuses on the effect of offering an increased proportion of plant-based relative to animal source foods as an example of a physical cue potentially being interpreted as a social norm encouraging plant-based food consumption among non-vegetarians. Both an online experiment and a lab-in-the-field experiment were performed, with different experimental manipulations simulating (online) supermarket settings and including different foods. To investigate how the (hypothetical or actual) selection of plant-based versus animal source foods is influenced by food availability, participants reported their (a) perceived descriptive norms about what others would choose, (b) perceived injunctive norms about the appropriate choice according to others, and (c) perceived salience of the foods – thus separating descriptive from injunctive norm interpretations in the norm measure (deepening/advancing the approach adopted in Chapter 3). Again, both direct and indirect effects of exposure to the availability manipulation on food choice were tested, as well as the direct effects on the proposed mediators to examine how such cues are interpreted. Chapter 4 also explores a potential moderator in the effect of altering sustainable food availability on food selection, namely, people's differences in meat attachment.

Chapter 5 describes an online experiment and a lab-based experiment testing the influence of being visually exposed to, or actually being served, smaller (versus larger) portion sizes on consumption of that food 24h later. In those experiments, either hypothetical portion size selection or actual portion size selection and food intake were measured, rather than a food choice task such as mainly included in the previous chapters. Both studies investigated the mediating role of generic perceptions of portion size normality in this effect, as assessed in previous studies by Robinson et al. (2019) and Robinson & Kersbergen (2018). The basis for these generic portion size normality judgements remained unclear however. Therefore, some more specific potential mediators in this effect were also tested: (a) perceived descriptive norms about how much others would choose to consume, (b) perceived injunctive norms about the appropriate consumption amount according to others, (c) personal norms about the normal/appropriate consumption amount according to themselves, and (d) expected

satiety beliefs about how much of a food one needs to consume to feel satisfied. Additionally, examination of the direct effect of portion size exposure on these proposed mediators revealed how such portion sizes were interpreted.

Chapter 6 summarizes and discusses the main results of the studies described in Chapters 2–5 with regard to the general aim of this dissertation. Further, a theoretical and methodological reflection on the main findings is presented, followed by some directions for future research and the implications for policy and practice that emerged from this dissertation.

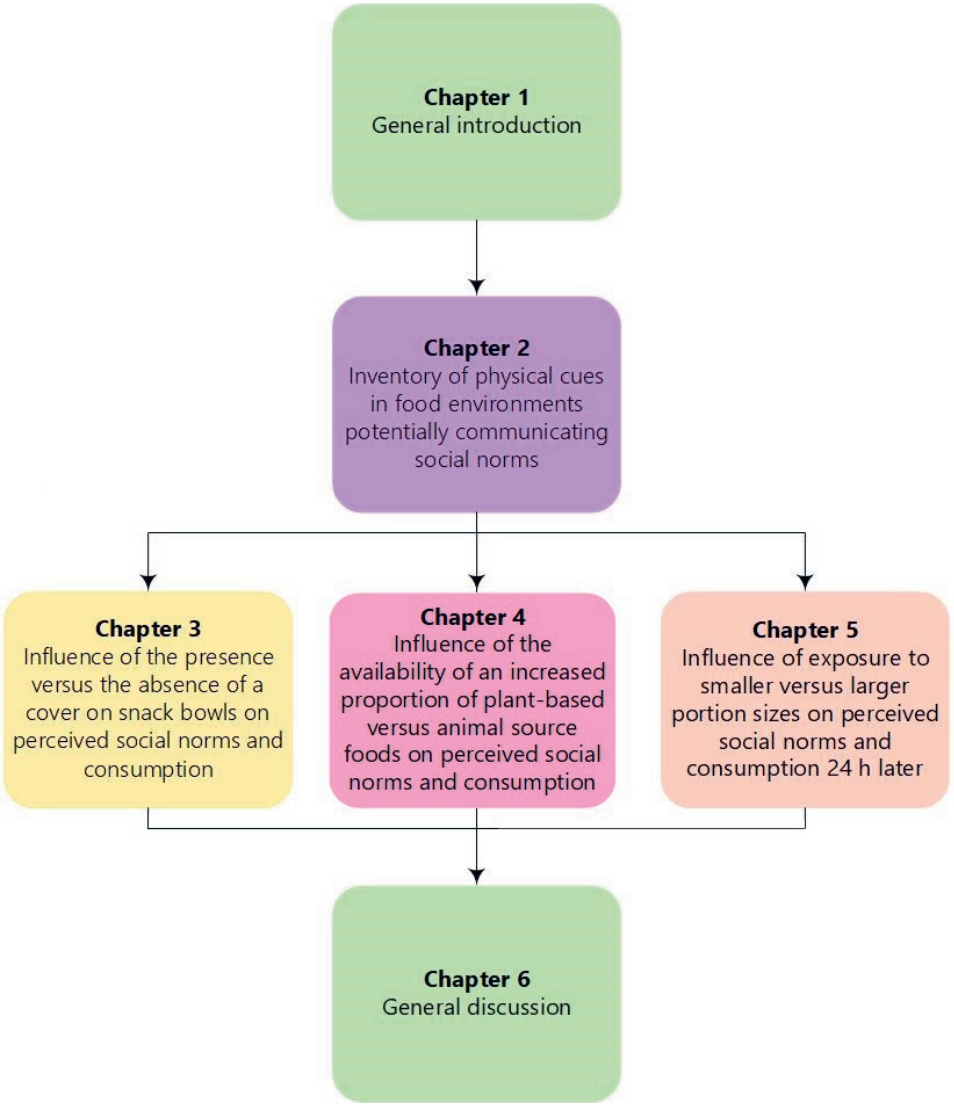

Figure 1.2. Visualization of the structure of this dissertation.

Chapter 2

Identifying social norms in physical aspects of food environments: A photo study

This chapter is published as:

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Abstract

It is widely accepted that physical food environments can contribute to unhealthy eating, but less is known about how physical cues in these environments actually stimulate eating. Our study starts from the assumption that social norms are embedded in physical cues and aims to make an inventory of physical cues that communicate what is socially accepted as normal and/or appropriate to eat in a Dutch outside-the-home food context. In Study 1, we conducted a qualitative study in which photographs taken in self-service food environments were analyzed using strategies from photo documentation and semiology. Grounded theory was applied to identify a wide variety of specific physical cues that were ultimately grouped into 18 higher level categories of physical cues (e.g., consumption traces, product availability). Most cue categories were associated with either descriptive or injunctive social norms, but some were associated with both types. In Study 2, we aimed to quantitatively cross-validate the social norm interpretations among laypeople (n = 173) by focusing on two selected photographs. More than half of the physical cues that participants identified in these photographs as being influential had been identified in Study 1 as cues bearing a normative message. The results further indicated that other people's behavior is easier to recognize in physical food environments than signals about what ought to be done. Given the great variety of identified physical cues associated with social norms, we posit that social norms are widely embedded in food environments and might guide eating behavior. Further research should study the effects of these cues on behavior and test whether the underlying process can be attributed to social norm interpretations.

2.1. Introduction

It is increasingly recognized that we live in environments that stimulate unhealthy eating. These environments, also referred to as 'obesogenic environments', have been defined as "the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations" (Swinburn et al., 1999, p. 564). The ANGELO framework (analysis grid for environments linked to obesity) has been widely used (e.g., Kirk, Penney, & McHugh (2010); Nieuwendyk et al. (2016); Simmons et al. (2009)) to gain a concrete understanding of the aspects of environments that specifically impair or support healthy diets. This framework distinguishes between the influence of micro environments (i.e., settings where people gather for specific purposes related to food or physical activity, such as neighborhoods, schools, and food retailers) and macro environments (i.e., sectors influencing food consumption and physical activity involving a group of industries, services, or supporting infrastructure such as media, food production, and transport systems). Within these micro and macro environments, four types of environmental aspects have been shown to influence food intake: physical aspects (what is available), economic aspects (what the costs are), political aspects (what the rules are) and sociocultural aspects (what the attitudes and beliefs are) (Swinburn et al., 1999). The present paper aims to gain a better understanding of the physical aspects of the micro food environment. Although the dominant view is that the high availability and easy accessibility of unhealthy foods contribute to overconsumption (Pitt et al., 2017; Story et al., 2008; Townshend & Lake, 2017), this view can be considered myopic. In this paper, we posit that social processes are physically embedded in food environments and that this may in turn affect our food consumption.

To date, associations between physical aspects of food environments (such as number and type of food stores in a neighborhood) and dietary behavior have predominantly been investigated in correlational studies (e.g., Morland, Wing, & Roux (2002)). However, it remains poorly understood how specific physical aspects (i.e., physical cues) affect eating behavior. Several scholars have examined the effect of a specific physical cue on food choice/intake by conducting small-scale experiments. For example, foods were made less accessible by increasing the distance to the foods or changing the serving utensils provided to obtain the foods (tongs instead of spoons). These subtle physical changes decreased food intake (Maas et al., 2012; Rozin et al., 2011). Subtle changes in the spatial presentation of foods have also been shown to have an influence on our food selection. For instance, a specific food was selected almost three times more when it was placed in the middle of the vendor tray instead of at the edge of the tray (Keller, Markert, & Bucher, 2015). Another study showed that placing

foods next to the cash register desk almost doubled their sales (Kroese, Marchiori, & De Ridder, 2015). Increasing the visibility of products by increasing their relative availability also increased the selection of these products (Pechey & Marteau, 2018).

Very limited research has had the aim of understanding the processes that drive consumption in response to physical cues in the environment. The present study aims to gain a better understanding of how physical cues in the food environment may be interpreted. Specifically, we propose that specific physical cues in the food environment bear social norms. Social norms are implicit codes of conduct that provide 'guidelines' for what is generally regarded as appropriate behavior (Higgs, 2015). Social norms can be descriptive, i.e., describing the behavior of others in identical situations and thereby showing what is considered 'normal'. Social norms can also prescribe the behavior one ought to exhibit and signal what behavior others approve/disapprove of, so-called injunctive norms (Cialdini et al., 1990). Ample research demonstrates that social norms are important in guiding eating behavior, as demonstrated in recent systematic reviews (Higgs, 2015; Robinson, Thomas, et al., 2014; Stok et al., 2016). Moreover, it has been proposed that changes in the food environment have coincided with changes in standards regarding the eating behaviors that are considered acceptable or approved of (De Ridder et al., 2013). This suggests that there might be an association between physical cues in food environments and social norms. Indeed, some preliminary evidence for this idea has been found. As many studies have shown that people tend to eat more when served larger portions (also known as the portion size effect), it has been suggested that portion size could function as a physical cue that subtly indicates the appropriate amount to eat (Herman et al., 2015). Other experimental studies (Burger et al., 2010; Prinsen et al., 2013) have examined the effect of empty snack wrappers on snack intake, in situations where food access was similar. The presence or absence of empty snack wrappers was experimentally varied between participants, and it was found that snack intake increased when empty snack wrappers were present. In both studies, it was inferred that this physical cue, empty snack wrappers, provides hints as to how others have behaved and thus communicates descriptive social norm information.

In the current study, performed in outside-the-home eating contexts in the Netherlands in 2016–2017, the role that social norms play in food environments is further explored. By studying food environments through a social norm lens, we aim to make an inventory of physical cues in the food environment that potentially function as a vehicle for social norm messages. In conformity with studies on empty snack wrappers (Burger et al., 2010; Prinsen et al., 2013), we expect that other physical aspects in food environments will clearly show the behavior of others and thus communicate a

descriptive social norm. For instance, increasing product availability might also be interpreted as a descriptive social norm suggesting what others typically choose, rather than that availability solely increases their visibility, as suggested by Pechey & Marteau (2018). In conformity with studies on portion size (Herman et al., 2015), we expect that other physical aspects in food environments will indicate the appropriate course of action and thus communicate an injunctive social norm. To illustrate, increasing physical distance to products might also be interpreted as an injunctive social norm suggesting a lower appropriateness of consumption as these products are placed further away from the individual, rather than that distance solely decreases their accessibility, as suggested by Maas et al. (2012). A photo study was conducted because photographs provide momentary visual input for systematically observing a wide range of physical cues. In Study 1, we conducted a qualitative study analyzing photographs taken in self-service food environments to identify social norms embedded in physical elements in such environments. In Study 2, we aimed to quantitatively cross-validate the social normative interpretations of physical cues among laypeople who were presented with a selection of the photographs analyzed in Study 1.

2.2. Study 1

To systematically take and analyze the photographs, a four-step method was developed inspired by a study by Suchar (1997) who combined photo-documentation strategies with grounded theory strategies. This combination offers a structural means for the researcher to obtain and interact with the visual data, thereby facilitating the identification and analysis of patterns in photographic data (Suchar, 1997). In line with the photo-documentation method, a 'shooting script' was used to structure the visual data collection and analysis. A shooting script consists of theoretically generated research questions for which photographic answers are obtained by the researcher (Suchar, 1988, 1997). For the current study, in conformity with the social norm theory developed by Cialdini et al. (1990), the distinction between descriptive and injunctive norms was used as the basis for the shooting script. Two researchers were jointly involved in obtaining and analyzing the photo data (SR, SvR) to facilitate a strategic and focused identification of social influences that are not readily apparent – i.e., to systematically reveal the underlying organization of the observed world (Suchar, 1997). In conformity with grounded theory (Strauss & Corbin, 1990), conceptual categories were constructed following an iterative coding process. The next section presents a detailed explanation of each step. An overview of the four-step research design can be found in Table 2.1.

Table 2.1. Research design.

Study 1 (photo documentation)	Study 2 (questionnaire)
Aim: To identify social norm cues embedded in physical food environments.	**Aim:** To cross-validate the findings of Study 1 in a sample of laypeople.
Step 1: Ninety-eight photographs of food environments were taken in eight different contexts based on a shooting script.	**Participants and materials**: One hundred seventy-three participants completed a questionnaire (consisting of two parts). Two photos from Study 1 were used in the questionnaire: one photo clearly representing an injunctive social norm and the other photo clearly representing a descriptive social norm.
Step 2: Forty photos out of the 98 were selected and analyzed by constructing descriptive fieldnotes.	**Procedure and measurements:** *Physical cue identification* The first part of the questionnaire consisted of an open question to discover the physical cues in the photos that participants indicated could encourage or discourage taking food. *Social norm interpretation* The second part of the questionnaire consisted of statements related to social norms, which were created on the basis of the connotations (meanings) used in Study 1. Participants were asked to focus on one specific physical cue per photograph while rating the statements.
Step 3: The descriptive fieldnotes were coded in an iterative process following a grounded theory procedure. Codes were assigned to all denotations (physical cues) and connotations (second order meanings). Codes were grouped into categories.	**Data analysis:** *Physical cue identification* The responses to open questions in the questionnaire were coded based on the code book developed in Study 1. New codes were created when necessary. *Social norm interpretation* The means of the connotative meaning ratings were analyzed in order to investigate the connotations that participants attach to the physical cues.
Step 4: Cue connotations were structured based on the following distinctions: (a) descriptive social norms vs. injunctive social norms, (b) effort vs. salience, and (c) encouragement of taking food vs. discouragement of taking food. Physical cue categories (denotations) were then linked to descriptive and/or injunctive social norm connotations.	

2.2.1. Methods

2.2.1.1. Step 1 – Photo Collection

As descriptive and injunctive social norms are conceptually and motivationally distinct – i.e., descriptive norms describe what most people do in a specific situation and motivate behavior by informing people of what is seen as effective or adaptive behavior, whereas injunctive norms indicate what is approved/disapproved of in a culture and motivate behavior by promising social sanctions (Cialdini et al., 1990; Jacobson et al., 2011) – the two types of social norms were approached separately in the current study. Hence, the shooting script consisted of the following two questions: (1) How are descriptive social norms communicated through physical elements in food environments? and (2) How are injunctive social norms communicated through physical elements in food environments? The criteria for the selection of food environments in which photographs were taken were (1) outside-the-home food selection by customers themselves (i.e., self-service) and (2) food selection intended for immediate consumption. These criteria were established based on the reasoning that, in such food environments, customers' food selection may be most directly influenced by cues in the environment. From this point of departure, it was reasoned that such self-service food environments can be found in different types of Dutch commercial food outlets in terms of direct/indirect payment, type of customer, and location. Accordingly, the main self-service food environment categories that we found were worksite restaurants (direct payment for food selection at cash desk, intended for employees, located within a worksite building), lunch buffets (no payment for food selection at cash desk (free selection), intended for preregistered guests, located within an hotel and/or event-hosting building), self-service restaurants (direct payment for food selection at cash desk, intended for visiting customers, located within a retail store), and roadside shops (direct payment for food selection at cash desk, intended for traveling customers, located at transportation sites). For each type of food environment, two establishments were selected to ensure a reliable as well as a comprehensive identification of cues that may communicate a norm. All eight participating food outlets (all located in various cities in the Netherlands, i.e., Wageningen, Utrecht, and Nijmegen) gave informed consent. The worksite restaurants, lunch buffets, and self-service restaurants all offered a lunch mainly including sandwiches, hot meals, fruits, snacks, and drinks. They varied substantially in variety and healthiness (e.g., one of the two worksite restaurants had a salad bar). The roadside shops had a variety of products, mostly packaged unhealthy foods products (e.g., cookies and candies) but also sandwiches, fruits, and nuts. The photographs were taken by two researchers (SR, SvR): two environments were jointly

photographed (SR and SvR) and six environments were photographed by one researcher (SR or SvR). To allow a structural observation of photos taken in different contexts, each photograph was taken with an iPhone approximately 1 m away from the food situation and was shot between 12.30 and 13.30. This time of the day was of interest as most included food contexts provided only lunch, and the timespan of an hour allowed for variations in food displays as a result of previous customers' interactions with the environment (untouched displays versus traces present). As stated in the informed consent letter, the researchers were instructed to photograph food only, and in the exceptional case of a person or persons being captured in the photo, no-one would be recognizable. Furthermore, each photograph contained a choice situation (e.g., water versus soda or 'big' plates versus 'small' plates), resulting in a total of 98 photographs (varying from 8 to 19 per food environment). See Figure 2.1. for two representative examples of the collected photographs.

Photo A

Photo B

Figure 2.1. Representative examples of photographs taken and analyzed by the researchers.

2.2.1.2. Step 2 – Photo analyses

For each of the eight contexts, five photographs were selected for further analyses. Four researchers with different backgrounds (SR consumer science, SvR health psychology, RL visual research methodology, EV health science) independently selected five photographs per context on which they most clearly detected potential social norm cues. Subsequently, each researcher ranked these five photographs on the extent to which social norms were salient in terms of encouraging or discouraging food selection from low (1) to high (5). Eventually, five photographs per context with the highest total score were included in further analyses, resulting in 40 photographs for the analyses.

To allow a structured identification of cues that may bear a social norm, each of the 40 photographs was analyzed by constructing descriptive fieldnotes using the terminology of semiology – the study of how signs may communicate meaning (Griffin, 2012; Hall, Evans, & Nixon, 2013). In the fieldnotes, physical cues potentially relevant to social norms were described as denotations (i.e., first order meanings related to signs in the photo such as crumbs or cutlery), and their second order meanings were described as connotations (i.e., interpretations of the denotations, such as appropriateness of taking food). Besides social norm connotations, associations related to effort to obtain food and salience of the food were considered, as these are evident alternative psychological processes underlying the consumer's interaction with the physical environment. Each connotation was concluded with a phrase about whether it would encourage or discourage taking food. See Table 2.2. for two examples of fieldnotes, each corresponding to a specific physical cue as depicted in the photos in Figure 2.1.

To enhance inter-observer agreement, a pilot study was performed in which four photographs were independently analyzed by two researchers (SR, SvR) who thereafter discussed all fieldnotes and sought to reach consensus about the level of detail of observation and scope and terminology of the fieldnotes. Next, both researchers independently analyzed half of the photographs and checked and revised the analyses of the other researcher. When this check resulted in revisions or complementary analyses, consensus was sought by discussion.

Table 2.2. Parts of the descriptive fieldnotes corresponding to Photos A and B of Figure 2.1. (original data were in Dutch).

Photo A	
Denotation	The six silver pans are each closed with a lid.
Connotation	1. The closed lid may communicate that the food cannot be taken, it may feel less appropriate to take the food. This may discourage people from taking food from the pans closed with a lid. 2. It requires more effort to take food from the pans closed with a lid. This may discourage people from taking food from the pans closed with a lid. 3. The food is less visible because of the closed lids. This may discourage people from taking food from the pans closed with a lid.
Photo B	
Denotation	There are empty places on four of the six plates filled with slices of cheese and meat.
Connotation	1. The empty places on the plates may communicate that other people have taken a slice of cheese or meat. This may encourage other people to also take a slice of cheese or meat. 2. The empty places on the plates may communicate that the slices of cheese and meat are scarce, due to insufficient supply. This may encourage people to take a slice of cheese or meat.

2.2.1.3. Step 3 – Coding

The descriptive fieldnotes for each of the 40 photos were imported into Atlas.ti (version 7.5.18). The coding process was jointly performed by two researchers (SR, SvR) to allow direct consensus on the creation and revision of codes. Codes were first assigned to all denotations (i.e., physical cues) and thereafter to the connotations (i.e., second order meanings). The coding process was iterative, as initial codes were continuously modified and added as familiarity with the dataset increased. In line with the grounded theory procedure, codes were first grouped into subcategories and ultimately grouped into higher level conceptual categories, following an increasing level of abstraction. To illustrate, the denotation 'the six silver pans are each closed with a lid' derived from Photo A (Figure 2.1.) may first be coded into the subcategory 'pan closed with a lid' and ultimately into the higher level physical cue category '(un)covered presentation'.

2.2.1.4. Step 4 – Cue-connotation structures

Finally, to cluster the findings, each of the physical cue subcategories (e.g., consumption traces) was linked to its associated (and coded) social norm connotation (e.g., others have taken). Subsequently, all social norm connotations were classified as either descriptive or injunctive social norms. For example, consumption traces were classified as a descriptive social norm, as this physical cue subcategory was linked to the social norm connotation describing that others have taken food. For each physical cue

subcategory, a cue-connotation structure was created, in which this classification process is depicted. Also, the connotations related to the alternative processes of effort and salience were linked to the physical cue subcategories. Ultimately, each connotation was linked to encouragement or discouragement of taking food. See Supplementary Figure S2.1. and S2.2. for two examples of the cue-connotation structures.[1] Each cue-connotation structure includes all possible corresponding connotations (e.g., others have taken), as identified across all descriptive fieldnotes.

2.2.2. Results

In the 40 photographs, 128 different specific physical cues were identified that could be related to social norms (e.g., 'middle shelf in refrigerator', 'fixed size of bowl', or 'plastic wrap on product plate'). These specific cues were further categorized into 41 subcategories (e.g., 'middle placement', 'fixed unit size', or 'covered presentation'), which in the end were categorized into 18 higher level conceptual categories (e.g., 'placement', 'unit size determination', or '(un)covered presentation'). Each higher level category represents the main common characteristic of its subcategories.

As deduced from the cue-connotation structures, four of the higher level conceptual categories were associated with descriptive social norm connotations, 10 of the higher level conceptual categories were associated with injunctive social norm connotations, and four of the higher level cue categories were associated with both descriptive and injunctive social norm connotations. Supplementary Table S2.1 presents an overview of all identified physical cues for each of these levels of abstraction and the descriptive and/or injunctive social norm connotations to which they relate.

The 18 higher level physical cue categories that were identified as bearing descriptive and/or injunctive social norms are presented below. Supplementary Table S2.1 lists the subcategories that belong to the higher level physical cue categories.

2.2.2.1. Physical cues associated with descriptive social norm connotations

Consumption traces show that other people have taken or interacted with the food as well; this was associated with an encouraging descriptive social norm.

Emptiness refers to situations in which empty spots are visible at places that are intended for displaying food products. A completely empty food display may suggest both that others have taken food (encouraging descriptive social norm) and that the food is 'unpopular' due to low demand (discouraging descriptive social norm).

[1] All cue-connotation structures can be retrieved from the corresponding authors. As shown in these structures, some of the physical cues relating to social norms were also associated with processes of effort and salience. As this study focused on social norms, these processes are not described in the results section.

Empty places may suggest that others have taken food as well (encouraging descriptive social norm).

Height of stacks refers to food products or tableware (e.g., bowls or plates) stacked in stacks varying in height. This height difference might suggest that others have taken food or tableware as well (encouraging descriptive social norm).

Neatness of presentation refers to either an obviously messy or an obviously tidy presentation. An apparently messy presentation may suggest that others have taken food as well (encouraging descriptive social norm), whereas an apparently tidy presentation may suggest that others have not taken the food (discouraging descriptive social norm). A tidy presentation might also suggest that it is less appropriate to take the food as this may 'disturb' a display that is remarkably neat and still untouched (discouraging injunctive social norm).

2.2.2.2. Physical cues associated with injunctive social norm connotations

Approachability refers to a deviating food display that is approachable from two sides (as opposed to one side), possibly suggesting that it is appropriate to take food from both sides (encouraging injunctive social norm).

Color refers to situations in which products are clearly marked or surrounded with either green or red. A 'green color' could signal approval and might suggest that it is appropriate to take food (encouraging injunctive social norm). In contrast, a 'red color' could function as an inhibition signal and might suggest that it is less appropriate to take food (discouraging injunctive norm).

Direction signal refers to a physical sign used to guide the direction for obtaining food, possibly suggesting that it is appropriate to take food and that one is expected to take the food in the guided direction (encouraging injunctive norm).

Distance refers to how far away products are placed from a consumer perspective. A relatively large distance to products may suggest that taking food is less appropriate and that one may feel less free to take food (discouraging injunctive norm). In contrast, a relatively small distance to products may suggest that taking food is appropriate and that one may feel free to take food (encouraging injunctive norm).

Handgrips serve to open a particular food display and allow self-service to obtain food. A handle and rotary knob may suggest that one is expected to use the particular handgrip and that it is appropriate to take food (encouraging injunctive social norm). A rotary knob may also suggest that one is free to serve oneself food (encouraging injunctive social norm).

Packaged product refers to individually packaged food products and may suggest that one is expected to take the food oneself and that it is appropriate to take

the food with one (encouraging injunctive social norm).

Presence of tableware refers to different types of tableware present near food and may suggest that one is free to serve oneself food, that one is expected to use the tableware to obtain food, and that it is appropriate to take food (encouraging injunctive social norm). Moreover, the physical design of the tableware may signal the normal amount of food to take (injunctive social norm).

(Un)covered presentation refers to a presentation of food products in which the foods are either covered or not. A covered presentation may suggest that it is less appropriate to take food that is covered (discouraging injunctive social norm). In contrast, an uncovered (open) presentation may suggest that it is appropriate to take food from an open container or bowl (encouraging injunctive social norm).

Unit size determination refers to whether or not a fixed unit size can be determined from the presented product. A fixed unit size might suggest that it is appropriate to take the amount of food of the fixed unit size, that one is expected to take this amount of food, and that this is the normal amount of food to take (encouraging injunctive social norm). An unfixed unit size might suggest both that one is free to serve oneself a certain amount of food (encouraging injunctive social norm) and that the appropriate amount of food to take is unclear (discouraging injunctive social norm) .

(Un-)transparent presentation refers to the transparency of the presentation of food products. A transparent presentation may suggest that it is appropriate to take food that is clearly visible (encouraging injunctive social norm). In contrast, an un-transparent presentation may suggest that it is less appropriate to take food that is not clearly visible (discouraging injunctive social norm).

2.2.2.3. Physical cues associated with both descriptive and injunctive social norm connotations

Availability refers to the relative number of products or stacked plates available. A relatively high availability of products might suggest both that fewer people have taken these products (discouraging descriptive social norm) and that the products were popular due to high demand (encouraging descriptive social norm). In contrast, a relatively low availability of products might suggest that more people have taken these products (encouraging descriptive social norm). A single available product might suggest that it may be less appropriate to take the last available product and that one may feel less free to take the last product (discouraging injunctive social norm). However, one available product might also suggest that others have taken this product as well (encouraging descriptive social norm).

Fullness refers to situations in which the placement capacity for products is either fully or incompletely used. An incompletely used placement capacity may suggest that others have taken food products or tableware as well (encouraging descriptive social norm). In contrast, a completely used placement capacity may suggest both that the food is popular due to its high demand (encouraging descriptive social norm) and that others have not taken the food (discouraging descriptive social norm). Moreover, an 'untouched' presentation may suggest that it is less appropriate to take the food and one may feel less free to take it (discouraging injunctive social norm).[2]

Notable presentation refers to choice contexts in which the manner of food presentation is rather outstanding. Upright standing product plates (as opposed to the usually horizontal presentation) may suggest that others have taken food (encouraging descriptive social norm) and that it is appropriate to take food (encouraging injunctive social norm). An elevated presentation, forwardly tilted presentation, and shortened container may suggest that it is appropriate to take food that is presented in the particular outstanding manner (encouraging injunctive social norm).

Placement refers to the specific placements of products. A food that is placed in the middle may suggest that the food is popular (often taken by others) (encouraging descriptive social norm). Eye-level placement may suggest that it is appropriate to take food that is clearly visible (encouraging injunctive social norm). Double placement of products may suggest that the food is popular due to high demand (encouraging descriptive social norm) and that it is appropriate to take food that is placed in more than one position (encouraging injunctive social norm). Placing products under the counter may suggest that it is less appropriate to take products that are less visible and not easy to obtain (discouraging injunctive social norm). In contrast, placing products in a container on the counter (at the same level as a serving tray) may suggest that it is appropriate to take food that is clearly visible and easy to obtain (encouraging injunctive social norm).

[2] The observant reader may have noticed that the category fullness is quite similar to the category emptiness; the cues are oppositely phrased. Although this is largely true, the distinction was based on the most obvious cue. The emptiness category emphasizes the lack of foods at places in a food display, whereas the fullness category emphasizes the completely filled food display (and the 'incompletely filled' cues did not necessarily show empty places at different spots but a display that could clearly be more filled). Moreover, whereas emptiness was only linked to descriptive norm connotations, fullness was linked to both descriptive and injunctive norm connotations. Specifically, injunctive norms were identified in 'completely filled' displays that showed an 'untouched' presentation.

2.2.3. Discussion

The results of Study 1 show that a wide range of physical cues in food environments have the potential to communicate descriptive and injunctive social norms about what is normal and/or appropriate to do. Notably, each choice situation (i.e., photograph) contained multiple physical cues that were associated with social norm connotations. For instance, in Photo B, specific physical cues relating to the higher level physical cue categories 'availability', 'consumption traces', 'tableware', 'emptiness', 'neatness of presentation', and 'placement' were identified. Hence, our findings suggest that various and diverse social norm messages may be communicated through physical cues in food environments.

2.3. Study 2

The results of Study 1 suggest that many physical cues can be interpreted in terms of social norms that encourage or discourage eating when food environments are studied through a social norm lens. Study 2 investigates whether laypeople actually make normative interpretations of these food scenes, as opposed to Study 1 where researchers purposively searched for social norms in a theory-driven way. First, it was examined what physical cues were spontaneously identified as encouraging or discouraging taking food in Photos A and B taken for Study 1 (see Figure 2.1.). These photos were selected as they both portray a clear, demarcated food display (i.e., pans and spoons in Photo A and plates with varying amounts of foods and serving forks in Photo B) and were identified in Study 1 as signaling either an injunctive social norm or a descriptive social norm.[3] Subsequently, it was investigated whether social norm interpretations were linked to a selection of two physical cues: 'pan closed with a lid' and 'empty place on plate with product'. See Table 2.1. for an overview of the research design.

2.3.1. Methods

2.3.1.1. Participants and materials

A convenience sample of 173 Dutch-speaking participants completed a questionnaire distributed through social media (Twitter, Facebook, and Instagram) and via email (sent

[3] A third photograph was included in the questionnaire; however, in hindsight we decided against analyzing this third photograph as the normative interpretations of this photograph were ambiguous. Many different cues were interpreted as both descriptive and injunctive norms, which were in turn linked to both discouraging and encouraging directions in Study 1. Studying the ambiguity of norms was outside the scope of this study, which focused on cross-validating our main findings.

to acquaintances of two research assistants). The questionnaire was available online for four weeks. Participants' age ranged from 17 to 65 years (M = 29.15, SD = 12.67) and 76.9% were female. Furthermore, 59.5% of the participants were students from more than 40 different study programs in the Netherlands. At the start of the questionnaire, participants provided active informed consent for using their answers in research. Ten €10 vouchers were raffled among participants.

Before actual data collection, 11 participants pretested the questionnaire. As a result of the pretest, small adjustments were made to improve its user-friendliness (e.g., some questions were reformulated and the answer boxes of open questions were enlarged).

2.3.1.2. Procedure

It was explained to participants that the questionnaire consisted of two parts. To examine which physical cues participants spontaneously identified in the photographs, an open question was asked separately for Photo A and Photo B (presented on different pages). To ensure that participants focused on physical cues, they were instructed to disregard their own preference (liking) and price considerations in their answers. In the second part, for each photograph separately, participants were instructed to focus on a specific physical cue selected by the researchers (SR, SvR). Subsequently, they were asked to what extent they agreed with a list of items measuring different social norm connotations. These items were explicitly formulated rather than spontaneously mentioned by participants because we know from previous studies that laypeople are generally unable to detect the influence of social norms on behavior themselves (Nolan et al., 2008). Each photograph along with the list of items was presented on different pages. Next, participants' demographics were assessed regarding their age, sex, occupation, and device used. Finally, participants had the option to provide two e-mail addresses to help us recruit potential future participants and their own e-mail address to be included in the raffle for the vouchers. The study was conducted according to the guidelines determined in the Declaration of Helsinki and complied under the code of conduct of Wageningen University & Research, Social Sciences.

2.3.1.3. Measurements

2.3.1.3.1. Physical cue identification

For each photograph, the following open question was asked: 'Which elements in the photograph may encourage and/or discourage one to obtain foods?' Participants typed their answer in a text box that had no word limit.

2.3.1.3.2. Social norm interpretation

Regarding Photo A, participants were asked to focus on the physical cue 'pan closed with a lid', and regarding Photo B participants were asked to focus on the physical cue 'empty place on plate with product', while rating a list of 10 items. The items were created on the basis of the connotative meanings derived from Study 1.[4] The order of the items was randomized on an individual level, for each photograph separately. All items were assessed on a 5-point Likert scale ranging from 1 (totally disagree) to 5 (totally agree). The items did not form subscales as some items measured a unique connotation.

Descriptive norm connotations were measured with two items ('the [physical cue] suggests that other people have taken food' and 'the [physical cue] suggests that the food is popular').

Injunctive norm connotations were measured with four items ('the [physical cue] suggests that taking food is appropriate', 'the [physical cue] suggests that one is expected to take food', 'the [physical cue] suggests that one is free to take food', and 'the [physical cue] suggests the normal amount of food to take').

2.3.1.4. Data analysis

Physical cue identification. The open question responses for Photos A and B were imported into Atlas.ti (version 7.5.18) to generate codes. The code book developed in Study 1 by the two researchers (SR, SvR) was used as the basis for coding, to facilitate comparison with the results of Study 1. New codes were created when necessary. The coding process was undertaken separately by two researchers (SR: Photo A, SvR: Photo B), after seeking consensus on the Photo A data for the first 10 participants about the type (denotation or connotation) and level of pre-existing and new codes. Coding was conducted on the physical cue subcategory level as presented in the second column of Supplementary Table S2.1. When answers were provided on the connotation level, connotative meaning codes were created as well. After the coding process, the frequency of physical cue codes was ascertained. Physical cues that occurred more than 10 times were briefly described. Albeit that any cut-off would be arbitrary, we chose to include physical cues that occurred more than 30 times for closer analyses – the physical cue was linked to the interpretations of encouragement and/or discouragement of taking food and the spontaneously provided explanations for this

[4] The list of items also included connotations relating to effort and salience, as the results of Study 1 showed that some of the physical cues relating to social norms were also associated with processes of effort and salience. As this study is focused on social norms, results relating to these processes are not described in the results section.

inference (when the cue occurs more than once).

Social norm interpretation. To detect what specific connotative meanings participants on average derive from the cues 'pans closed with a lid' (Photo A) and 'empty places on plates' (Photo B), the means of the connotative meaning ratings were analyzed for each item.

2.3.2. Results

2.3.2.1. Physical cue identification

2.3.2.1.1. Photo A

Regarding Photo A, participants mentioned 30 different physical cues, 17 (56.7%) of which corresponded with the identified subtle social norm cues in Study 1. Physical cues that occurred 10 or more times are listed in Supplementary Table S2.2. The three cues most frequently mentioned by participants corresponded with the subtle social norm cues identified in Study 1 (i.e., covered presentation, tidy presentation, presence of serving cutlery). These three cues are explained in more detail below. Other cues frequently mentioned by participants related to the attractiveness of the presentation (e.g., *'nice bowls'*, *'shiny bowls'*, *'chic presentation'*) or to a less attractive presentation (e.g., *'no variety in pans'*, *'boring presentation'*). Furthermore, participants frequently mentioned the presence of a clear name tag (e.g., *'name tags that indicate what the food is'*), the dirtiness of the serving cutlery (e.g., *'dirty serving spoons'*), and usage traces (e.g., *'used spoons'*).

Covered presentation was the most frequently mentioned cue (98 times). This cue was associated 83 times (84.7%) with discouragement of taking food, whereas it was associated 15 times (15.3%) with encouragement of taking food. The most frequently mentioned explanation relating to discouragement of taking food was 'less salient presentation' (co-occurred 21 times – e.g., *'the closed pans may discourage people from taking something, as the foods are invisible'*). Furthermore, discouragement of taking food because of the covered presentation co-occurred five times with the explanation 'require effort to take' (e.g., *'the cover discourages taking as it requires more effort'*). Explanations relating to encouragement of taking food because of the covered presentation were: 'hygiene' (co-occurred five times – e.g., *'the cover on the food is hygienic'*), 'heated food' (co-occurred four times – e.g., *'because of the cover the food keeps warm'*), 'arousing curiosity' (co-occurred three times – e.g., *'it arouses curiosity to see what the food is'*), and 'fresh' (co-occurred once – *'the covered presentation helps keep the food fresh'*).

Tidy presentation was mentioned 59 times. This cue was associated 49 times (83.1%) with encouragement of taking food, whereas it was associated six times (10.2%) with discouragement of taking food. Explanations provided for why a tidy presentation encourages taking food were 'attractive presentation' (co-occurred twice – e.g., *'it is nicely presented'*) and 'hygiene' (co-occurred twice – e.g., *'it looks clean and hygienic'*). No explanations were provided for why a tidy presentation may discourage taking food.

Presence of serving cutlery was mentioned 34 times. This cue was associated 26 times (76.5%) with encouragement of taking food, whereas it was associated five times (14.7%) with discouragement of taking food. An explanation provided for why serving cutlery encourages taking food was 'requires less effort to take' (co-occurred twice – e.g., *'makes it easier to serve'*). No explanations were provided for why serving cutlery may discourage taking food.

2.3.2.1.2. Photo B

Regarding Photo B, participants mentioned 22 different physical cues, 13 (59.1%) of which corresponded with the identified subtle social norm cues in Study 1. Physical cues that occurred 10 or more times are listed in Supplementary Table S2.2. Two of the three cues most frequently mentioned by participants corresponded with the subtle social norm cues identified in Study 1 (i.e., messy presentation, presence of serving cutlery). The three most frequently mentioned cues are explained in more detail below. Other cues frequently mentioned by participants related to the presentation of foods, namely, uncovered (open) presentation (e.g., *'the food is visible, no lid'*) and tidiness of presentation (e.g., *'the food is not mixed together'*). Furthermore, participants frequently mentioned the relatively high availability of products (e.g., *'there is sufficient stock'*), variety of choice (e.g., *'a lot of choice'*), and warmth of food (e.g., *'the food has not cooled'*).

Less attractive presentation was the most frequently mentioned cue (44 times) and was consistently associated with discouragement of taking food (100%). Explanations provided for why a less attractive presentation discourages taking food were 'less fresh' (co-occurred four times – e.g., *'the food does not look very fresh'*) and 'less hygiene' (co-occurred three times – e.g., *'probably touched by people'*).

Messy presentation was mentioned 39 times and was associated 38 times (97.4%) with discouragement of taking food. An explanation provided for why a messy presentation discourages taking food was 'less hygiene' (co-occurred five times – e.g., *'it looks very messy and therefore unhygienic'*).

Presence of serving cutlery was mentioned 38 times. This cue was associated 32 times (84.2%) with encouragement of taking food, whereas it was associated five

times (13.2%) with discouragement of taking food. Explanations provided for why the presence of serving cutlery encourages taking food were 'requires less effort to take' (co-occurred six times – e.g., *'easy to take with the serving cutlery'*) and 'hygiene' (co-occurred three times – e.g., *'not touching the food with dirty fingers because of the serving cutlery'*). Explanations relating to discouragement of taking food because of the presence of serving cutlery were: 'requires effort to take' (co-occurred once – *'the food is easier to take with hands than with serving cutlery'*) and 'less hygiene' (co-occurred once – *'people with mysophobia may not want to grab the fork'*).

2.3.2.2. Social norm interpretation

2.3.2.2.1. Photo A

Pan closed with a lid. Concerning descriptive norm connotations, participants disagreed that the closed lids suggest that other people have taken food and that the food is popular. Concerning injunctive norm connotations, participants disagreed that the closed lids suggest that taking food is appropriate, one is free to take food, one is expected to take food, and the normal amount of food to take.

2.3.2.2.2. Photo B

Empty places on plates. Concerning descriptive norm connotations, participants agreed that the empty places suggest that other people have taken food and that the food is popular. Concerning injunctive norm connotations, participants agreed that the empty places suggest that taking food is appropriate, one is free to take food, and one is expected to take food. However, they disagreed that empty places suggest the normal amount of food to take.

See Table 2.3. for the mean ratings for each of the connotative meaning statements for the physical cues 'pans closed with a lid' (Photo A) and 'empty places on plates' (Photo B).

Table 2.3. Means (SD) for connotative meanings (range 1–5) relating to the physical cues 'pans closed with a lid' and 'empty places on plates'.

Higher level conceptual categories	Connotative meanings	Closed lids	Empty places
Descriptive norm connotation	1. Others have taken	1.84 (.82)	4.49 (.55)
	2. Popularity	1.89 (.74)	3.84 (.68)
Injunctive norm connotation	3. Appropriate to take	2.44 (.90)	4.20 (.63)
	4. Expected to take	2.20 (.85)	3.87 (.68)
	5. Feeling free to take	2.32 (.90)	4.09 (.56)
	6. Normal amount to take	1.60 (.65)	2.31 (.87)

NB: Categories of this Likert scale were (translated from Dutch) 1: totally disagree, 2: disagree, 3: neither agree nor disagree, 4: agree, 5: totally agree.

2.3.3. Discussion

Laypeople mentioned a large set of different physical cues that could encourage or discourage taking food. Notably, more than half of these physical cues were identical to the subtle social norm cues identified in Study 1. Interestingly, participants spontaneously provided explanations for why these cues could discourage or encourage taking food (e.g., explanations related to effort, salience, and hygiene). None of the participants freely mentioned explanations (connotative meanings) related to the social norm account that is central in this paper. This might suggest that people do not spontaneously associate physical cues with social norms. However, when explicitly measured, lay participants associated the cue 'empty places on plates' with both a descriptive and an injunctive social norm, whereas the cue 'pan closed with a lid' was not associated with social norm connotations.

2.4. General discussion

The current study provides a novel interpretation of physical aspects in micro food environments, proposing that various social norm messages are physically embedded in food environments. For this purpose, in Study 1, an innovative qualitative four-step approach was adopted, combining several social research methods including photo documentation, semiology, and grounded theory. Both descriptive and injunctive social norm messages were structurally linked to a great variety of physical cues. For instance, food traces, empty places, and a tidy presentation were considered to bear a descriptive social norm message communicating whether it is normal to take food following the behavior of others, whereas cues such as the presence of serving cutlery, a covered

presentation, and a transparent presentation were considered to bear an injunctive social norm message communicating approval or disapproval of taking food.

It might be regarded as obvious that normative influences are identified in physical food environments when environments are analyzed through a social norm lens. Therefore, in Study 2, our findings were cross-validated among laypeople who viewed two preselected photos. In these photos, participants identified more than half of the physical cues that in Study 1 were recognized as cues bearing a normative message. Interestingly, participants interpreted an empty place as a social norm encouraging food intake, whereas the normative interpretation of a pan closed with a lid appeared less straightforward. An explanation for the different normative interpretations of physical cues might be related to the way in which social norms are derived. The normative interpretation of an empty place – which in Study 1 was recognized as bearing a descriptive social norm – is derived from the behavior of previous consumers, and these traces of others' behavior are clearly visible in environments. In contrast, the normative interpretation of a pan closed with a lid – which in Study 1 was recognized as bearing an injunctive social norm – is derived from informal behavioral rules about appropriate behavior, which is not clearly visible in environments. Physically embedded descriptive norms that show the behavior of others could work as efficient and quick heuristics of 'social proof' (i.e., a rule of thumb: if others have done it, it is the normal thing to do), whereas physically embedded injunctive norms might require cognitive deliberation about social approval/disapproval to have an influence (Jacobson et al., 2011; Salmon, Fennis, De Ridder, Adriaanse, & De Vet, 2014). Although this reasoning is plausible given the results of Study 2, further research should carefully examine the cognitive processes underlying the potential effect of specific normative aspects in food environments on actual behavior.

Remarkably, a range of physical cues identified in Study 1 could be associated with both descriptive and injunctive social norms. For instance, the last product left might be interpreted as a descriptive social norm communicating that it is normal to take it as others had done so, or it might be interpreted as an injunctive social norm communicating that it is less appropriate to take the last product left. Physical cues associated with both norm types could be considered ambiguous, especially when their impact on behavior is not congruent. It could be reasoned that the ambiguity of these cues overrules their normative interpretations, as previous research has shown that ambiguous norms are comparable with having no norms at all, because a clear pattern of others' behavior is lacking. Instead of following norms, people will probably behave in conformity with their own preferences (Leone, Pliner, & Herman, 2007). Following

this reasoning, it might be argued that physical cues bearing both a descriptive and an injunctive social norm, but encouraging the same behavior, reinforce the influence of social norms. For instance, the double placement of products might be interpreted as a descriptive social norm indicating that the food is popular because of high demand and as an injunctive social norm signaling that it is appropriate to take food that is placed at different locations, both encouraging food intake. However, this cannot be concluded from the current results and remains an empirical question.

Although our study is focused on normative influences in micro food environments, micro environments must be considered as part of wider society with its own ideological beliefs (i.e., macro-sociocultural environment), as norms embedded in micro environments are often affected by sociocultural influences on the macro level. For instance, as described in the ANGELO framework (Swinburn et al., 1999, p. 564), societal popularity of high-fat foods could be considered a sociocultural environmental barrier to a healthy diet. This popularity (demand) encourages a higher availability of such foods in physical micro food environments, and this might in turn communicate social norms encouraging unhealthy eating. Hence, normative influences on eating may be bi-directionally shaped by both the macro-sociocultural and the micro-physical food environment.

2.4.1. Strengths and limitations

The present study provides a novel approach to the study of food environments, allowing a detailed observation of different food environments at a particular juncture and through a social norm lens. Notably, the methodological combination of observation of what is actually occurring in physical food environments and the normative interpretation of this allowed for the identification of many different cues, whether or not new in the food environment research domain. This wide range of identified cues potentially bearing social norms indicates that much is still unknown about specific influences in micro food environments.

A limitation of the methodology in Study 2 is that injunctive norms opposing food consumption were not explicitly measured, as all items were formulated in the same direction: encouraging food consumption. When participants disagreed about items measuring injunctive social norms encouraging intake, it could only be assumed that participants recognized an injunctive social norm opposing food consumption, but we cannot provide conclusive evidence. Furthermore, it has to be stressed that the current research needs to be understood in a Dutch cultural context and may not be generalizable to other nations or cultures. Although we cannot specifically outline how the Dutch cultural context differs from other countries in terms of norms embedded in

the physical food environment, it can be generally speculated that culture-dependence may be especially true for injunctive norms as these suggest what is approved/disapproved of in a particular culture. Descriptive norms may act as guidelines for eating behavior across many cultures or nations, given their influence in specific situations rather than cultures, although it can be speculated that they may be more relevant in collective societies in which there is more emphasis on group behavior. To enable generalization of this research, it would be interesting to replicate the present research in another cultural context. Likewise, our study was focused on outside-the-home self-service food contexts and may not be generalizable to other food contexts. For example, people probably are not so much guided by rules of appropriateness in the home environment as opposed to a food environment that is new and/or has other customers. Also, studying social norm cues in full-service restaurants would be of interest, as it has already been shown that food positioning cues affect behavior differently for food selection from a menu as compared with physical food selection. Specifically, it was shown that foods were more popular when they appeared at the beginning and the end of a menu (Dayan & Bar-Hillel, 2011), whereas another study showed that foods in a vendor tray were more popular when placed in the middle (Keller et al., 2015). This illustrates that social norms are context specific, and it might be interesting for future research studying normative cues to compare different types of food contexts.

2.4.2. Directions for further research

A next step in this line of research would be to experimentally test the effect of each identified specific cue and its normative interpretation on actual behavior (e.g., Schüz, Papadakis, & Ferguson (2018)). It would be especially interesting to focus on the effect of physical cues associated in the current study with ambiguous social norm interpretations. Moreover, the current research may also inspire future experimental research studying the effect of subtle changes in physical aspects of food environments on food selection, in conformity with the nudging approach. We recommend researchers to make strategical changes to those aspects that unambiguously promote healthy eating or discourage unhealthy eating. For instance, physical aspects that are assumed to communicate injunctive norms signaling that it is less appropriate to take food (e.g., closed lids) could be used to discourage unhealthy eating, whereas physical aspects that are assumed to communicate descriptive social norms signaling that others have taken food (e.g., usage traces) could be used to encourage healthy eating. Ultimately, this research line could be incorporated in public health promotion interventions. Illustrating the reach of such a practical implication, a recent longitudinal

natural experiment showed that the placement of healthier foods at checkouts in UK supermarkets was associated with a reduction in purchases of unhealthy foods (Ejlerskov et al., 2018).

Given that physical food environments bear many encouraging social norm messages that may contribute to obesogenic influences, further research may study this proposition on the level of the built environment. Although the association between features of the built food environment (e.g., fast-food access) and diet and health has been widely studied, there is still a research gap in specifying mechanisms underlying this association (Caspi et al., 2012; Fleischhacker et al., 2011; Giskes et al., 2011). In line with the current study, it might be reasoned that neighborhoods in which unhealthy foods are readily available and accessible convey social norms (descriptive and injunctive) favoring unhealthy eating. Hence, it would be interesting to test whether neighborhood food access is associated with residents' perceptions about the food that is normal to purchase or eat. This idea is supported by a cross-sectional study that focused on the role of neighborhoods in shaping norm perceptions about drug injection behaviors. The results of that study showed that both social and physical aspects (e.g., litter) were associated with perceived norms about risk behaviors (Davey-Rothwell, Siconolfi, Tobin, & Latkin, 2015).

2.5. Conclusion

Acknowledging the widely studied influence that availability and accessibility of unhealthy foods in physical food environments has on eating behavior and obesity, the current study built on evidence that social norms are important drivers of eating behavior and proposed a new understanding of the physical aspects of obesogenic environments. In light of the present results, we suggest that social norms physically embedded in food environments might guide food consumption. However, the behavioral influence of most physical cues observed in this research is still unclear, particularly when normative evaluation is taken into account. Further research is needed to test the effect of these cues on actual eating behavior and to verify the extent to which social norm interpretations can be attributed to this.

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Chapter 3

How physical cues surrounding foods influence snack consumption: The case of covering foods

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Abstract

Physical cues surrounding foods are known to influence consumption, but research into the underlying mechanisms is limited. This research aims to disentangle these underlying mechanisms, testing one specific physical aspect: the presence or absence of a cover on snack bowls. We hypothesized that the presence (versus the absence) of a cover would decrease the likelihood of consumption and that the effect would be explained through a) norm perceptions discouraging eating, b) heightened effort to take the foods, and c) lowered salience of attractive foods. In two field contexts (Study 1, 40 observation periods; Study 2, n = 711) and a lab experiment (Study 3, n = 151), the cover's presence was manipulated and the number of snacks taken was observed. In Studies 2 and 3, perceptions of social norms, effort, and salience were reported. The likelihood of taking snacks indeed decreased when the cover was present versus absent (Studies 1–3). In Study 2, a trend was observed that the presence (versus the absence) of the cover marginally significantly decreased perceived social norms and increased perceived effort, whereas in Study 3 a significant decrease in perceived social norms and salience and an increase in perceived effort were observed. Moreover, the effect of the cover on likelihood of consumption was mediated by perceptions of salience. The organization of physical aspects in food environments influences consumption and may change perceptions of social norms, effort, and salience. Particularly, perceptions of salience might explain the effect of the cover on likelihood of consumption.

3.1. Introduction

Food environments, broadly defined as 'any opportunity to obtain food' (Townshend & Lake, 2009), encompass many aspects including food availability and accessibility (Lake & Townshend, 2006). Attention is increasingly being paid to the types of foods available within a person's food environment and the association with consumption and obesity, because unhealthy foods are now widely available and easily accessible (Pitt et al., 2017; Story et al., 2008; Townshend & Lake, 2017). Although it is widely accepted that there is a relation between food accessibility and availability and food consumption, the mechanisms that drive consumption have received limited attention (Raghoebar, Van Rongen, Lie, & De Vet, 2019). Increasing the understanding of the causal mechanisms explaining why we eat food that is available may improve (or optimize) the development of effective intervention strategies, specifically by providing insight into how to use (i.e., design and implement) such strategies (Marteau et al., 2020; Szaszi et al., 2018). The importance of such an understanding has been highlighted by recent research providing explanations for why the relative availability of specific foods in food environments may lead to desired or undesired effects. Specifically, it was shown that this single aspect in the food environment (i.e., the relative availability of particular foods) may be perceived differently, and thereby dictate contradictory conduct, in different situations depending on their specific design and implementation (Raghoebar, Van Kleef, & De Vet, 2020b). This may suggest that signals conveyed by or in connection to available foods are relevant to take into consideration when developing such intervention strategies.

In this article, we identify and study three explanatory mechanisms. First, we investigate how food accessibility affects consumption through a heightened salience of foods, as the relatively easy accessibility of foods might increase the foods' visual salience by making their properties more vivid (Maas et al., 2012). Second, we investigate the idea that high food accessibility lowers the effort required to obtain foods and that a low effort consequently might motivate people to obtain these easily accessible foods (Maas et al., 2012). Finally, we propose that social standards about what is normal and/or appropriate to eat may explain why people eat easily accessible foods (De Ridder et al., 2013; Higgs & Thomas, 2016). Whereas salience and effort have repeatedly been proposed as explanatory processes (e.g., Hunter et al. (2018); Knowles et al. (2019); Maas et al. (2012)), the social standard explanation is rather novel. Social standards have proved to be powerful in steering eating behavior, as they provide implicit guidelines for what is generally considered normal and/or appropriate behavior in a given situation – also referred to as *social norms* (see systematic reviews in Robinson, Thomas, et al. (2014); Stok et al. (2016)). To our knowledge, relatively few

studies have focused on how these normative processes are embedded in physical food environments and determine consumption.

Recent insights suggest that standards about what is normal and socially acceptable to consume can be inferred from physical aspects of food environments, even in the absence of a person being told or shown what and how much to eat (Burger et al., 2010; Herman, Polivy, Pliner, & Vartanian, 2019; Prinsen et al., 2013; Raghoebar, Haynes, Robinson, Van Kleef, & De Vet, 2019; Raghoebar, Van Rongen, et al., 2019). To illustrate, it has been shown that consumers interpret the amount of food served in a given situation as a social cue that determines their food intake 24h later, as they are likely to believe that the served portion size was not chosen at random by the food provider. Specifically, participants who were served a smaller (rather than a larger) food portion reported a smaller social norm for portions of that food the next day (Raghoebar, Haynes, et al., 2019). Another series of experiments demonstrated that, rather than food availability itself, physical cues surrounding available foods drive consumption, presumably as these contextual details signal social information about the normal and/or appropriate course of action. Particularly, keeping food availability constant, it was shown that people tended to take more snacks in the presence of empty snack wrappers, compared to a situation in which there were no empty snack wrappers. It was assumed that the empty snack wrappers operationalized a social norm signaling that others in that situation had previously consumed the snacks, albeit that norm perceptions were not explicitly measured in these studies (Burger et al., 2010; Prinsen et al., 2013).

In a series of three experiments, we aim to disentangle the mechanisms underlying the effect of one specific, not yet tested, physical cue surrounding foods: the presence or absence of a cover on snack bowls. Specifically, we hypothesize that the presence (versus the absence) of a cover will decrease the likelihood of consumption (hypothesis 1) and that the effect will be explained through a) norm perceptions discouraging eating, b) heightened effort to take the foods, and c) lowered salience of attractive foods (hypothesis 2). We build our first hypothesis on former experimental studies demonstrating that physical aspects connected to available foods can influence consumption (e.g., Burger et al. (2010); Hunter et al. (2018); Keller et al. (2015); Kroese, Marchiori, & De Ridder (2015); Maas et al. (2012); Prinsen et al. (2013); Rozin et al. (2011)). For example, the relative physical distance at which food is positioned (e.g., at 20cm or 70cm from armrest) can be regarded as such a physical cue, because increasing the distance to snack bowls resulted in a reduced proportion of snacks taken (Hunter et al., 2018; Maas et al., 2012). Given the aforementioned studies, we expect that the presence of a cover on snack bowls (compared to a situation

in which the cover is absent) will function as a barrier to consumption and thus result in reduced snack consumption.

Furthermore, we propose that consumers may believe that there is some reasonable rationale behind the presence of the cover and therefore infer that it is less normal and/or appropriate to take snacks from a serving bowl when the cover is present (versus absent). This social norm interpretation of physical cues conforms with the rationale behind the effect of empty snack wrappers and served portion sizes on consumption (Burger et al., 2010; Prinsen et al., 2013; Raghoebar, Haynes, et al., 2019). Alternatively, the presence of the cover might influence consumption for reasons of a non-social nature, and one might argue that a covered serving bowl is less easily accessible and that more effort is required to obtain foods, compared to a situation in which the cover is absent. This reasoning accords with evidence that a larger physical distance to snacks resulted in a greater perceived effort to obtain the snacks, although the mediating role of perceived effort in the effect of distance on consumption was not tested in those studies (Hunter et al., 2018; Maas et al., 2012). Likewise, one could argue that snacks presented in a covered serving bowl are less salient to consumers, as the cover makes its properties less visible. Previous studies testing the effect of distance to snacks on perceived salience of the snacks did not find significant differences between the distant conditions (Hunter et al., 2018; Maas et al., 2012). However, it might be plausible that snacks presented in covered serving bowls are less vivid than a situation in which relatively small changes are made in physical distance to snacks.

3.1.1. Research overview

In three experiments, we investigated whether a cover on snack bowls being present (discouraging condition) rather than absent (control condition) would decrease the proportion of snacks taken, and the mechanisms that might explain the effect by examining perceptions of social norms, effort, and salience. The first study was conducted in a field context (front desk of a university building) and focused specifically on the effect of the cover on snack consumption. The second study was conducted in another field context in which more (competing) food cues were present, testing the same hypotheses under more complex circumstances attempting to conceptually replicate the effects under different conditions (i.e., seeking to validate the phenomenon under various circumstances) (Earp & Trafimow, 2015; Nosek, Spies, & Motyl, 2012; Schmidt, 2009). Specifically, Study 2 was performed at the checkout corner of a petrol station shop, and included preliminary measures of perceptions of social norms, effort, and salience. Study 3 was performed in a controlled laboratory setting, testing effects under ideal conditions and focused specifically on the role of perceived

social norms, effort, and salience as possible underlying mechanisms of the cover effect on consumption. A third condition was included in the study design, in which the cover was removed from the bowl in the participants' presence (encouraging condition), thereby testing whether a snack bowl presented without a cover (in this study treated as the control condition) could be considered as an encouraging condition in itself, or whether the physical removal of the cover was needed to encourage participants to take snacks.

3.2. Study 1

3.2.1. Methods

3.2.1.1. Design and procedure

A quasi-experimental field study employing a one-factor design was conducted at the front desk of a university building. A transparent jar with chocolate bars was placed on the desk, varying the presence (discouraging condition: see Figure 3.1. (a)) or absence (control condition: see Figure 3.1. (b)) of a transparent lid covering the jar between conditions. In both conditions, the jar was accompanied with a signboard stating: "Have a nice day on behalf of the staff", suggesting that the snacks were offered for free and increasing the salience of the jar. All experiments (1–3) were conducted according to the Declaration of Helsinki guidelines and complied with the Wageningen University & Research code of conduct.

Conditions were counterbalanced between four timeslots a day: 9am to 11am, 11am to 1pm, 1pm to 3pm, and 3pm to 5pm. Both conditions were run equally during these timeslots for a period of 10 days (Monday–Friday), resulting in 20 observation periods per condition. In both conditions, the jar was three-quarters full with 600 g of individually packaged mini chocolate bars (Twix, 10 g per unit). The jar was monitored several times during each timeslot and refilled when the jar was half full. Before and after each timeslot, the jar was weighed to determine the number of chocolate bars taken (grams), treated as the outcome variable in this study.

(**a**) (**b**)

Figure 3.1. Snack jar used in Study 1: (**a**) discouraging condition; (**b**) control condition.

3.2.2. Results

3.2.2.1. Test of hypothesis 1: Consumption

On average, 268.50 g of chocolate bars (± 27 pieces, SD = 139.13 g) were taken per two-hour timeslot. An ANCOVA was performed to compare the number of snacks taken (grams) per timeslot (dependent variable) when the lid was present and absent (independent variable), controlling for day and time effects. As consumption data deviated from a normal distribution, a square root transformation was performed before testing. When the jar was covered by a lid (M = 221.23 g, SD = 129.75 g), significantly fewer snacks were taken compared to when the jar was presented without a lid (M = 315.78 g, SD = 134.87 g), $F(1, 36) = 7.22$, $p = 0.01$, $\eta_p^2 = 0.17$. Approximately 29.9% fewer snacks were taken when the lid was present rather than absent.

3.2.3. Discussion

The number of snacks taken (grams) was significantly lower when the lid was present rather than absent, indicating that the lid functioned as a barrier to consumption. The second study aimed to extend this finding in an environment in which more (competing) food cues were present: a Dutch petrol station shop. Unlike in Study 1, we attempted to measure the number of people that have taken the snacks in Study 2, as well as the number of snacks taken by each person, as it is hard to establish from the current study whether the cover manipulation affected the number of people that have

taken snacks and/or the amount of snacks taken by each person. Furthermore, perceptions of social norms, effort, and salience regarding the snacks were measured in Study 2.

3.3. Study 2

3.3.1. Methods

3.3.1.1. Participants and design

Customers who encountered the checkout corner in a Dutch petrol station shop were observed in a quasi-experimental field study employing a one-factor design (n = 720), in which 203 customers (called questionnaire participants) participated in an additional questionnaire to measure their perceptions of social norms, effort, and salience regarding the snacks. Most participants who declined to complete the questionnaire stated that they had no time. Participants who indicated any allergies or intolerances for the foods included in the study were excluded from analyses, as well as participants who indicated not having encountered the checkout corner, did not follow the study instructions, or were not capable of completing the questionnaire. The final analytic sample included 711 customers and 194 questionnaire participants (see Figure 3.2.). The questionnaire participants – 163 males and 31 females – had an average age of 45.16 years (SD = 15.81, n = 190).

The experimental manipulation was similar to Study 1. In both conditions, the jar was placed on the checkout corner next to the pin device, accompanied with a sign board stating, "Have a nice trip on behalf of [petrol station name]". Conditions were counterbalanced between two timeslots a day during rush hours: 7.30am to 11.30am and 2.30pm to 6.30pm. Both conditions were run equally during these timeslots for a four-day period (Monday–Thursday). Accordingly, customers were automatically assigned to either the discouraging condition (see Figure 3.3. (a)) or the control condition (see Figure 3.3. (b)).

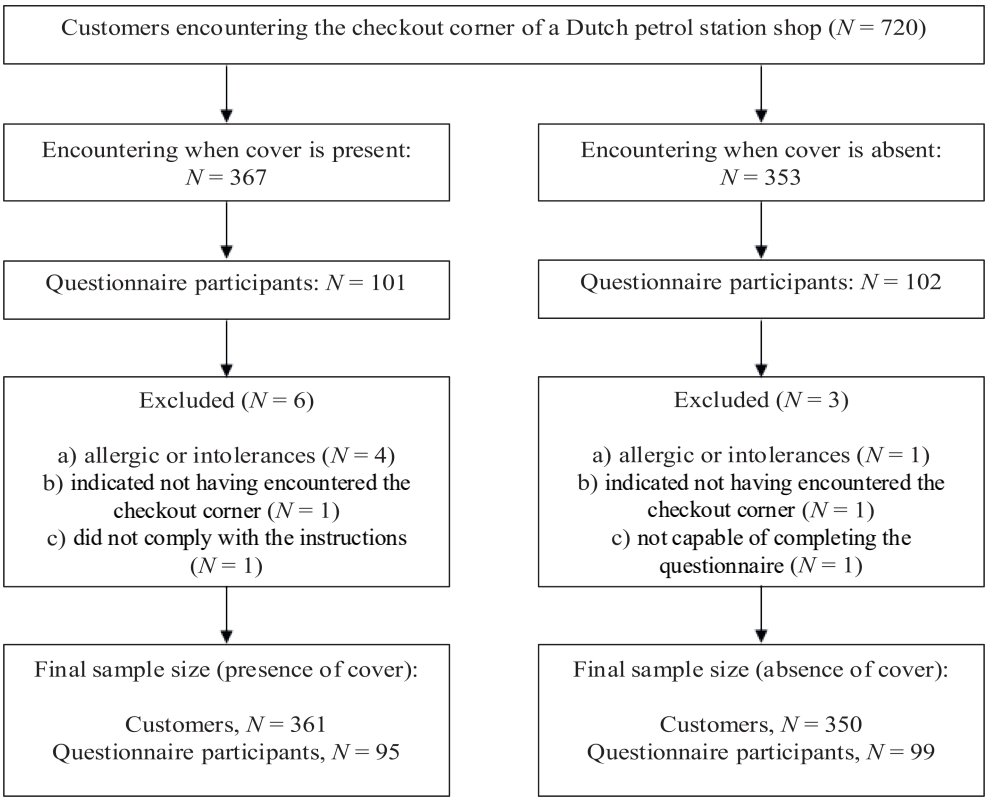


Figure 3.2. Flowchart of customers and questionnaire participants. The participant excluded because of noncompliance with study instructions purposely took four chocolate bars after completion of the questionnaire although initially not aware of the jar.

(**a**) (**b**)

Figure 3.3. Snack jar used in Study 2: (**a**) discouraging condition; (**b**) control condition.

3.3.1.2. Procedure

During each timeslot, petrol shop employees counted the number of customers who encountered (within one-meter distance) the checkout corner. Again, the jar was three-quarters full with 600 g of individually packaged mini chocolate bars (Twix, 10 g per unit). To determine the number of chocolate bars taken, the researcher counted the number of chocolate bars before and after each timeslot.

Customers leaving the petrol station shop were invited to complete a questionnaire about consumer choices in petrol stations (cover story). The questionnaires were administered by two female researchers using two tablets. First, participants provided their informed consent. Thereafter, they reported their rush state and their hunger state, then their healthy eating goal and their weight goal (also a filler item asking about their money goal). Then, participants reported their liking for the offered snacks, as well as their desire to eat the offered snacks to measure potential compensatory after-effects (Supplementary materials (Methods: Study 2). Subsequently, participants indicated whether other people were present in the line at the checkout corner (responses: yes/no). Thereafter, it was checked whether participants had noticed the snack jar (responses: yes/no). Participants who indicated noticing the jar reported the number of chocolate bars taken, as well as their perceptions of social norms, effort, and salience regarding the snacks. Participants then reported whether the snack jar was covered by a lid (responses: yes/no/do not know). Finally, all participants reported their demographics (age and sex) and indicated any

allergies or intolerances. Participants were thanked for their participation and could give their email address to win a free tank of fuel, which was raffled among questionnaire participants.

3.3.1.3. Measures

3.3.1.3.1. Proposed mediators

The items measuring perceptions of social norms, effort, and salience are described in Table 3.1. A mean score was calculated for variables (perceptions of social norms and salience) with Cronbach's $\alpha \geq 0.70$. As reliability analysis showed a low level of internal consistency between items measuring perceptions of effort, items were analyzed separately.

Table 3.1. Overview of items measuring perceptions of social norms, effort, and salience.

Measures	Items
Perceptions of social norms (Cronbach's α = 0.82)	1. 'did you feel free to take [snacks]?' (1: not free at all to 7: very free) 2. 'did you feel that the [snacks] were meant to be taken?' (1: not at all to 7: very much) 3. 'how normal or abnormal do you think it was to take [snacks]?' (1: very abnormal to 7: very normal) 4. 'how appropriate or inappropriate do you think it was to take [snacks]?' (1: very inappropriate to 7: very appropriate)
Perceptions of effort (Maas et al. (2012)) (Cronbach's α = 0.18)	1. 'the [snacks] required effort to take' (1: strongly disagree to 7: strongly agree) 2. 'the [snacks] were up for grabs' (1: strongly disagree to 7: strongly agree) [reverse coded]
Perceptions of salience (Maas et al. (2012)) (Cronbach's α = 0.87)	1. 'the [snacks] stood out' (1: strongly disagree to 7: strongly agree) 2. 'the [snacks] attracted attention' (1: strongly disagree to 7: strongly agree)

3.3.1.3.2. Descriptive information

Hunger state was measured by asking, 'how hungry are you at the moment?' (1: not hungry at all to 7: very hungry). Healthy eating goal was measured by stating (Salmon et al. (2014)), 'in my daily live I strive to eat healthily' (1: not important at all to 7: very important). Weight goal was measured by stating, 'in my daily life I strive to watch my weight' (1: not important at all to 7: very important). General liking for the offered snacks was measured by asking (Maas et al. (2012)), 'how tasty or non-tasty do you find [snacks]?' (1: very non-tasty to 7: very tasty). Rush state was measured by asking, 'to what extent are you in a hurry at the moment?' (1: no hurry at all to 7: very much hurry).

3.3.2. Results

3.3.2.1. Descriptive statistics and randomization check

Questionnaire participants' (n = 194) descriptive statistics are presented in Supplementary Table S3.1. (reported per condition). Pearson chi-square analysis showed no significant difference in accuracy of noticing the snack jar between participants in the discouraging condition (30.5% reported noticing the jar) and the control condition (33.3% reported noticing the jar), $X^2(1)= 0.18$, p = 0.68.

Participants who indicated noticing the jar were included in further analyses (n = 62); see their descriptive statistics per condition in Table 3.2. In the discouraging condition, 62.1% of the participants correctly indicated the presence of the cover (20.7% incorrectly indicated the absence of the cover and 17.2% did not know), and 60.6% of the participants in the control condition correctly indicated the absence of the cover (3.0% incorrectly indicated the presence of the cover and 36.4% did not know). A randomization check was performed to ascertain whether this subsample of participants was comparable across conditions regarding the descriptive variables (age, sex, hunger state, healthy eating goal, weight goal, general liking for the offered snacks, rush state, and presence of others). Likelihood ratio chi-square analysis comparing the presence of others between conditions showed a significant difference and was continuously included as a covariate in further analyses. To check for other possible covariates, correlations between the descriptive variables and the outcome variables (proposed mediators and desire) were checked (Supplementary Table S3.2.). Rush state was significantly associated with perceptions of salience (r = 0.29, p = 0.02), and general liking for the offered snacks was significantly associated with desire to eat the offered snacks (r = 0.56, p < 0.001). Consequently, rush state and general liking for the offered snacks were included as covariates in these specific analyses. Results without the inclusion of covariates are reported when they differed significantly from results including covariates. Results of desire are described in Supplementary materials (Results: Study 2).

Table 3.2. Means, SDs, and statistics for descriptive variables and proposed mediators per condition (n = 62, Study 2).

	Discouraging condition (n = 29) [b]	Control condition (n = 33) [c]	Test statistic	p-value	η_p^2
	Mean (SD) or Number (%)	Mean (SD) or Number (%)			
Differences between conditions in descriptive variables					
Age (y)	43.61 (15.35)	38.62 (15.93)	$F(1, 58) = 1.51$	0.22	0.03
Sex (female)	5 (17.2%)	6 (18.2%)	$X^2(1) = 0.01$	0.92	-
Hunger state [a]	3.24 (1.90)	3.88 (2.01)	$F(1, 60) = 1.63$	0.21	0.03
Healthy eating goal [a]	5.17 (1.63)	4.94 (1.77)	$F(1, 60) = 0.29$	0.59	0.01
Weight goal [a]	4.79 (1.84)	4.55 (1.89)	$F(1, 60) = 0.27$	0.60	0.01
General liking snacks [a]	5.34 (1.29)	5.18 (1.83)	$F(1, 60) = 0.16$	0.69	0.001
Rush state [a]	3.90 (2.16)	4.27 (2.07)	$F(1, 60) = 0.49$	0.49	0.01
Presence of others (no)	28 (96.6%)	25 (78.1%)	$\Lambda = 5.08$	0.02	-
Effect of condition on proposed mediators					
Perceptions of social norms [a]	3.63 (1.51)	4.50 (1.67)	$F(1, 58) = 4.01$	0.05	0.07
Perceptions of effort (item 1) [a]	3.21 (1.90)	2.76 (2.05)	$F(1, 58) = 0.83$	0.37	0.01
Perceptions of effort (item 2) [a]	3.55 (2.15)	2.45 (1.64)	$F(1, 58) = 4.71$	0.03	0.08
Perceptions of salience [a]	5.74 (1.39)	5.47 (1.57)	$F(1, 57) = 0.63$	0.43	0.01

[a] Measured on a 7-point scale (range 1–7). [b] n = 28 for age. [c] n = 32 for age and presence of others. Age values were missing because of an unrealistically high reported age, and one participant did not know whether other people were present in the line at the checkout corner.

3.3.2.2. Test of hypothesis 1: Consumption

The relative likelihood (RL) of chocolate bars being taken when the lid was present versus absent was calculated using the online calculator MedCalc (https://www.medcalc.org/calc/relative_risk.php), including all customers that encountered the checkout corner (n = 711). In total, four chocolate bars were taken when the jar was covered by a lid, whereas 12 chocolate bars were taken when the jar was presented without a lid. RL estimates showed that it was less likely for a chocolate bar to be taken when the lid was present rather than absent ($RL_{control \rightarrow discouraging}$ = 0.32, 95% CI (11, 0.99), p = 0.049). Of the questionnaire participants who indicated noticing the jar (n = 62), 11.3% reported taking a chocolate bar (discouraging condition: n = 3, control condition: n = 4). None of these participants reported taking more than one chocolate bar.

3.3.2.3. Test of hypothesis 2: Perceptions of social norms, effort, and salience [1]

An ANCOVA testing the effect of condition on perceptions of social norms, with presence of others as a covariate, showed a marginally significant effect (n = 61, Table 3.2.). Participants who were presented the jar covered by a lid (compared to without a lid) reported a marginally significantly weaker norm to take snacks. An ANCOVA testing the effect of condition on perceptions of effort (item 1: 'the Twix bars required effort to take'), with presence of others as a covariate, showed no significant effect (n = 61, Table 3.2.), whereas results of a similar ANCOVA including the second item measuring perceptions of effort ('the Twix bars were up for grabs' [reverse coded]) showed a significant effect (n = 61, Table 3.2.). Participants who were presented the jar covered by a lid (compared to without a lid) reported that the chocolate bars were significantly less up for grabs. An ANCOVA testing the effect of condition on perceptions of salience, with presence of others and rush state as covariates, showed no significant effect (n = 61, Table 3.2.).

3.3.3. Discussion

Customers were less likely to take a snack when a cover on the snack jar was present (versus absent), although snacks were hardly taken in both conditions and more than two thirds of the questionnaire participants indicated that they had not noticed the snack jar. The presence (versus the absence) of the cover on the snack jar marginally significantly decreased perceptions of social norms to take snacks, and there were indications that the presence of the cover (significantly) increased perceptions of effort to obtain snacks. As the first two studies were conducted in a field context, not allowing for random assignment of participants to conditions, the third study was conducted in a controlled laboratory setting and focused particularly on the mechanisms underlying the effect of the cover on consumption.

[1] An ANOVA testing the effect of condition on perceptions of social norms showed a significant effect (F(1, 60) = 4.60, p = 0.036, $\eta_p 2$ = 0.07, n = 62).

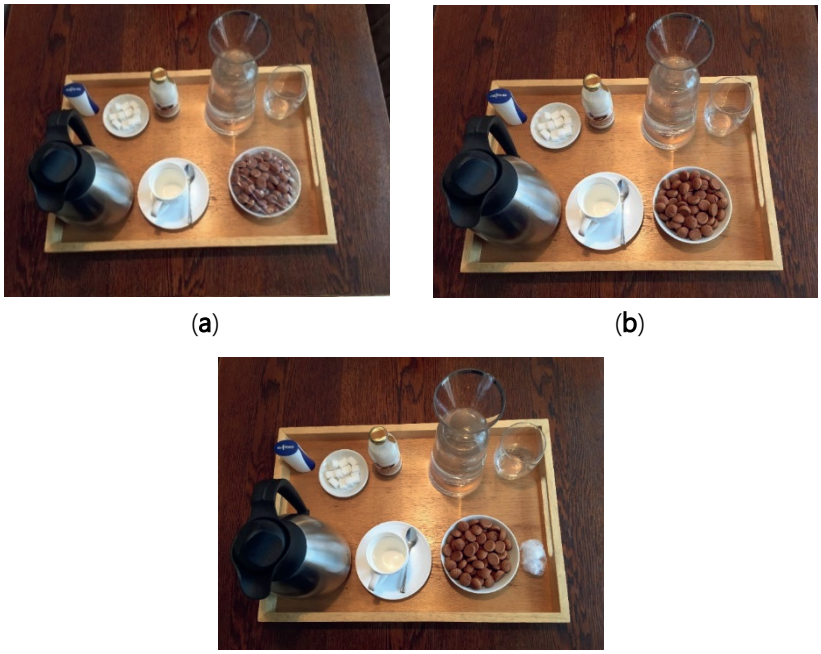
3.4. Study 3

3.4.1. Method

3.4.1.1. Participants and design

In total, 156 participants participated in a between-subjects lab experiment. Five participants who indicated any allergies or intolerances for the foods included in the study were excluded from analyses (discouraging condition: n = 3; control condition: n = 1; encouraging condition: n = 1). The final analytic sample included 151 participants (56 males and 95 females), with an average age of 23.83 years (SD = 8.17), and 84.8% were students from more than 20 different study programs.

Different from Studies 1 and 2, a third condition (labeled as the encouraging condition) was included in the design to test whether a snack bowl presented without a cover (treated here as the control condition) could be considered as an encouraging condition in itself, or whether the physical removal of the cover was needed to encourage participants to take snacks. Participants were randomly assigned to one of the three conditions, according to a predetermined computer-generated random sequence of conditions. All participants were unobtrusively presented a bowl of small gingerbread cookies (given the small unit size, about 2g per unit) while performing a bogus coffee taste task for 10 minutes. Thereafter, participants indicated their perceptions of social norms, effort, and salience regarding the snack bowl. Different from Study 2, additional items were included in Study 3 (e.g., measuring perceptions of freshness, presentation, and hygiene), to allow for a more specific examination of the effects which is facilitated by the controlled laboratory setting (compared to the field settings in Study 1 and 2). The presence or absence of a transparent foil covering the snack bowl was manipulated between conditions (see Figure 3.4.).



(**a**) (**b**)

(**c**)

Figure 3.4. Snack bowl used in Study 3: (**a**) discouraging condition; (**b**) control condition; (**c**) encouraging condition.

3.4.1.2. Procedure

Each participant was tested individually by one female researcher to ensure that participants could not influence one another. The study was promoted as a bogus coffee taste test for a new coffee that would soon be served in grand cafés. To bolster the cover story, the experiment was conducted in an ambiance room mimicking a grand café (Supplementary materials (Methods: Study 3)). First, participants provided their informed consent, after which they completed a questionnaire to assess their demographics (age, sex, and occupation), hunger state, healthy eating goal, and weight goal (using similar items as in Study 2, including six filler items; e.g., 'how thirsty are you at the moment?' (1: not thirsty at all to 7: very thirsty). After completion of the questionnaire, the researcher returned with a tray including a coffeepot, a mug on a saucer served with a spoon, sweetener, sugar, coffee milk, a water pitcher, and a glass. Also, a white non-transparent bowl with 110 g small gingerbread cookies (equal to 500 kcal) was presented on the tray, varying the presence or absence of the cover according to the condition (discouraging, control, or encouraging) to which they were assigned

(see Figure 3.4.). Participants in the encouraging condition were presented the bowl covered by transparent foil, but the researcher removed the foil before leaving the room and placed it next to the bowl (see Figure 3.4. (c)). All participants were invited to taste the coffee and were told that the study focused mainly on the aftertaste of the coffee and therefore the researcher left the room for 10 minutes (nothing was mentioned about the snacks).

After 10 minutes, the researcher removed the product tray and measured consumption out of sight of the participants (by subtracting the post-bowl weight from the pre-bowl weight; both likelihood of taking (yes/no) and amount of intake (grams) were defined). Participants completed a second questionnaire about the bogus coffee taste test (including 23 filler questions; e.g., 'how tasty or non-tasty did you find the aftertaste of the coffee?' (1: very non-tasty to 7: very tasty), after which they indicated their specific liking for the eaten snacks (Supplementary materials (Methods: Study 3), as well as their general liking for the offered snacks (measured as in Study 2). They also indicated their desire to eat the offered snacks and the attractiveness of the offered snacks to measure potential compensatory after-effects (Supplementary materials (Methods: Study 3). Furthermore, they completed the proposed mediator items (perceptions of social norms, effort, and salience). As a manipulation check, participants reported their perceptions of freshness, presentation, and hygiene regarding the snacks, to exclude these alternative interpretations of the presence of the cover. Finally, they wrote down their thoughts on the study aim and indicated any allergies or intolerances. Afterwards, they were thanked and reimbursed for their participation. Furthermore, 10 small bags of small gingerbread cookies and 10 small packs of fruit biscuits were presented in an open basket. Participants were instructed to choose either a bag of small gingerbread cookies or a pack of fruit biscuits, again to measure potential compensatory after-effects (Supplementary materials (Methods: Study 3). When data collection was finished, participants were debriefed about the true study aim.

3.4.1.3. Measures

3.4.1.3.1. Proposed mediators

Perceptions of social norms were measured using eight items that were averaged (Cronbach's $\alpha = 0.89$). In addition to the four-item social norm scale used in Study 2 (Table 3.1.), four additional items were included to allow for a more specific measurement of social norms. The following additional items were included: 'did you feel uncomfortable about taking [snacks]?' [reverse coded] (1: not uncomfortable at all

to 7: very uncomfortable), 'do you think you were supposed to take [snacks]?' (1: not supposed at all to 7: very supposed), 'did you feel encouraged or discouraged to take [snacks]' (1: very discouraged to 7: very encouraged), and 'how likely or unlikely is it that other participants took [snacks]?' (1: very unlikely to 7: very likely). Perceptions of effort (Cronbach's α = 0.88) and salience (Cronbach's α = 0.87) were measured using the same items as in Study 2 (Table 3.1.), mean scores were calculated.

3.4.1.3.2. Manipulation check

Perceptions of freshness, presentation, and hygiene were measured by stating, 'the [snacks] looked fresh', 'the [snacks] looked well-presented', and 'the [snacks] looked hygienic'. Responses ranged from 1: strongly disagree to 7: strongly agree.

3.4.2. Results

3.4.2.1. Descriptive statistics and randomization check

Descriptive statistics of participants per condition are reported in Table 3.3. One participant in the encouraging condition mentioned the link between the presentation of the snacks (presence/absence of the cover) and snack intake and was consequently categorized as having guessed the study aim. Results after exclusion of this participant did not significantly deviate from results including this participant; therefore, results with this participant included are further reported.

Conditions did not differ significantly in the descriptive variables (age, sex, hunger state, healthy eating goal, weight goal, and general liking for the offered snacks), confirming successful randomization. To check for other possible covariates, correlation coefficients between the descriptive variables and the outcome variables (consumption, proposed mediators, specific liking for the eaten snacks, and potential compensatory after-effects (e.g., desire)) were checked (Supplementary Table S3.3.). Age, sex, hunger state, and general liking for the offered snacks were significantly associated with one or more of the outcome variables (all $p < 0.04$). Consequently, these variables were included as covariates in further analyses when they correlated significantly with an outcome variable. Results without the inclusion of covariates are reported when they significantly differed from results including covariates. Results of specific liking for the eaten snacks and potential compensatory after-effects (desire, attractiveness, and participation reward) are described in Supplementary materials (Results: Study 3, Table S3.4.).

Table 3.3. Means, SDs, and statistics for descriptive variables, consumption, and proposed mediators per condition (n = 151, Study 3).

	Discouraging condition (n = 50) [b]	Control condition (n = 49) [c]	Encouraging condition (n = 52)	Test statistic	p-value	η_p^2
	Mean (SD) or Number (%)	Mean (SD) or Number (%)	Mean (SD) or Number (%)			
Differences between conditions in descriptive variables						
Age (y)	23.30 (6.23)	24.35 (10.01)	23.87 (8.00)	$F(2, 148) = 0.20$	0.82	0.00
Sex (female)	30 (60.0%)	31 (63.3%)	34 (65.4%)	$X^2(2) = 0.32$	0.85	-
Hunger state [a]	3.40 (1.41)	3.51 (1.62)	3.62 (1.47)	$F(2, 148) = 0.26$	0.77	0.00
Healthy eating goal [a]	5.54 (0.95)	5.84 (0.92)	5.85 (0.87)	$F(2, 148) = 1.82$	0.17	0.02
Weight goal [a]	4.44 (1.57)	4.79 (1.58)	4.96 (1.39)	$F(2, 147) = 1.57$	0.21	0.02
General liking snacks [a]	5.31 (1.31)	5.69 (0.96)	5.69 (1.20)	$F(2, 147) = 1.82$	0.17	0.02
Effect of condition on consumption						
Likelihood of taking (yes)	22 (44.0%)	34 (69.4%)	43 (82.7%)	$X^2(2) = 17.37$	< 0.001	-
Amount of intake (grams)	6.15 (12.43)	9.76 (12.88)	9.77 (12.22)	$F(2, 145) = 2.72$	0.069	0.04
Effect of condition on proposed mediators						
Perceptions of social norms [a]	4.47 (1.23)	5.01 (0.71)	5.32 (0.94)	$F(2, 146) = 9.44$	< 0.001	0.12
Perceptions of effort [a]	4.24 (1.54)	1.61 (0.71)	1.70 (0.88)	$F(2, 148) = 92.03$	< 0.001	0.55
Perceptions of salience [a]	5.09 (1.26)	5.69 (1.23)	5.83 (1.03)	$F(2, 146) = 5.48$	0.01	0.07

[a] Measured on a 7-point scale (range 1–7). [b] n = 49 for general liking snacks, perceptions of social norms, and perceptions of salience, because of incorrect values. [c] n = 48 for weight goal and perceptions of salience, because of incorrect values.

3.4.2.2. Manipulation check

Three separate univariate ANOVAs testing the effect of condition on perceptions of freshness ($F(2, 147) = 1.57$, $p = 0.21$, $\eta_p^2 = 0.02$, n = 150), presentation ($F(2, 148) = 2.06$, $p = 0.13$, $\eta_p^2 = 0.03$, n = 151), and hygiene ($F(2, 148) = 1.77$, $p = 0.17$, $\eta_p^2 = 0.02$, n = 151) showed no significant effects, suggesting a successful manipulation.

3.4.2.3. Test of hypothesis 1: Consumption [2]

In the discouraging condition, 44.0% of the participants took some snacks, whereas 82.7% in the encouraging condition and 69.4% in the control condition took some snacks. Pearson chi-square analyses showed a significant difference in likelihood of taking between the conditions (Table 3.3.). To predict the likelihood of participants taking snacks based on the condition to which they were assigned (all three levels of condition were dummy coded), two binary logistic regression analyses were performed controlling for hunger state and general liking (n = 150). Hunger state and general liking were entered in block 1, and two dummy variables of condition were entered in block 2 (the encouraging condition and the control condition in the first analysis and the encouraging condition and the discouraging condition in the second analysis). The results showed a significant effect between condition and likelihood of taking. Specifically, in comparison to the discouraging condition, participants in the control condition ($OR_{discouraging \rightarrow control}$ = 2.67, Wald = 4.28, 95% CI (1.05, 6.78), p = 0.04) and the encouraging condition ($OR_{discouraging \rightarrow encouraging}$ = 6.29, Wald = 12.44, 95% CI (2.27, 17.49), p < 0.001) were significantly more likely to take snacks. No differences in likelihood of taking were observed between the control condition and the encouraging condition ($OR_{control \rightarrow encouraging}$ = 2.36, Wald = 2.55, 95% CI = (0.82, 6.75), p = 0.11).

A square root transformation on amount of intake data (grams) was performed, as residuals were not normally distributed. An ANCOVA testing the effect of condition on amount of intake (including transformed data), with hunger state and general liking as covariates, showed a marginally significant effect (n = 150, Table 3.3.). *Post hoc* tests (Bonferroni) demonstrated that participants in the discouraging condition (M_{adj} = 1.65) had a marginally significantly lower amount of intake than participants in the encouraging condition (M_{adj} = 2.45), p = 0.088. No differences in amount of intake were observed between the control condition (M_{adj} = 2.31) and the discouraging condition, p = 0.22, and the control condition and the encouraging condition, p = 1.00.

3.4.2.4. Test of hypothesis 2: Perceptions of social norms, effort, and salience

An ANCOVA testing the effect of condition on perceptions of social norms, with age as a covariate, showed a significant effect (n = 150). Two separate univariate ANOVAs testing the effect of condition on perceptions of effort (n = 151) and salience (n = 149)

[2] An ANOVA testing the effect of condition on amount of intake (including transformed data) showed a significant effect (F(2, 148) = 4.44, p = 0.01, η_p^2 = 0.06, n = 151). *Post hoc* tests (Bonferroni) demonstrated that participants in the discouraging condition (M_{adj} = 1.46) had a significantly lower amount of intake than participants in the encouraging condition (M_{adj} = 2.55), p = 0.02 and a marginally significantly lower amount of intake than participants in the control condition (M_{adj} = 2.37), p = 0.068. No differences in intake amount were observed between the control and the encouraging condition, p = 1.00.

also showed a significant effect (Table 3.3.). Particularly, *post hoc* tests (Bonferroni) demonstrated that participants in the discouraging condition (social norms: M_{adj} = 4.49; effort: M_{adj} = 4.24; salience: M_{adj} = 5.09) reported a significantly weaker norm to take snacks, higher effort to obtain the snacks, and a lower salience of the snacks than participants in the encouraging condition (social norms: M_{adj} = 5.32, p < 0.001; effort: M_{adj} = 1.70, p < 0.001; salience: M_{adj} = 5.83, p = 0.01) and participants in the control condition (social norms: M_{adj} = 5.00, p = 0.03; effort: M_{adj} = 1.61, p < 0.001; salience: M_{adj} = 5.69, p = 0.04). No differences in perceptions of social norms (p = 0.30), effort (p = 1.00), and salience (p = 1.00) were observed between the control condition and the encouraging condition.

To test whether the effect of the cover on likelihood of taking can be explained by perceptions of social norms, effort, and salience, a single multiple mediation analysis was performed using Hayes's (2017) PROCESS tool for SPSS, controlling for hunger state and general liking (n =149). A priori, it was checked whether conditions for mediation were met by performing separate multiple linear regression analyses (to test the effect of condition on the proposed mediators) and separate binary logistic regression analyses (to test the effect of the proposed mediators on likelihood of consumption) (Yzerbyt, Muller, Batailler, & Judd, 2018). Perceptions of social norms, effort, and salience were included in mediation analyses, as both component paths of the indirect effect were significant (Supplementary Table S3.5.). The percentile bootstrapping method was applied to generate 95% confidence intervals, based on 10,000 resamples. To allow for the use of bootstrapping with an independent variable (condition) with three levels, two dummy coded variables were created using indicator coding (Hayes & Preacher (2014)), with the discouraging condition as the reference group (no matter which specific condition is selected as the reference group, significant conclusions remain similar). Relative to the discouraging condition, the absence of a cover on snack bowls indirectly influenced likelihood of consumption through perceptions of salience (control condition: relative indirect effect = 0.30, SE = 0.20, 95% CI (0.01, 0.78); encouraging condition: relative indirect effect = 0.37, SE = 0.23, 95% CI (0.05, 0.95)), but not through perceptions of social norms (control condition: relative indirect effect = 0.15, SE = 0.18, 95% CI (-0.15, 0.58); encouraging condition: relative indirect effect = 0.23, SE = 0.27, 95% CI (-0.23, 0.86)) and perceptions of effort (control condition: relative indirect effect = -0.36, SE = 0.71, 95% CI (-1.87, 0.96); encouraging condition: relative indirect effect = -0.35, SE = 0.70, 95% CI (-1.84, 0.93)).

3.4.3. Discussion

Again, participants were significantly less likely to take a snack when a cover on snack bowls was present (versus absent). A trend was observed that the number of snacks eaten (grams) was marginally significantly different between participants in the encouraging condition and the discouraging condition, although this finding needs to be interpreted carefully because of the risk of making a type 1 error. This suggests that the cover manipulation has a stronger impact on the decision to take or not to take rather than the amount of intake. Furthermore, results indicate that the control condition – a snack bowl presented without a cover – can be considered as an encouraging condition in itself, as no significant differences were observed between the control condition and the condition in which the cover was removed in the participants' presence. This might suggest that the effect is attributable to the *mere* presence or absence of a cover. In line with expectations, the presence (versus the absence) of a cover on snack bowls significantly decreased perceived social norms to take snacks and perceived salience of the snacks, and perceived effort to obtain the snacks was increased. However, the relationship between the cover manipulation and the likelihood of consumption was only significantly mediated by changes in perceptions of salience regarding the snacks; no significant mediating role for perceptions of social norms and effort was observed in this relationship.

3.5. General discussion

The present research investigated whether the presence (versus the absence) of a cover on snack bowls affected consumption (Studies 1–3) and whether this effect was explained through a) perceived social norms about snack consumption, b) perceived effort needed to obtain snacks, and c) perceived salience of the snacks (Studies 2 and 3). In line with our expectations, the results indicate that being presented a snack bowl with (versus without) a cover decreases the likelihood of taking snacks both in field contexts (Studies 1 and 2) and in a lab context (Study 3). In Study 2, a trend was observed that the presence (versus the absence) of a cover on snack bowls marginally significantly decreased perceptions of social norms to take snacks and increased perceptions of the effort to obtain snacks, whereas in Study 3, consistent with expectations, the presence of the cover significantly decreased perceptions of social norms to take snacks and salience of the snacks, and significantly increased perceptions of the effort needed to obtain snacks. However, contrary to expectations, the relationship between the cover manipulation and the likelihood of consumption was significantly mediated only by changes in perceptions of salience (Study 3).

The result that a cover might function as a barrier (or an obstacle) to

consumption is consistent with previous research showing that physical cues surrounding foods influence an individual's decision to take foods (Burger et al., 2010; Hunter et al., 2018; Keller et al., 2015; Kroese et al., 2015; Maas et al., 2012; Prinsen et al., 2013; Rozin et al., 2011). Together, these findings may challenge the dominant view that people consume whatever is available (Herforth & Ahmed, 2015), because small details in the organization of physical food environments might influence consumption decisions over and above the presence of food itself. In other words, although in both situations the snacks were available for consumption, the likelihood of consumption differed depending on the presence or absence of the cover. One could reason that these small changes in physical aspects of food environments can support individuals' self-regulation strategies, helping them to alter or override their immediate responses to available snacks. These insights seem especially important given the obesogenic food environments in which we currently live (Pitt et al., 2017; Story et al., 2008; Townshend & Lake, 2017). However, our studies were mainly performed to fundamentally understand how these environmental changes work rather than encouraging desired behavioral outcomes – this needs to be investigated in future research. We thereby acknowledge that our dietary decisions may also be impacted by other cues in environments (e.g., the behavior of other people in that environment), individual factors (e.g., habits and a priori preferences) or more macro levels of influence, such as pricing strategies, laws, policies and food marketing (Story et al., 2008). A recent study showed positive effects on healthy food purchases by combining environmental cues (colored frames and arrows encouraging healthier food choices in this study) with pricing strategies (salient price increases and/or discounts specifically) (Hoenink et al., 2020). It would be interesting to examine the interaction between physical cues functioning as a barrier to consumption and such pricing strategies on people's dietary decisions and perceptions of social norms.

As expected, the current results suggest that the presence (versus the absence) of a cover on snack bowls decreases people's perceived social norms to take snacks, although we failed to show that perceptions of social norms underlie the effect of the cover on likelihood of consumption. To our knowledge, the present research is the first to show evidence for the proposition that social norms can be inferred from physical cues surrounding foods, with food availability kept constant (Burger et al., 2010; Prinsen et al., 2013; Raghoebar, Van Rongen, et al., 2019), by directly hypothesizing and demonstrating the normative interpretation of such physical cues. Generally, two types of social norms are distinguished in the literature: descriptive norms and injunctive norms (Cialdini et al., 1990; Deutsch & Gerard, 1955). First, participants may have interpreted the presence of the cover as a signal that previous participants did not

consume any snacks. This interpretation relates to a descriptive norm describing the behavior of others in identical situations (Cialdini et al., 1990; Raghoebar, Haynes, et al., 2019). Second, participants may (also) have interpreted the presence of the cover as signaling a deliberate choice by the food provider and inferred that there was some justification behind its presence; this interpretation relates more to an injunctive norm prescribing the behavior that one ought to exhibit (Cialdini et al., 1990; Raghoebar, Haynes, et al., 2019). Unfortunately, the social norm measure used in the present research precluded separating descriptive from injunctive norm interpretations. Future studies should disentangle both norm types and evaluate them independently.

Alternatively, it was examined whether the presence of the cover influenced consumption for reasons of a non-social nature by investigating perceptions of effort and salience. Consistent with expectations, the findings from the lab experiment suggest that perceived salience of the snacks is decreased when the cover on snack bowls is present (versus absent), whereas perceived effort to obtain snacks is increased. Remarkably, only perceptions of salience significantly underlay the effect of the cover manipulation on likelihood of consumption. In other words, the presence (absence) of the cover resulted in a lower (higher) likelihood of consumption, as the snacks were perceived as less visible or salient due to the presence of the cover. The impact of food salience on consumption accords with the rationale behind the ban on point-of-sale tobacco product displays, implemented in many countries (He, Shang, Huang, Cheng, & Chaloupka (2018)). It has been shown that seeing tobacco product displays serves as a cue to smoke, even on impulse (i.e., unintentionally) and among people trying to avoid smoking (Wakefield, Germain, & Henriksen, 2008). One could reason that seeing snacks in our study acted as a cue to consume and that covering snacks thus might support people's self-regulation strategies to inhibit snacking. However, non-significant results of the cover manipulation on perceptions of salience were observed in the petrol station shop context. This inconsistency in results might be related to the transparency of the bowls used in both studies. Although in both studies the snacks were clearly visible, the snacks in the petrol station shop study were presented in a transparent jar in which the snacks were visible through the transparent snack jar (see Figure 3.3.), whereas the snacks in the lab study were presented in a non-transparent white bowl in which the snacks were visible only from above (see Figure 3.4.). One might argue that the snacks in the petrol station shop study were perceived as more salient when the cover was present (versus absent), as its presence might make the transparent snack jar more robust and visible, particularly in an environment in which other (competing) food cues surrounding the snack jar were present. This pattern of results was indeed observed, although not significant.

It should be noted that snacks were hardly taken in the petrol station shop context regardless of the presence or absence of the cover; this might be observed as a limitation of the current study. One interpretation of the low consumption numbers could be that people in general considered it less normal and/or appropriate to take snacks in the petrol station shop context, especially given that the snack jar was surrounded by plenty of other food cues that were not offered for free. This interpretation is supported by the relatively low social norms ratings observed in the petrol station shop study compared to the lab study. A different explanation for the low consumption numbers might be that approximately two third of the customers reported not noticing the snack jar; this might also be caused by the presence of other food cues surrounding the snack jar. Another remarkable finding of Study 2 pertains to the observation that approximately one fifth of the participants in the discouraging condition incorrectly reported the absence of the cover. One possible explanation for this incorrect recollection of the situation may be that some participants did not notice the (probably unexpected) presence of the cover. One may reason that this environmental cue was unnoticed by some participants due to a lack of attention, as rather unexpected cues may be overlooked when one is attending to other cues or tasks in that environment (e.g., the snack jar itself or the pin device at the checkout corner). This phenomenon is called inattentional blindness and may also be an explanation for the large number of customers reporting not noticing the snack jar itself (Simons & Chabris, 1999).

The quasi-experimental design employed in both field studies is associated with several limitations. For instance, no conclusions can be drawn on an individual level. The different snacks used in the field studies (Study 1 and 2) compared to the lab study (Study 3) may be observed as a strength of the current research, as we attempted to validate the phenomenon under different circumstances, testing similar hypotheses. However, this may also be observed as a limitation of the current research, as ideally the snacks were similar in all three studies for a more exact comparison between the studies. For example, recent research showed that snacks presented with a layer of wrapping (as in Study 1 and 2) were perceived as less salient and requiring more effort compared to unwrapped snacks (as in Study 3), and the presence of the wrapper may affect consumption (Knowles et al., 2020). Another methodological limitation of the current research is that the social norms measure was not validated and precluded separating descriptive from injunctive norm interpretations. Furthermore, we assessed mainly compensatory after-effects by self-report measures (Stok et al., 2015), and it is unclear whether people compensated at a later stage and/or in a different context. It is also unclear whether the cover effect sustains after repeated exposure to the cover

manipulation; this should be examined in future research. Finally, the impact of physical cues on consumption and perceptions of social norms, effort, and salience was limited to testing one specific cue. Future research should investigate the influence of other physical cues, such as the transparency of serving bowls or the relative availability of healthy versus less healthy snacks.

3.6. Conclusion

The present findings indicate that the presence (versus the absence) of a cover on snack bowls can decrease the likelihood of taking snacks in both field and lab contexts, suggesting that physical cues surrounding foods can influence consumption. Further, first indications suggest that a cover being present (rather than absent) might decrease both perceptions of social norms to take snacks and the salience of the snacks, whereas perceived effort to obtain the snacks is increased. These results suggest that the organization of physical aspects in food environments can change perceptions of social norms, effort, and salience, although the effect of the cover on consumption was explained only by changes in perceptions of salience.

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Chapter 4

Increasing the proportion of plant-based foods available to shift social consumption norms and food choice among non-vegetarians

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Abstract

Increasing the relative availability of plant-based (versus animal source) foods seems promising in shifting consumption, but it remains unknown how and under what circumstances this happens. We performed two availability manipulations including different foods. The impact on food choice, social norm perceptions about what others do (descriptive) or approve of (injunctive), and salience was assessed. Non-vegetarian participants were visually (Study 1, n = 184) or physically (Study 2, n = 276) exposed to (a) four plant-based and two animal source foods or (b) vice versa. Participants chose one food item, either hypothetically (Study 1) or actually (Study 2), and reported the perceived social norms and salience of plant-based and animal source foods. The results showed no direct effects on food choice, injunctive norms, or salience. An increased proportion of plant-based (versus animal source) foods was interpreted in Study 1 as plant-based foods being less often chosen by others, whereas in Study 2, these foods were interpreted as being more often chosen (marginally significant), while animal source foods were interpreted as being less often chosen. The results suggest that a higher availability of plant-based foods influences descriptive norms, but future research should examine aspects potentially contributing to the contradictory normative interpretations (e.g., norm salience).

4.1. Introduction

In an era when unhealthy and unsustainable food consumption patterns pose a global risk to people and planet, transitioning to healthier and more sustainable diets is one of the biggest global challenges. Recommendations for these so-called 'win-win' diets emphasize mainly an increase in the consumption of plant-based foods and a decrease in the consumption of animal source foods (Willett et al., 2019), with ruminant meats (e.g., beef), for example, having an environmental impact that is 20–100 times greater than that of plant-based foods (Clark & Tilman, 2017). Consequently, an increasing body of research focuses on strategies promoting dietary shifts towards plant-based foods and/or lowering demand for animal source foods (e.g., see systematic reviews by Bianchi, Dorsel, Garnett, Aveyard, & Jebb (2018); Bianchi, Garnett, Dorsel, Aveyard, & Jebb (2018)).

It is increasingly acknowledged that the organization of physical micro food environments (e.g., worksite cafeterias, supermarkets) plays a major role in transitioning current diets towards healthier and more sustainable consumption patterns, rather than putting all responsibility on the consumer and solely targeting conscious determinants of behavior (e.g., information provision) (Bianchi, Dorsel, et al., 2018; Bianchi, Garnett, et al., 2018). Particularly, it has been shown that physical cues—physical aspects of environments (Pechey & Marteau, 2018)—influence consumers' food choices in these micro food environments. One such physical cue that has repeatedly been identified as a key driver of food selection is in-store food availability (e.g., see systematic review by Pitt et al. (2017)). In-store food availability refers to the number of instances of a product within the physical micro environment (Pechey et al., 2020). Given the impact of food availability on consumption, a substantial number of studies have addressed and shown the impact of increasing the availability of low-calorie foods—thereby decreasing the number of high-calorie foods—to stimulate healthy food selection (e.g., see Cochrane systematic review by Hollands et al. (2019)). Limited attention has been paid to understanding the circumstances under which food availability influences the consumption of more sustainable foods in micro food environments (Bianchi, Garnett, et al., 2018; Garnett et al., 2019). Furthermore, little is known about the psychological mechanisms that underlie the effect of altering availability on food selection (Hollands et al., 2019; Pechey et al., 2020). The present paper aims to tackle these gaps in the literature by investigating the circumstances under which, and how, the selection of plant-based versus animal source foods is influenced by food availability.

Interventions altering the number of available food products can be executed in various ways: By (a) providing a larger or smaller number of different product options to alter the product range, (b) providing a larger or smaller number of available units

of a product (while the range remains similar), or (c) a combination of both strategies (Hollands et al., 2019). The present paper is inspired by the observed trend of meat substitutes gaining more shelf space in Dutch supermarkets in recent years (ABN AMRO, 2019; NOS, 2019). We aim to investigate the effect of further increasing the number of units of plant-based food products available to a situation in which more units of plant-based alternatives are available than units of animal source food products. To do so, we manipulate the proportion of units of plant-based food products available relative to the proportion of units of animal source food products available, without altering the range of products available (Hollands et al., 2019; Pechey et al., 2020). We are not aware of other studies aiming to keep the product range constant, although previous interventions have tried to keep the absolute (overall) number of options similar. For instance, an intervention study including six worksite cafeterias showed that increasing the proportion of low-calorie (to high-calorie) food options available—by removing high-calorie options and introducing low-calorie options—decreased the amount of energy (kcal) purchased, although results varied by site (significant differences were observed in two of the six sites) (Pechey, Cartwright, et al., 2019). Regarding sustainable food consumption, as far as we know, only one observational and one experimental field study conducted in three college cafeterias investigated the effect of proportionally providing a larger or a smaller number of different vegetarian meal options on meal selection (Garnett et al., 2019). The results showed that doubling the number of vegetarian meal options available increased the sales of vegetarian meals by between 41% and 79%. To illustrate, the number of vegetarian meal options was, for example, increased from 1 in 4 to 2 in 4 by removing an animal source meal option and introducing a vegetarian meal option (Garnett et al., 2019).

One may argue, however, that the effectiveness of such subtle changes in the choice architecture in stimulating more sustainable choices depends on consumers' affective connection towards meat, which is associated with consumers' willingness to shift towards a more plant-based diet (Graça, Calheiros, & Oliveira, 2015), and may be interpreted as a continuum: One end referring to disgust associated with negative affect and repulsion towards meat and the other end referring to a meat attachment pattern associated with positive affect and dependency towards meat (Graça, Oliveira, & Calheiros, 2015). We reason that people with higher levels of meat attachment are less affected by an availability intervention stimulating plant-based food selection, whereas people with lower levels of meat attachment could be more susceptible towards these initiatives (Graça, Calheiros, et al., 2015; Graça, Oliveira, et al., 2015). Therefore, in this article, consumers' differences in meat attachment are assessed as a

potential moderator in the effect of altering sustainable food availability on food selection.

In the literature, it has been suggested (rather than tested) that availability can affect consumer choices in different ways, as altering the proportion of foods may for instance influence how consumers pay attention to, and evaluate, these products (Hollands et al., 2019; Pechey et al., 2020). To our knowledge, this is the first study to empirically test potential underlying mechanisms of the availability effect. We thereby focus on explanations other than altering the range of different product options (e.g., a greater range might increase consumer satisfaction as there is more variety (Pechey et al., 2020; Van Kleef et al., 2012). Rather, we reason that an increased availability of plant-based foods relative to animal source foods may increase the salience of plant-based foods when they take up a larger space in the visual field (e.g., supermarket shelves) (Pechey et al., 2020; Pechey & Marteau, 2018; Van Kleef et al., 2012). This greater visual space dedicated to plant-based foods may increase the likelihood of the presumably more salient plant-based foods being observed by consumers, as consumers often focus on the most salient product (Itti & Koch, 2001; Pechey et al., 2020). This may, in turn, encourage the selection of plant-based foods (Pechey et al., 2020).

An increased availability of plant-based foods can consequently serve as a cue that implies a consumption norm or even a new (or updated) social norm, and thereby alter behavior (Pechey, Cartwright, et al., 2019; Pechey et al., 2020; Raghoebar, Van Rongen, et al., 2019; Van Kleef et al., 2012). Two types of social norms that are conceptually and motivationally different may be influenced by increasing the relative availability of plant-based foods: Descriptive norms and injunctive norms (Cialdini et al., 1990). Consumers may interpret the availability of a higher proportion of plant-based foods as representing what other people in that environment are typically consuming. Consumers observing a relatively greater supply of plant-based foods may believe that these products are popular because of a high demand (i.e., greater consumption of these products by others) (Pechey et al., 2020). This explanation is related to a descriptive norm indicating what other people normally do in that environment (Cialdini et al., 1990); it is supported by previous studies suggesting that descriptive norms can influence behavior through physical aspects in food environments without seeing others (Burger et al., 2010; Prinsen et al., 2013; Raghoebar, Haynes, et al., 2019; Raghoebar, Van Rongen, et al., 2019). Likewise, we argue that consumers may (also) infer that a greater availability of plant-based foods signals what other people consider as the appropriate choice in that environment. This explanation is related to an injunctive norm indicating what other people approve of in that environment (Cialdini

et al., 1990) and is built upon the idea that consumers interpret the number of products available as a deliberate decision by the food provider (e.g., supermarket) (Raghoebar, Haynes, et al., 2019). This normative interpretation of availability as a reflection of the choice that consumers are supposed to make according to others is consistent with previous research showing that consumers believe that a served portion size in a given situation is chosen after some deliberation, determining their food intake 24 h later (Raghoebar, Haynes, et al., 2019).

In this article, we propose that a relatively high availability of plant-based (versus animal source) food products will (a) increase the likelihood of plant-based (versus animal source) foods being chosen, (b) increase (versus decrease) the perceived salience of plant-based (versus animal source) foods, (c) increase (versus decrease) perceived descriptive norms signaling that others typically choose plant-based (versus animal source) foods, and (d) increase (versus decrease) perceived injunctive norms signaling that plant-based (versus animal source) foods ought to be chosen according to others. Furthermore, we examined whether perceptions of salience, descriptive norms, and injunctive norms mediate the relationship between the availability condition and food choice. Across two different experimental manipulations simulating (online) supermarket settings and using different meat reduction practices, we tested our hypothesis by visually (Study 1) and physically (Study 2) exposing non-vegetarian participants to an increased availability of plant-based foods or to a more actual situation in which animal source foods were highly available.

4.2. Study 1

4.2.1. Methods

4.2.1.1. Design

A between-subjects design with two conditions was utilized in an online study (inspired by an online experiment by Pechey & Marteau (2018)). Across conditions, participants were visually exposed to an array of images depicting two different plant-based and two different animal source food products (product range: Four different options); all images were similar in size and were shot from the same angle. The number of available units of plant-based and animal source food products was manipulated between conditions (keeping the product range similar to eliminate potential effects of the introduction of new products): (a) Four plant-based and two animal source food products (increased availability of plant-based foods (Figure 4.1. (a))), and (b) two plant-based and four animal source food products (increased availability of animal source

foods (Figure 4.1. (b))). From the array of food items, participants were asked to select one food product that they would choose to eat. Additionally, their perceptions of salience, descriptive norms, and injunctive norms of both the plant-based and the animal source foods were measured as potential mediators. Furthermore, meat attachment and sex were measured as potential moderators. Study approval was obtained from the research ethics committee of Wageningen University and Research (CoC number 09215846; Raghoebar 2019-23). We preregistered the study on the Open Science Framework (https://osf.io/bqmzg/) before data collection.

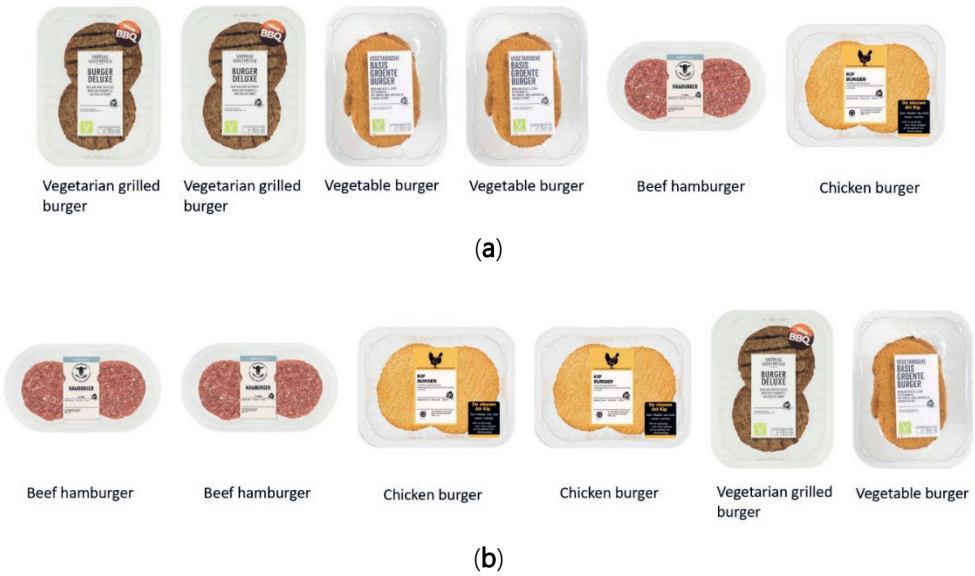

Figure 4.1. Examples of the availability manipulation keeping the product range on offer unchanged between conditions: (**a**) Increased availability of plant-based foods; (**b**) increased availability of animal source foods.

4.2.1.2. Participants and sample size

We recruited Dutch participants aged≥18 years on the online survey platform Prolific Academic. Participants who considered themselves as vegetarians were excluded from participation. Based on power estimations of a Monte Carlo power analysis for indirect effects (Schoemann, Boulton, & Short, 2017) (see Supplementary materials (Methods: Study 1)), it was planned to recruit 200 participants (roughly 100 participants in each condition).

4.2.1.3. Materials (food options: burgers)

Burgers (Albert Heijn Supermarket) were used as food stimuli, thereby presenting participants with a meal format in which the protein source (e.g., meat) is usually the main component of the meal (Schösler, De Boer, & Boersema, 2012). Instant meat substitutes (specifically produced and labeled to substitute (imitate) meat) were offered as plant-based alternatives to their animal source options, as these plant-based burgers are gaining more shelf space in Dutch supermarkets. They were selected based on the results of an online pilot study (see Supplementary materials (Methods: Study 1)), including 100 Dutch students and employees of Wageningen University and Research who considered themselves as non-vegetarians (88% students, 83% female, M age = 23.66 years, SD = 5.41). Participants reported their liking for, and familiarity with, the different burgers (measured on 7-point scales (range 1–7)), as these product-related factors have been identified as key barriers to consumer acceptance (Hoek et al., 2011). Two different options of plant-based and animal source food products that scored highest on these liking and familiarity items were selected for inclusion in the experiment. The plant-based food products included were (each product included two burgers (portions)) vegetarian grilled burgers (based on soy protein and wheat protein: 180 g, 279 kcal; M liking = 4.46 (SD = 1.28), M familiarity = 2.49 (SD = 1.70)) and vegetable burgers (vegetable mix including carrots, garden peas, corn and bell pepper: 200 g, 340 kcal; M liking = 4.54 (SD = 1.40), M familiarity = 2.76 (SD = 1.95)). The animal source food products included were (each product included two burgers (portions)) beef hamburgers (200 g, 530 kcal; M liking = 5.49 (SD = 1.21), M familiarity = 5.42 (SD = 1.77)) and chicken burgers (205 g, 584 kcal; M liking = 5.13 (SD = 1.29), M familiarity = 4.42 (SD = 2.05)).

4.2.1.4. Measures

4.2.1.4.1. Hypothetical food choice

One image of each different food option (two plant-based and two animal source food products) was presented on a single line as the response scale for the hypothetical food choice item (Table 4.1.). The position of images was randomized to eliminate order effects, and participants responded by selecting one food option. A dichotomous variable was created with two categories: Plant-based and animal source foods.

Table 4.1. Items used to measure hypothetical food choice, perceptions of salience, descriptive norms, and injunctive norms.

Variables	Items
Hypothetical food choice	'Which [food option] would you choose to eat for dinner?'
Perceptions of salience	'To what extent did this [food option] stand out?' (1: Not at all to 7: Very much) (Maas et al., 2012; Raghoebar, Van Kleef, & De Vet, 2020a)
Perceptions of descriptive norms	'How likely is it that other participants similar to you would choose this [food option]?' (1: Not at all likely to 7: Extremely likely) (Cialdini et al., 1990; Raghoebar, Haynes, et al., 2019; Raghoebar et al., 2020a)
Perceptions of injunctive norms	'To what extent do other participants similar to you think you ought to choose this [food option]?' (1: Not at all to 7: Very much) (Cialdini et al., 1990; Raghoebar, Haynes, et al., 2019; Raghoebar et al., 2020a)

4.2.1.4.2. Proposed mediators

The items measuring perceptions of salience, descriptive norms, and injunctive norms are presented in Table 4.1. For each proposed mediator variable, participants completed the corresponding item separately for the two plant-based and the two animal source foods. This resulted in four ratings for each mediator variable (12 ratings in total). Then, for each mediator variable, two single scores were calculated including the sum of (a) two ratings of plant-based foods and (b) two ratings of animal source foods. This ultimately resulted in a plant-based and an animal source measure for each mediator variable (six measures in total).

4.2.1.4.3. Meat attachment

Meat attachment was assessed on a 16-item scale developed by (Graça, Calheiros, et al., 2015), consisting of four subscales: Hedonism (e.g., 'to eat meat is one of the good pleasures in life'; including four items), affinity (e.g., 'by eating meat I'm reminded of the death and suffering of animals'; including four items, all reverse coded), entitlement (e.g., 'to eat meat is an unquestionable right of every person'; including three items), and dependence (e.g., 'I don't picture myself without eating meat regularly'; including five items, one item was reverse coded). Responses ranged from 1: Strongly disagree to 7: Strongly agree. Cronbach's α was 0.92, and a mean score was calculated for the 16 items.

4.2.1.5. Procedure

The various stages of the online experiment are outlined in Table 4.2. Regarding Stage 5a, in which the participant was instructed to choose one burger, the availability manipulation (i.e., the number of units of plant-based and animal source burgers available per option) to which the participant was visually exposed was dependent upon his/her randomly assigned condition (via Qualtrics). The burgers were presented on a single line, and the order of presentation of categories (plant-based burgers versus animal source burgers) was evenly randomized, as well as the order of presentation of burgers within each category (keeping analogous options together). Furthermore, the product names were placed directly below the product images, corresponding to the product names provided by the supermarket (Figure 4.1.). Regarding Stages 5b and 5c, in which the participant was instructed to hypothetically choose his/her bun and toppings, in each condition one product per option was shown on a single line.

Table 4.2. The various stages of the online experiment.

Stage 1. Participants were informed that they were participating in a study about the influence of composing a meal on their mood (cover story).
Stage 2. Eligible participants provided their informed consent and were instructed to complete the questionnaires on a desktop or laptop computer (programmed in Qualtrics).
Stage 3. Participants completed an 8-item filler mood questionnaire about their current mood, also including one item measuring their hunger (see Supplementary materials (Methods: Study 1)). The items were shown in an evenly randomized order.
Stage 4. Participants were asked to imagine the following: 'It is 5 p.m. and you are in the supermarket. You are buying groceries for your evening meal, only for yourself, as you will eat alone. Burgers are on your menu'.
Stage 5. Participants were instructed to hypothetically compose their own evening meal by selecting: **(a)** one burger from the array of different burgers available (Figure 4.1.; the availability manipulation to which the participant was visually exposed was dependent upon the condition to which the participant was assigned); **(b)** one bun (to bolster the cover story; options: A white bun, a wholegrain bun, or a brown bun); **(c) t**wo out of five toppings (to bolster the cover story; options: Lettuce, tomatoes, pickles, onions, or jalapenos). Note: a, b, and c were presented on separate pages, and on each of these pages the hypothetical food choice item was presented. It was explicitly stated that they could not add anything to their burger at home.
Stage 6. Participants completed: **(a)** the proposed mediator items. Each mediator item was presented on a separate page (shown below the relevant availability manipulation). The order of presentation of mediators was evenly randomized, as well as the order of presentation of burgers regarding each mediator; **(b)** the quality control question (Feitosa, Joseph, & Newman, 2015) (see Supplementary materials (Methods: Study 1)); **(c)** the liking and familiarity items (see Supplementary materials (Methods: Study 1)). The liking and familiarity items for each burger were presented on the same page, but the different burgers were presented on separate pages in an evenly randomized order; **(d)** the meat attachment items (items were presented per subscale); **(e)** the frequency of meat consumption item (De Boer, Hoogland, & Boersema, 2007) (see Supplementary materials (Methods: Study 1)); **(f)** the same mood questionnaire as in Stage 3 (to corroborate the cover story); **(g)** their awareness of the study aim question (Raghoebar, Haynes, et al., 2019) (see Supplementary materials (Methods: Study 1)); **(h)** their demographic information (age, sex, nationality, and education); **(i)** the question about any allergies or intolerances for the included burgers.
Stage 7. Participants were debriefed and reimbursed.

4.2.1.6. Statistical procedure

IBM SPSS Statistics 24 (IBM corp., Armonk, NY, USA) was used for data analyses. Participants who identified the study aim were excluded from analyses, as well as participants who indicated any food allergies or intolerances for the included burgers, participants who incorrectly answered the quality control question, and participants who did not follow instructions (planned a priori).

A Pearson chi-square analysis was conducted to test whether hypothetical food choice differed significantly between conditions. Six separate univariate ANOVAs were run to assess whether condition affected perceptions of (a) salience, (b) descriptive norms, and (c) injunctive norms, run for both the plant-based and the animal source foods.

The conditions for mediation were checked (Yzerbyt et al., 2018) by conducting six linear regressions to examine the effect of experimental condition on perceptions of (a) salience, (b) descriptive norms, and (c) injunctive norms, run for both the plant-based and the animal source foods, and the effect of each proposed mediator on hypothetical food choice was assessed by conducting six logistic regressions, again run for both the plant-based and the animal source foods. Proposed mediators that showed significant effects for both components of the indirect effect were included in mediation analyses using the PROCESS macro for SPSS (Model 4) (Hayes, 2017), generating 95% percentile bootstrap confidence intervals for the indirect effect, based on 10,000 bootstrap resamples.

PROCESS macro for SPSS (Model 1) was used to examine (1) the interaction between condition and sex on hypothetical food choice and (2) the interaction between condition and meat attachment on hypothetical food choice, generating 95% percentile bootstrap confidence intervals for the interaction effect, based on 10,000 bootstrap resamples.

Potential covariates were identified by running correlation analyses between descriptive variables (demographics, hunger, liking, familiarity, meat attachment, frequency of meat consumption) and hypothetical food choice or the proposed mediator variables. We repeated primary analyses adjusting for significantly correlated covariates. Only results of primary analyses that were significantly impacted by the inclusion of these covariates were reported as a sensitivity analysis.

4.2.2. Results

4.2.2.1. Participant characteristics

In total, 370 Dutch Prolific Academic participants were eligible to participate in the study, of which 188 participants completed the questionnaire on a desktop or laptop computer (response rate: 49%, all participants passed the quality control question), although it was a priori planned to reach a total sample size of 200 participants. A total of 184 participants were included in the final analytic sample after planned exclusions (see Supplementary Figure S4.1.). In Table 4.3., descriptive statistics per condition are presented.

Table 4.3. Descriptive statistics per condition (n = 184).

	Increased plant-based foods condition (n = 90)	Increased animal source foods condition (n = 94)
	Mean (SD) or Number (%)	Mean (SD) or Number (%)
Age (y)	27.10 (8.75)	27.49 (9.77)
Sex (female)	21 (23.3%)	37 (39.4%)
Nationality (Dutch)	85 (94.4%)	88 (93.6%)
Education (academic education)	31 (34.4%)	22 (23.4%)
Hunger [a]	3.41 (1.54)	3.38 (1.66)
Liking [a]		
Plant-based foods [b]	7.18 (2.57)	7.85 (2.60)
Animal source foods [b]	10.99 (1.70)	10.77 (1.83)
Familiarity [a]		
Plant-based foods [b]	4.44 (2.95)	5.28 (3.36)
Animal source foods [b]	10.56 (3.16)	10.46 (2.79)
Meat attachment [a]	4.63 (1.17)	4.42 (1.12)
Frequency of meat consumption (range 0–7)	5.86 (1.77)	5.59 (1.64)

[a] Measured on a 7-point scale (range 1–7). [b] Sum score (range 2–14).

4.2.2.2. Hypothetical food choice

In total, 13.0% of the participants chose a plant-based food option (see Figure 4.2. for the percentage of chosen items of each food option per condition). No significant difference in hypothetical food choice was observed between participants who were visually exposed to an increased availability of plant-based (versus animal source) foods (Table 4.4.).

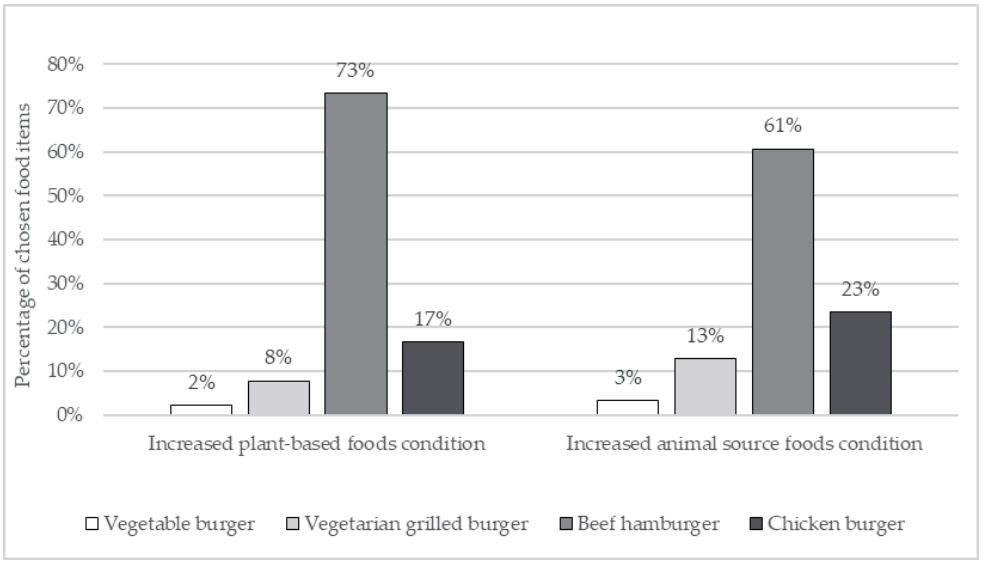

Figure 4.2. Percentage of chosen items of each food option per condition (*n* = 184).

Table 4.4. Hypothetical food choice and the proposed mediators per condition (n = 184).

	Increased plant-based foods condition (n = 90)	Increased animal source foods condition (n = 94)	Test statistic	p-value	η_p^2
	Mean (SD) or Number (%)	Mean (SD) or Number (%)			
Effect of condition on hypothetical food choice					
Hypothetical food choice (plant-based foods)	9 (10.0%)	15 (16.0%)	$X^2(1) = 1.44$	0.23	-
Effect of condition on the proposed mediators					
Perceptions of salience [a]					
Plant-based foods [b]	7.61 (2.43)	7.94 (2.23)	$F(1, 182) = 0.89$	0.35	0.01
Animal source foods [b]	9.69 (2.34)	9.51 (1.99)	$F(1, 182) = 0.31$	0.58	0.00
Perceptions of descriptive norms [a]					
Plant-based foods [b]	5.88 (2.44)	6.72 (2.35)	$F(1, 182) = 5.74$	0.02	0.03
Animal source foods [b]	10.46 (1.92)	10.05 (1.75)	$F(1, 182) = 2.21$	0.14	0.01
Perceptions of injunctive norms [a]					
Plant-based foods [b]	6.13 (2.66)	6.12 (2.88)	$F(1, 182) = 0.00$	0.97	0.00
Animal source foods [b]	7.61 (2.86)	7.82 (2.89)	$F(1, 182) = 0.24$	0.62	0.00

[a] Measured on a 7-point scale (range 1–7). [b] Sum score (range 2–14).

4.2.2.3. Proposed mediators

No significant differences in perceptions of salience and injunctive norms (regarding either plant-based or animal source foods) were observed between participants who were visually exposed to an increased availability of plant-based (versus animal source) foods (Table 4.4.). A significant difference in perceptions of descriptive norms regarding plant-based foods, but not animal source foods, was observed between the conditions (Table 4.4.). Participants who were visually exposed to an increased availability of plant-based (versus animal source) foods reported a lower likelihood of other participants selecting a plant-based food option. However, the effect became non-significant when covariates were included in the model (see Supplementary materials (Results: Study 1, Table S4.1.)).

Perceived descriptive norms of the plant-based foods were included in mediation analyses (see Supplementary Table S4.2. for the components of the indirect effect). The analyses indicated a significant indirect effect of visual exposure to an increased availability of plant-based (versus animal source) foods on hypothetical food choice through perceived descriptive norms of the plant-based foods (indirect effect = -0.28, SE = 0.15, 95% CI (-0.63, -0.04)). However, when covariates were included in the model,

the conditions for mediation were no longer met (see Supplementary materials (Results: Study 1, Table S4.1.)).

4.2.2.4. Proposed moderators

The effect of availability on food choice was not significantly moderated by sex (interaction effect = −0.6, 95% CI (−2.50, 1.26), p = 0.52) or meat attachment (interaction effect = −0.86, 95% CI (−2.07, 0.36), p = 0.17).

4.2.3. Discussion

Visual exposure to a relatively high availability of plant-based (versus animal source) food products did not affect hypothetical food choice, neither did it change perceptions of salience and injunctive norms. It did, however, change perceived descriptive norms of the plant-based (not animal source) foods, but in a direction contrary to our expectations. Participants who were visually exposed to an increased availability of instant meat substitutes reported a lower probability of others choosing a meat substitute than did participants who were exposed to a higher availability of meat products. Furthermore, the effect of condition on hypothetical food selection may be mediated by perceived descriptive norms of the plant-based foods. However, as planned, we repeated our primary analyses by including significantly correlated covariates in the model, and this revealed that all significant effects disappeared. This may suggest that the effects are not robust against a greater precision of the estimation, and the results should therefore be interpreted with some caution.

Two main explanations can be offered for the current results. First, it may be possible that the availability manipulation was interpreted by some participants as products being scarce (e.g., caused by interpretations of empty places in the assortment or products being limited available) rather than products being abundantly available. To illustrate, a high availability of plant-based foods may also have suggested that other participants more often chose an animal source food product, whereas the current study is based on the rationale that a high availability of products can increase the choice of abundantly available products (Garnett et al., 2019; Hollands et al., 2019; Pechey, Cartwright, et al., 2019). Previous research has shown that product scarcity can also increase the choice of scarce products (Brock, 1968; Gierl & Huettl, 2010; Van Herpen, Pieters, & Zeelenberg, 2014), and this possibly affected our manipulation. Second, it could be that participants were not that open and willing to shift towards an instant meat substitute, as the majority of participants chose a meat burger (specifically the beef option), reported a high meat consumption (almost six days a week), and indicated a relatively lower liking for, and familiarity with, instant meat substitutes.

Previous research, for instance, showed that environmental changes aimed at stimulating healthy choices (decreasing soft drink consumption for example) did not influence behavior when individuals held strong personal preferences (e.g., a high liking for soft drinks) that were incongruent with the targeted behavioral change (Venema, Kroese, De Vet, & De Ridder, 2019). Moreover, when consumers are unwilling to shift towards a plant-based diet (i.e., when the intervention differs from their personal goals), the intervention may be at risk of being accused of undermining consumers' right to consume what they want (Brehm & Brehm, 1981; Lea, Crawford, & Worsley, 2006a, 2006b). Possibly, some participants felt threatened in their autonomy and this may have led to reactance in that some participants, for instance, selected the opposite of what was being promoted (Brehm & Brehm, 1981; Van Kleef et al., 2012).

4.3. Study 2

In Study 2, we tested our hypothesis with a different experimental manipulation. Non-vegetarian participants were exposed to an increased availability of physically present plant-based (versus animal source) food products in a lab-in-the-field setting (measuring actual food choice). Furthermore, a different meal format was used in which meat was treated as a secondary meal ingredient rather than a dominant meal component (Schösler et al., 2012). Moreover, we attempted to diminish interpretations of products being scarce caused by perceptions of empty places in the assortment (by showing an equally filled shelf within a clear border) or by products being limitedly available (by explicitly stating that all products were in stock) (Van Herpen, Pieters, & Zeelenberg, 2009), thereby making the availability manipulation more salient, as we aim to encourage a transition from animal source diets to plant-based diets for large groups of consumers rather than promoting plant-based foods as an exclusive product. Moreover, for exploratory purposes, we examined whether the availability manipulation affected participants' perceptions of autonomy in selecting their food product, as a lower perceived autonomy may reduce the effectivity of the intervention (Brehm & Brehm, 1981; Lea et al., 2006a, 2006b).

4.3.1. Methods

4.3.1.1. Design

A between-subjects design with three conditions was utilized in a lab-in-the-field setting. Across conditions, participants were exposed to an array of physically present food options, including two different plant-based and two different animal source food products (product range: Four different options). Like in Study 1, the number of

available units of plant-based and animal source food products was manipulated between conditions (keeping the product range similar to eliminate potential effects of the introduction of new products): (a) Four plant-based and two animal source food products (increased availability of plant-based foods), (b) two plant-based and four animal source food products (increased availability of animal source foods), and (c) two plant-based and two animal source food products (control condition). From a product display (Figure 4.3.), like in Study 1, participants were asked to select one food product that they would choose to eat (products in this study included or excluded meat). Additionally, their perceptions of salience, descriptive norms, and injunctive norms of both the plant-based and the animal source foods were measured as potential mediators. Meat attachment was also measured as a potential moderator. In addition to the measures in Study 1, participants' perceived autonomy in selecting their food product was measured for exploratory purposes. Moreover, a control condition was added to the design—showing one unit of each food option—to be able to disentangle the direction of potential effects. In comparison with a control condition, we propose that a relatively high availability of plant-based (versus animal source) food products will increase the likelihood of plant-based (versus animal source) food products being chosen and vice versa. Study approval was obtained from the research ethics committee of Wageningen University and Research (CoC number 09215846; Raghoebar 2019-29). We preregistered the study on the Open Science Framework (https://osf.io/3aqnk/) before data collection.

(**a**) (**b**)

Figure 4.3. Example of the availability manipulation showing an increased availability of plant-based foods: (**a**) Product display consisting of three shelves, with the middle and the bottom shelf functioning as a hypothetical selection task; (**b**) example of the middle and the bottom shelf covered by white canvas, with the upper cover removed in order to select one pasta sauce.

4.3.1.2. Participants and sample size

The study was conducted at a women's summer fair (in Dutch: Libelle Zomerweek) held from 23 May to 29 May 2019. At this fair, Dutch participants aged≥16 years could register to participate in the study. Male participants were not eligible to participate (and could thus not register to participate), as females were the main visitors to the women's summer fair (approximately 82,000 female visitors during the fair, mainly aged>30 years) (Libelle Zomerweek); this enabled a more specific examination of the effect. A maximum of 315 participants could register to participate in the study, and we aimed to reach this number (roughly 105 participants in each condition). Power estimations of a Monte Carlo power analysis for indirect effects indicate that a power of 0.85 ($p < 0.05$) is reached with 315 participants in a model with two parallel mediators (Schoemann et al., 2017) (see Supplementary materials (Methods: Study 2)). As we planned to include three mediators in our analyses (i.e., perceptions of salience, descriptive norms, and injunctive norms) and to exclude participants who considered themselves as vegetarians and participants who identified the study aim, we expected a medium effect size.

4.3.1.3. Materials (food options: pasta sauces)

Readymade pasta sauces (Grand'Italia) were used as food stimuli instead of burgers for practical and food safety reasons as we could distribute only shelf-stable products at the women's summer fair. Consequently, this study was focused on the inclusion or exclusion of animal source ingredients in the pasta sauces, rather than targeting instant meat substitutes. The pasta sauces were selected based on the results of an online pilot study (see Supplementary materials (Methods: Study 2)), including 60 Dutch female students and employees of Wageningen University and Research who considered themselves as non-vegetarians (86.7% students, M age = 23.50 years, SD = 4.26). Like in Study 1, two different options of plant-based and animal source food products that scored highest on liking and familiarity items (measured on 7-point scales (range 1–7)) were selected for inclusion in the experiment. The plant-based food products included were (each product included two portions) Basilico with basil (tomato sauce with basil: 260 g, 187 kcal; M liking = 5.72 (SD = 1.20), M familiarity = 4.73 (SD = 2.01)) and Toscana with sundried tomatoes (tomato sauce with sundried tomatoes: 260 g, 231 kcal; M liking = 5.02 (SD = 1.35), M familiarity = 3.02 (SD = 1.89)). The animal source food products included were (each product included two portions) Bolognese with beef (tomato sauce with beef: 260 g, 265 kcal; M liking = 4.92 (SD = 1.20), M familiarity = 3.78 (SD = 1.98)) and Carbonara with pancetta (cream sauce with bacon: 260 g, 569 kcal; M liking = 4.10 (SD = 1.62), M familiarity = 3.35 (SD = 1.95)).

4.3.1.4. Measures

4.3.1.4.1. Food choice

The selected pasta sauce was observed and reported by the researcher. A dichotomous variable was created with two categories: Plant-based and animal source foods.

4.3.1.4.2. Proposed mediators

The items measuring perceptions of salience, descriptive norms, and injunctive norms were similar to those in Study 1 and are presented in Table 4.1. Again, for each proposed mediator variable, participants completed the corresponding item separately for the two plant-based and the two animal source foods. This resulted in four ratings for each mediator variable (12 ratings in total). Then, for each mediator variable, two single scores were calculated including the sum of (a) two ratings of plant-based foods and (b) two ratings of animal source foods. This ultimately resulted in a plant-based and animal source measure for each mediator variable (six measures in total). Different from Study 1, norm items referred to 'visitors to the Libelle Zomerweek', a situation-specific

group, instead of referring to 'participants similar to you' (e.g., 'how likely is it that other visitors to the Libelle Zomerweek would choose this pasta sauce?').

4.3.1.4.3. Meat attachment

Meat attachment was assessed with the same 16-item scale as used in Study 1. Cronbach's α was 0.89, and a mean score was calculated for the 16 items.

4.3.1.4.4. Perceptions of autonomy

Based on the categorization of three types of autonomy, i.e., freedom of choice, agency, and self-constitution (Vugts, Van den Hoven, De Vet, & Verweij, 2018), eight items were included to report freedom of choice (e.g., 'I felt that I had a choice'; including two items), agency (e.g., 'I had my own reasons for making this choice'; including three items), and self-constitution (e.g., 'the choice is typical for me'; including three items). Responses ranged from 1: Strongly disagree to 7: Strongly agree. Cronbach's α was 0.84, and a mean score was calculated for the eight items.

4.3.1.5. Procedure

In mass media communications about the women's summer fair and at the women's summer fair itself, the study was promoted as follows: Participate in a shopping game and bring your own collected groceries home. The study was conducted over a 7-day period (Thursday–Wednesday), including six testing times a day (10.30 a.m., 11.30 a.m., 12.30 p.m., 2.30 p.m., 3.30 p.m., 4.30 p.m.), and 15 cubicles were available for participation. The study was conducted by three female researchers.

The various stages of the lab-in-the-field experiment are outlined in Table 4.5. Regarding Stage 6a, in which the participant was instructed to choose one readymade pasta sauce, the availability manipulation (i.e., the number of units of plant-based and animal source pasta sauces available per option) to which the participant was exposed was dependent upon her randomly assigned condition (according to a predetermined computerized random sequence of conditions). The pasta sauces were presented on a single line, and the order of presentation of categories (plant-based pasta sauces versus animal source pasta sauces) was evenly randomized, as well as the order of presentation of pasta sauces within each category (keeping analogous options together). Regarding Stages 6b and 6c, in which the participant was instructed to hypothetically choose her carbohydrate (pasta) and vegetable, in each condition one product per option was offered on a single line (Figure 4.3. (a)). To diminish scarcity effects, the upper shelf was equally filled with pasta sauces and was presented within a clear border (diminishing interpretations of empty places in the assortment).

Furthermore, it was explicitly stated that all pasta sauces were in stock (diminishing interpretations of products being limitedly available (inspired by Van Herpen et al. (2009)). To bolster the cover story, it was mentioned that all carbohydrate (pasta) and vegetable products were in stock.

Table 4.5. The various stages of the lab-in-the-field experiment.

Stage 1. As in Study 1, participants were informed that they were participating in a study about the influence of composing a meal on their mood (cover story).
Stage 2. Participants were verbally instructed about the procedure, which supported and corresponded to the questionnaire instructions.
Stage 3. At the start of the questionnaire (programmed in Qualtrics, displayed on a tablet), participants provided their informed consent, after which the cover story was repeated.
Stage 4. As in Study 1, participants completed an 8-item filler mood questionnaire about their current mood, again including one item measuring their hunger (see Supplementary materials (Methods: Study 1)). The items were shown in an evenly randomized order.
Stage 5. Participants were asked to imagine the following: 'You are coming home late tonight after the women's summer fair and you are in the supermarket. You are buying groceries for your evening meal. You will cook something simple and only for yourself, as you will eat alone. Pasta is on your menu'.
Stage 6. Participants were directed to a wooden product display in front of them, consisting of three shelves that were separately covered by white canvas, making the products initially invisible to participants (Figure 4.3. (b)). Participants were instructed to compose their own evening meal by removing the cover and selecting: **(a)** one readymade pasta sauce from the upper shelf (the availability manipulation to which the participant was exposed was dependent upon the condition to which the participant was assigned); **(b)** one carbohydrate (pasta) from the middle shelf (to bolster the cover story; options: Fusilli or spaghetti); **(c)** one vegetable from the bottom shelf (to bolster the cover story; options: Zucchini or red pepper). Note: Participants were instructed to first remove the cover from the target shelf and to put their selected product directly in a paper bag in front of them before removing the following cover and selecting the following product (in the order a, b, c). It was explicitly stated that it was not possible to change their products after they made a choice and that they could not add anything to their pasta at home.
Stage 7. Participants completed: **(a)** the proposed mediator items (as in Study 1). Each mediator item was presented on a separate page and the order of presentation of mediators was evenly randomized, as well as the order of presentation of pasta sauces regarding each mediator; **(b)** the perceptions of autonomy items (items were presented per subscale); **(c)** the liking and familiarity items (see Supplementary materials (Methods: Study 1)). The liking and familiarity items for each pasta sauce were presented on the same page, but the different pasta sauces were presented on separate pages in an evenly randomized order; **(d)** the frequency of meat consumption item (De Boer et al., 2007) (see Supplementary materials (Methods: Study 1));

(e) the meat attachment items (as in Study 1; items were presented per subscale); **(f)** the same mood questionnaire as in Stage 4 (to corroborate the cover story); **(g)** their awareness of the study aim question (Raghoebar, Haynes, et al., 2019) (see Supplementary materials (Methods: Study 1)); **(h)** their demographic information (age, nationality, and education); **(i)** the question about considering themselves as a vegetarian; **(j)** the question about any allergies or intolerances for the included pasta sauces.
Stage 8. All participants in the same time slot were jointly verbally debriefed.
Stage 9. Without the presence of participants, the selected pasta sauce, carbohydrate (pasta), and vegetable were reported, as well as the time of participation.

4.3.1.6. Statistical procedure

IBM SPSS Statistics 24 (IBM corp., Armonk, NY, USA) was used for data analyses. Participants who identified the study aim were excluded from analyses, as well as participants who considered themselves as vegetarians, indicated any food allergies or intolerances for the included pasta sauces, participants aged<16years, and participants who did not follow instructions (planned a priori).

A Pearson chi-square analysis was conducted to test whether food choice differed significantly between conditions. Thereafter, two binary logistic regression analyses were conducted to predict the likelihood of participants selecting a plant-based (versus animal source) food product depending on the availability condition to which they were assigned (three dummy variables were created for each condition). The animal source foods condition was the reference group in the first analysis, and the control condition was the reference group in the second analysis. The statistical procedure for the proposed mediators was similar to that in Study 1, running six separate univariate ANOVAs and, unlike in Study 1, Bonferroni-corrected pairwise comparisons were checked when significant effects were found.

A similar statistical procedure for the examination of the conditions for mediation was also performed in Study 2 (Yzerbyt et al., 2018), although, in Study 2, 12 multiple linear regressions were performed instead of the six linear regressions performed in Study 1 (as condition has three levels in Study 2). Like in Study 1, mediation analyses were conducted using the PROCESS macro for SPSS (Model 4) (Hayes, 2017). Given that condition has three levels in Study 2, the PROCESS macro generated two dummy coded variables using indicator coding (Hayes & Preacher, 2014), entering the increased animal source foods condition as the reference group in the first analysis and the control condition as the reference group in the second analysis.

Like in Study 1, PROCESS macro for SPSS (Model 1) was used to examine the interaction between condition and meat attachment on food choice. Unlike in Study 1,

two dummy coded variables using indicator coding were generated, entering the increased animal source foods condition as the reference group in the first analysis and the control condition as the reference group in the second analysis. The PROCESS macro generated coefficient estimates of condition on food choice at three levels of meat attachment: Low (1 SD below the mean), average (mean), and high (1 SD above the mean).

The same statistical procedure as in Study 1 for the sensitivity analysis was performed for Study 2. For exploratory purposes, a separate univariate ANOVA was run to assess whether condition affected perceptions of autonomy. Bonferroni-corrected pairwise comparisons were checked when a significant effect was found.

4.3.2. Results

4.3.2.1. Participant characteristics

In total, 311 Dutch females participated in the study. A total of 276 participants were included in the final analytic sample after planned exclusions (see Supplementary Figure S4.2.). In Table 4.6., descriptive statistics per condition are presented.

Table 4.6. Descriptive statistics per condition (*n* = 276).

	Increased plant-based foods condition (*n* = 93) [c]	Increased animal source foods condition (*n* = 87)	Control condition (*n* = 96)
	Mean (SD) or Number (%)	Mean (SD) or Number (%)	Mean (SD) or Number (%)
Age (y)	48.33 (15.10)	46.14 (15.73)	47.16 (15.41)
Nationality (Dutch)	92 (98.9%)	84 (96.6%)	92 (95.8%)
Education (academic education)	4 (4.3%)	3 (3.4%)	12 (12.5%)
Hunger [a]	3.55 (1.66)	3.44 (1.74)	3.10 (1.61)
Liking [a]			
Plant-based foods [b]	9.96 (2.57)	9.63 (2.65)	9.49 (2.62)
Animal source foods [b]	8.90 (2.72)	9.24 (2.78)	8.84 (3.31)
Familiarity [a]			
Plant-based foods [b]	7.30 (3.67)	6.61 (3.85)	6.79 (3.51)
Animal source foods [b]	7.83 (3.78)	7.84 (3.94)	7.67 (3.74)
Meat attachment [a]	4.50 (0.91)	4.05 (1.06)	4.30 (1.07)
Frequency of meat consumption (range 0–7)	6.09 (1.43)	5.31 (1.68)	5.66 (1.84)

[a] Measured on a 7-point scale (range 1–7). [b] Sum score (range 2–14). [c] *n* = 91 for age (missing values because of unrealistically high reported ages).

4.3.2.2. Food choice

In total, 54.0% of the participants chose a plant-based food option (see Figure 4.4. for the percentage of chosen items of each food option per condition). No significant differences in food choice were observed between the conditions (Table 4.7.). Compared to the increased animal source foods condition, participants in the increased plant-based foods condition ($OR_{\text{animal source foods}\rightarrow\text{plant-based foods}}$ = 1.30, Wald = 0.76, 95% CI (0.72, 2.33), p = 0.38) and the control condition ($OR_{\text{animal source foods}\rightarrow\text{control}}$ = 1.32, Wald = 0.85, 95% CI (0.74, 2.36), p = 0.36) did not show a significantly higher likelihood of choosing a plant-based food product; neither were differences in food choice found between the control condition and the increased plant-based foods condition ($OR_{\text{control}\rightarrow\text{plant-based foods}}$ = 0.99, Wald = 0.002, 95% CI (0.56, 1.75), p = 0.96).

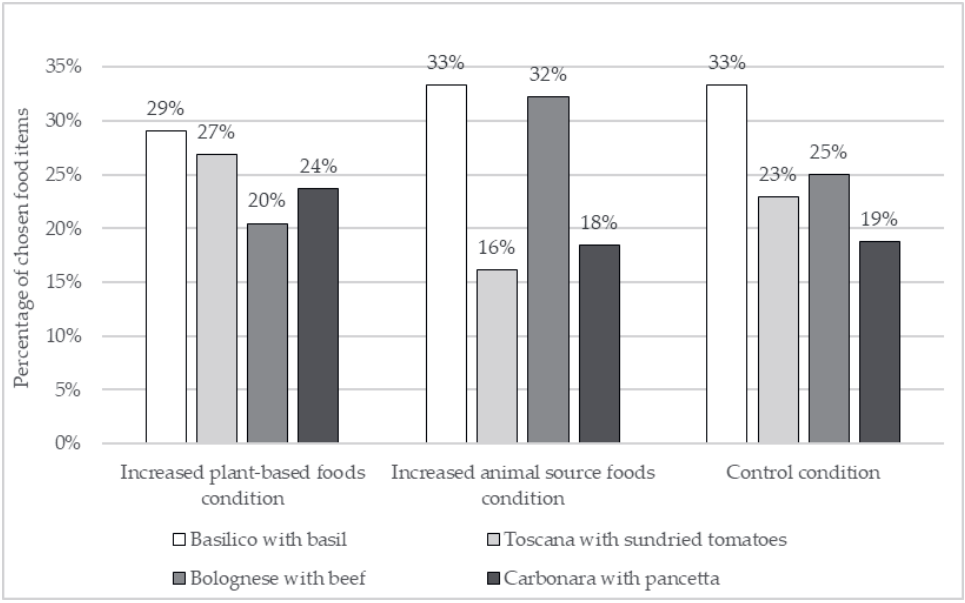

Figure 4.4. Percentage of chosen items of each food option per condition (n = 276).

Table 4.7. Food choice, the proposed mediators, and perceptions of autonomy per condition (n = 276).

	Increased plant-based foods condition (n = 93)	Increased animal source foods condition (n = 87)	Control condition (n = 96)	Test statistic	p-value	η_p^2
	Mean (SD) or Number (%)	Mean (SD) or Number (%)	Mean (SD) or Number (%)			
Effect of condition on food choice						
Food choice (plant-based foods)	52 (55.9%)	43 (49.4%)	54 (56.3%)	$X^2(2) = 1.07$	0.59	-
Effect of condition on the proposed mediators						
Perceptions of salience [a]						
Plant-based foods [b]	9.06 (2.75)	8.85 (2.62)	8.93 (2.41)	$F(2, 273) = 0.16$	0.85	0.00
Animal source foods [b]	9.30 (2.58)	9.02 (2.65)	9.31 (2.20)	$F(2, 273) = 0.39$	0.68	0.00
Perceptions of descriptive norms [a]						
Plant-based foods [b]	9.39 (2.30) [c]	8.54 (2.52) [c]	9.04 (2.37)	$F(2, 273) = 2.84$	0.06	0.02
Animal source foods [b]	8.84 (2.37) [d]	9.72 (2.06) [d]	9.48 (2.27)	$F(2,273) = 3.79$	0.02	0.03
Perceptions of injunctive norms [a]						
Plant-based foods [b]	8.48 (2.65)	8.02 (2.85)	8.10 (2.67)	$F(2,273) = 0.75$	0.47	0.01
Animal source foods [b]	8.09 (2.63)	8.53 (2.51)	8.56 (2.63)	$F(2, 273) = 0.98$	0.38	0.01
Effect of condition on perceptions of autonomy						
Perceptions of autonomy [a]	5.61 (1.11)	5.72 (0.98)	5.69 (1.11)	$F(2, 273) = 0.27$	0.77	0.00

[a] Measured on a 7-point scale (range 1–7). [b] Sum score (range 2–14). [c] Marginally significant difference between the two conditions (p = 0.055). [d] Significant difference between the two conditions (p = 0.03).

4.3.2.3. Proposed mediators

Again, no significant differences in perceptions of salience and injunctive norms (regarding either plant-based or animal source foods) were observed between the conditions (Table 4.7.). Consistent with our hypothesis, a marginally significant difference in perceptions of descriptive norms of the plant-based foods, as well as a significant difference in perceptions of descriptive norms of the animal source foods, were observed between the conditions (Table 4.7.). Specifically, participants who were physically exposed to an increased availability of plant-based (versus animal source) foods reported a marginally significantly higher likelihood of other participants selecting a plant-based food option (p = 0.055) and a significantly lower likelihood of other participants selecting an animal source food option (p = 0.03). No significant differences were observed between the control condition and (a) the increased plant-based foods condition (descriptive norms regarding plant-based (p = 0.97) and animal source foods (p = 0.15)) and (b) the increased animal source foods condition

(descriptive norms regarding plant-based (p = 0.47) and animal source foods (p = 1.00)). For outcomes of the sensitivity analysis, see the Supplementary materials (Results: Study 2, Table S4.3.).

Perceptions of descriptive norms of both the plant-based and the animal source foods were included in mediation analyses (see Supplementary Table S4.4. for the components of the indirect effect). Relative to the increased animal source foods condition, physical exposure to an increased availability of plant-based foods indirectly affected food choice through perceptions of descriptive norms of both the plant-based (relative indirect effect = 0.14, SE = 0.08, 95% CI (0.02, 0.33)) and the animal source foods (relative indirect effect = 0.14, SE = 0.07, 95% CI (0.02, 0.30)). No significant indirect effects were observed in relation to the control condition (see Supplementary materials (Results: Study 2)). However, when covariates were included in the model, the conditions for mediation were no longer met (see Supplementary materials (Results: Study 2, Table S4.3.)).

4.3.2.4. Proposed moderator

The interaction between condition (increased animal source versus plant-based foods condition) and meat attachment on food choice was significant (interaction effect = 1.12, SE = 0.38, 95% CI (0.38, 1.87)). Probing the significant interaction showed that, among participants who reported a high meat attachment (1 SD above the mean), increasing the availability of plant-based (versus animal source) foods significantly increased the likelihood of selecting a plant-based food option (B = 1.76, SE = 0.54, 95% CI (0.70, 2.81), p < 0.01). No significant difference between the increased animal source and plant-based foods condition was observed among participants who reported a low meat attachment (1 SD below the mean) (B = −0.55, SE = 0.49, 95% CI (−1.51, 0.42), p = 0.27). The interaction between condition (increased animal source foods condition versus control condition) and meat attachment on food choice was non-significant (interaction effect = 0.57, SE = 0.38, 95% CI (−0.17, 1.31), p = 0.13). The interaction between condition (control condition versus increased plant-based foods condition) and meat attachment on food choice was marginally significant (interaction effect = 0.55, SE = 0.33, 95% CI (−0.09, 1.19), p = 0.09). However, when significant effects were probed, no significant differences were observed between the specific conditions (all p's > 0.18). See Figure 4.5. for a visualization of the interaction effect. For outcomes of the sensitivity analysis, see the Supplementary materials (Results: Study 2, Table S4.3.).

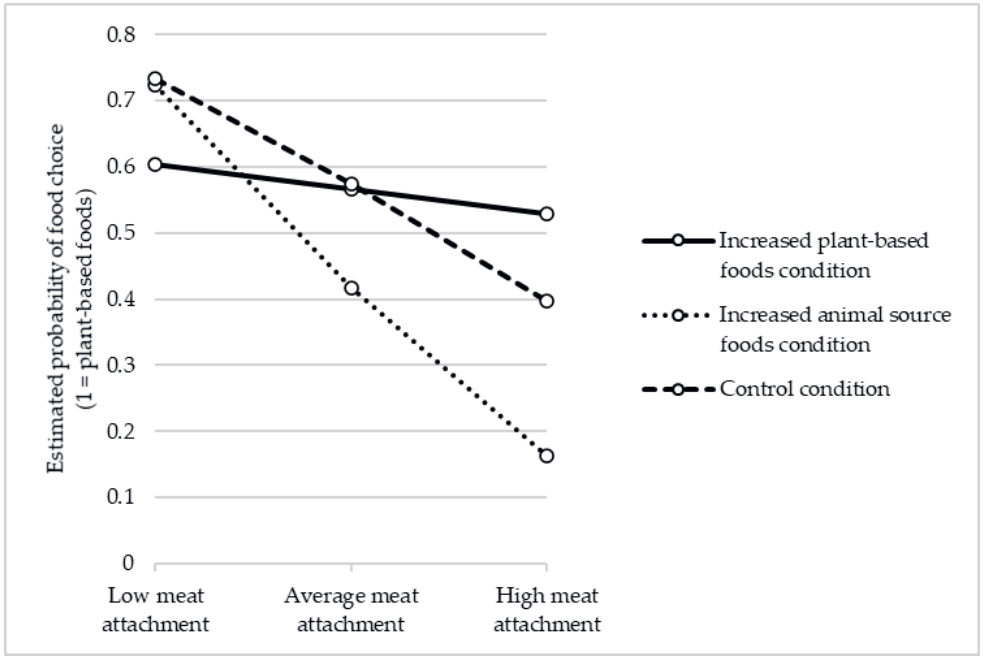

Figure 4.5. Interaction between condition and meat attachment on the estimated probability of food choice (1 = plant-based foods) (*n* = 276).

4.3.2.5. Perceptions of autonomy (exploratory purposes)

No significant difference in perceptions of autonomy was observed between the conditions (Table 4.7.).

4.3.3. Discussion

Like in Study 1, no effects of physical exposure to a relatively high availability of plant-based (versus animal source) food products on food choice, perceptions of salience, and injunctive norms were observed in Study 2. The results did show—although we expected the opposite pattern—that the availability intervention was effective among participants who reported high levels of meat attachment. These participants had a higher likelihood of choosing a pasta sauce excluding (versus including) meat when they were exposed to a relatively high availability of pasta sauces excluding meat. Furthermore, in contrast to the results of our online study, physical exposure to an increased availability of plant-based (versus animal source) foods affected perceived descriptive norms of both the plant-based and the animal source foods in the predicted direction. The effect of condition (increased animal source versus plant-based foods condition) on food selection may even be mediated by these perceived descriptive

norms of both the plant-based and the animal source foods, although the mediation results again should be interpreted with some caution (like in Study 1 the significant effects disappeared after inclusion of covariates). No significant differences were observed in relation to a situation where plant-based and animal source pasta sauces were equally available (i.e., the control condition). Neither did we observe significant differences in perceived autonomy in selecting the plant-based or the animal source foods, suggesting that the availability intervention is rather subtle.

4.4. General discussion

The present research shows that visual (Study 1) and physical (Study 2) exposure to an increased proportion of plant-based (versus animal source) foods available in imaginary supermarket settings did not directly affect the hypothetical food choice (Study 1) and the actual food choice (Study 2) of non-vegetarian participants. We found, however, that participants who reported high levels of meat attachment had a higher likelihood of choosing a plant-based food option when physically (but not visually) exposed to more available plant-based (versus animal source) foods. Moreover, the proportion of plant-based (versus animal source) foods available affected the participants' perceived descriptive norms about what other people typically choose (Studies 1 and 2). Perceived injunctive norms about the appropriate/inappropriate choice according to other people were not influenced by the availability manipulation, nor was the perceived salience of plant-based (versus animal source) foods (Studies 1 and 2). In the following sections, we discuss how and under what circumstances the selection of plant-based versus animal source foods is influenced by our two availability interventions, aiming to shift non-vegetarian consumers towards more environmentally friendly and healthier consumption patterns (Clark & Tilman, 2017; Garnett et al., 2019; Poore & Nemecek, 2018) .

As far as we are aware, this is the first study to empirically examine different psychological responses towards an increased proportion of plant-based foods available in assortment structures (Hollands et al., 2019; Pechey et al., 2020). We particularly showed that descriptive norms can be inferred from the number of plant-based foods available, providing further evidence for the proposition that social norms are embedded in physical aspects of food environments (Raghoebar, Haynes, et al., 2019; Raghoebar et al., 2020a; Raghoebar, Van Rongen, et al., 2019). The proportion of plant-based (versus animal source) foods available may serve as a cue that implies a consumption norm reflecting what other people typically choose, rather than reflecting the appropriate choice according to others (i.e., an injunctive norm). This finding shows potential for the idea that assortment structures may shift (or shape) social

consumption norms for plant-based foods in supermarket settings. It remains unclear, however, how the relatively increased number of plant-based foods is perceived by individuals, as the availability cue was interpreted in contradictory directions in our online study compared to our lab-in-the-field study. In the online setting, against our predictions, individuals interpreted the relatively increased availability of plant-based (versus animal source) foods as a sign that plant-based foods were less often the favorite choice of others. Conversely, and in line with our predictions, in the lab setting, a trend was observed of participants indicating these more greatly available plant-based foods as being more often chosen by others, and they reported a lower likelihood of others choosing an animal source food. The observed inconsistency in interpretations ties in with the results of a recent photo study in which contradictory normative connotations were associated with availability cues (Raghoebar, Van Rongen, et al., 2019).

How can the conflicting interpretations of the availability manipulation in the online and the lab setting be explained? One answer may be related to the presence of counter nudges (i.e., approaches that steer people in contradictory directions) (Sunstein, 2017). Our study is built upon the rationale that abundantly available products are perceived as being the popular choice (Garnett et al., 2019; Hollands et al., 2019; Pechey, Cartwright, et al., 2019; Pechey et al., 2020). By relatively increasing the number of target products, inevitably the number of non-target products is decreased. The accordingly limitedly available products may be considered as a counter 'nudge' to the availability cue, suggesting that the less available products are more popular, as advocated by the scarcity principle (Brock, 1968; Gierl & Huettl, 2010; Van Herpen et al., 2014). Following social norm theory, people tend to adhere to the norm that is most focal in attention (i.e., most salient) when different norms are present in a similar situation (Cialdini et al., 1991; Cialdini et al., 1990; Jacobson et al., 2011). Unlike in our online study, we purposely increased the salience of the abundantly available products in the lab experiment by diminishing potential interpretations of scarcity of the relatively less available products. Now, this indeed resulted in participants perceiving descriptive norms promoting the consumption of abundantly available products (rather than limitedly available products), underlining the importance of making norms salient (Cialdini et al., 1991; Cialdini et al., 1990; Jacobson et al., 2011). We did not observe any significant differences in perceptions of salience of the plant-based and the animal source foods in either study; this may suggest that perceived salience is not a separate mechanism that underlies the availability effect, but indeed a prerequisite for descriptive norms to be perceived (Cialdini et al., 1991; Cialdini et al., 1990; Jacobson et al., 2011). This needs to be further investigated in future research.

Remarkably, the (contradictory) perceived descriptive norms observed in both studies did guide the food choice of some individuals, but the mediating pathway disappeared when covariates were included in the model. The availability intervention was thus less effective in steering behavior than expected (both directly and indirectly), and several reasons may be responsible for this. Focusing on the indirect effect, from a social norm perspective, one may reason that the adult participants were less sensitive to social norms (compared to younger people) or had a weak identification with the norm referent group (Higgs, 2015; Stok et al., 2016). Focusing on the direct effect, to shift the dietary choices of meat eaters towards plant-based alternatives, one may reason whether a single exposure occasion to the availability manipulation is adequate to affect their food choice, although this seemed to be sufficient to change perceived descriptive norms. Previous comparable availability interventions indeed utilized the availability manipulation for a prolonged period, making repeated exposure to the manipulation more likely (Garnett et al., 2019; Pechey, Cartwright, et al., 2019). One could further argue that strong pre-intervention preferences have determined people's food choice, making the availability intervention ineffective (Sunstein, 2017; Venema et al., 2019). It may even be possible that people did not notice the increased availability of plant-based foods when they were actively searching for an animal source food product (referred to as inattentional blindness) (Pechey et al., 2020; Simons & Chabris, 1999). To support the development of successful interventions stimulating plant-based food consumption, future research needs to unravel the specific aspects that are responsible for the low direct and indirect impact of our availability interventions on consumer choice.

Promisingly, but unexpectedly, our results suggest that the availability intervention stimulating plant-based food choices is most effective among the subgroup of participants showing high meat attachment patterns. This seems hopeful, as the reduction of meat consumption is regarded as more difficult among people who show a high affect and dependency towards meat (Graça, Calheiros, et al., 2015). Our findings are in line with Garnett et al. (2019) availability studies, showing that an increased availability of vegetarian meals resulted in more vegetarian sales, especially among people who initially chose a vegetarian meal less often. The interaction effect was, however, observed only in our lab-in-the-field experiment in which meat was treated as a secondary meal ingredient rather than a dominant meal component, such as in the online study. It may be argued whether people explicitly chose a meal excluding meat, as the absence of meat in a dish in which meat is typically a secondary meal ingredient (such as the pasta sauce) is probably less pronounced and may be less important compared to the absence of meat in a dominant meal component (such as

the burger). The pasta sauces excluding meat were rated as a more equivalent (and attractive) alternative to animal source foods than the instant meat substitutes. As expected, both meat reduction practices were thus not comparable in terms of liking and familiarity, and these observations may also explain the inconsistent results between both studies. This may suggest that intermediate steps to get people out of their routinized meat eating practices may be more effective than strategies promoting the consumption of rather unknown and less preferred instant meat substitutes (Coucke, Vermeir, Slabbinck, & Van Kerckhove, 2019; De Boer, Schösler, & Aiking, 2014; Graça, Calheiros, et al., 2015; Lea & Worsley, 2003; Schösler et al., 2012). Previous availability interventions encouraging sustainable food choices indeed included such a step-by-step approach (e.g., stimulating the consumption of meat products with a relatively lower environmental impact (poultry)) (Coucke et al., 2019; Garnett et al., 2019). From an environmental sustainability perspective, it should be noted that these intermediate approaches may also lead to undesirable effects. For example, the greater availability of poultry products did increase their sales in a supermarket butchers' section, but did not decrease the sales of less sustainable meat products (Coucke et al., 2019). Future research should compare the effectiveness of availability interventions testing different meat reduction strategies, among people with different levels of meat attachment, and taking possibly undesirable environmental effects into account.

This research uniquely contributes to the current knowledge in the domain of availability research and social norms: First, by focusing on the relation between product availability and sustainable food consumption, rather than focusing solely on energy intake (Hollands et al., 2019; Pechey, Cartwright, et al., 2019; Pechey et al., 2020); second, by empirically testing different psychological mechanisms, including social norms, that may be changed by changes in the proportion of products available. We acknowledge that there may be other mechanisms that are relevant for the availability effect (e.g., (expected) liking for the target option), such as described in the conceptual framework of Pechey et al. (2020). A methodological strength of this research is that we isolated the availability effect by keeping the product range on offer unchanged between conditions, which is yet rather uncommon (see for example Garnett et al. (2019); Pechey, Cartwright, et al. (2019); Pechey & Marteau (2018); Van Kleef et al. (2012)). This may also be an explanation for the absence of a direct or an indirect effect on food choice in our study, as the introduction of new product options in the increased availability condition, for example, may result in more people selecting these items as they are novel, or as there is more variety (Pechey et al., 2020; Pechey, Jenkins, Cartwright, & Marteau, 2019; Van Kleef et al., 2012).

This research is also subject to some limitations. As already outlined in the previous sections, both intervention studies differed in many aspects (e.g., exposure type (visual/physical), meat reduction strategies, the target groups involved, the participants' educational level); this may be observed as a limitation of this research, as we cannot assign the inconsistent results across studies to specific aspects. Future studies should disentangle how and to what extent particular components of the availability intervention influence their psychological interpretations and subsequently food choice. Furthermore, the use of an online survey platform to perform the online experiment is associated with several limitations, including lack of attention (although a quality control question was included). A different limitation of Study 1 is that we did not measure participants' perceptions of autonomy in selecting their food product, which seems especially relevant given the inclusion of relatively less preferred and less familiar meat substitutes in this study. Further, it remains unclear whether the results of Study 2 are generalizable to males, as only females were included. Also, the Carbonara with pancetta pasta sauce included in Study 2 was very different in appearance from the three other red-colored pasta sauces selected for this study (Figure 4.3.; pasta sauces were included based on the highest liking and familiarity ratings rather than their similarity in appearance (see Supplementary materials (Methods: Study 2)), and this may have affected the results of Study 2. Furthermore, a comparable availability intervention in an actual supermarket setting is recommended, as many previous successful availability studies were conducted in more naturalistic settings allowing repeated exposure to the availability manipulation (Garnett et al., 2019; Pechey, Cartwright, et al., 2019). Such a study could also shed light on the effect of availability on descriptive norms outside controlled settings.

4.5. Conclusion

This research presented a novel test of how and under what circumstances the selection of plant-based versus animal source foods is influenced by exposure to a relatively greater availability of plant-based foods in imaginary supermarket settings. Our results suggest that the proportion of plant-based foods available in assortment structures may shift (or shape) the ideas of non-vegetarians about what other people typically choose (i.e., descriptive norms about 'normal' consumption among meat eaters). The direction of the descriptive norm effect remains unclear, however, and seems to depend upon the operationalization of the availability intervention. Further, among the subgroup of participants showing high meat attachment patterns, our results suggest that an increased availability of physically present plant-based (versus animal source) foods increased the likelihood of a person choosing a plant-based food option. We did

not observe a direct effect of exposure to our availability manipulation on food choice. These findings empirically underscore the importance of carefully designing and implementing availability interventions, as an apparently comparable availability cue may lead to contradictory normative interpretations.

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Chapter 5

Served portion sizes affect later food intake through social consumption norms

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Abstract

Portion sizes of commercially available foods have increased, and there is evidence that exposure to portion sizes recalibrates what is perceived as 'normal' and subsequently, how much food is selected and consumed. The present study aims to explore the role of social (descriptive and injunctive) and personal portion size norms in this effect. Across two experiments, participants were either visually exposed to (Study 1, n = 329) or actually served (Study 2, n = 132) a smaller or larger than normal food portion. After 24 h, participants reported their intended consumption (Study 1) or served themselves and consumed (Study 2) a portion of that food and reported perceived portion size norms. In Study 1, visual exposure to portion size did not significantly affect intended consumption and perceived portion size norms. In Study 2, participants consumed a smaller portion of food when they were served a smaller rather than a larger portion the previous day, which was mediated by perceived descriptive and injunctive social (but not personal) portion size norms. Results suggest that being served (but not mere visual exposure to) smaller (relative to larger) portions changes perceived social norms about portion size and this may reduce future consumption of that food.

5.1. Introduction

Portion sizes of commercially available foods have dramatically increased over recent decades (Schwartz & Byrd-Bredbenner, 2006; Young & Nestle, 2012), and it has been consistently demonstrated that people eat more from larger than from smaller food portions (Hollands et al., 2015; Zlatevska, Dubelaar, & Holden, 2014). Large food portion sizes have therefore been identified as a possible contributor to the obesity epidemic (Livingstone & Pourshahidi, 2014; Young & Nestle, 2002). Recent insights show that portion sizes served in a given eating occasion not only affect immediate consumption, but also affect subsequent portion selection and consumption at later eating occasions (Robinson et al., 2019; Robinson & Kersbergen, 2018). Particularly, it has been shown that when served a smaller portion, people select and consume a smaller portion of food in the future compared to when they are served a larger portion. Thus, changes to portion sizes in the environment have potential downstream consequences beyond a single eating occasion (Robinson et al., 2019; Robinson & Kersbergen, 2018). However, relatively little is known about the mechanism responsible for this effect (Zuraikat, Smethers, & Rolls, 2019).

Previous findings suggest that exposure to and consumption of smaller portion sizes may recalibrate perceptions of portion size, making smaller portions more 'normal'. In one study, mere visual exposure to images of small (versus large) portions decreased subsequent perceptions of what constituted a 'normal' sized portion, and this resulted in participants selecting a smaller ideal portion of that food immediately afterwards, but this effect did not translate to actual food selection (Robinson et al., 2016). Furthermore, in a series of studies, when participants were served a small (versus large) portion of a lunch meal they consumed significantly less one day later, and chose a smaller ideal portion of that same meal one week later (Robinson et al., 2019; Robinson & Kersbergen, 2018). It was demonstrated that this effect partly occurs because being served a smaller (versus larger) portion size decreases peoples' perceptions of what constitutes a 'normal' portion size (Robinson & Kersbergen, 2018). Comparable results on food intake were found in an experiment manipulating visual exposure to physically present portion sizes of snack foods. In this study, visual exposure to portion sizes affected perceptions of portion size normality 24 h later, although perceptions of portion size normality did not formally mediate the effect of visual exposure on subsequent consumption of the same snack food (Robinson et al., 2019). In this previous work (Robinson et al., 2019; Robinson & Kersbergen, 2018), perceptions of portion size normality were measured by asking participants to indicate what they thought was a 'normal' portion size of food to eat in a given situation, but it remains unclear what these portion size normality judgments are based on.

Previous research has demonstrated that consumers possess divergent social and personal norms for portion size. A perceived 'social norm' represents what consumers believe *other people* consider to be a normal and/or appropriate amount to eat. A perceived 'personal norm' represents the amount of food consumers consider to be a normal and/or appropriate amount for *themselves* to eat (Lewis et al., 2015; Schwartz, 1977). The construction of a 'personal norm' is a dynamic process that is influenced by the external environment (Schwartz, 1977), and a served portion size may affect future consumption by affecting one's 'personal' norm. There are two conceptually and motivationally distinct types of social norms that may be affected by exposure to different portion sizes. First, consumers may believe a served portion size is based on what other people consume (a 'descriptive' social norm) (Cialdini et al., 1990). This is consistent with evidence that social norms about food consumption are inferred from physical aspects of food environments. For example, previous experiments in laboratory and real-world settings have shown that consumers who were presented with a bowl of snacks surrounded by empty snack wrappers consumed more than those who were presented the same snack bowl but without empty wrappers (Burger et al., 2010; Prinsen et al., 2013). The wrappers may have communicated that others had previously consumed the snacks in the same situation, therefore exemplifying a descriptive social norm communicated by the eating environment. Second, an 'injunctive' social norm is what one perceives *ought* to be done (Cialdini et al., 1990). Consumers are likely to assume that a served portion size was not chosen at random by the person serving it, but that there was some reasonable rationale behind providing that amount of food (Herman et al., 2015). They may therefore infer that a portion size served to them represents what others think is the appropriate amount for them to eat (an injunctive social norm), and this could affect later portion size selection and consumption.

Rather than via a perceived norm, an alternative explanation is that portion size communicates how much of that food one needs to consume in order to feel satisfied. This 'expected satiety' belief may be learned from the post-ingestive consequences of having consumed a given portion (the feeling of satisfaction and the avoidance of hunger after eating), or merely inferred from the amount presented (e.g., 'this must be enough to keep me satisfied if someone has decided to serve this amount'). Higher expected satiety associated with a given food is associated with the selection of smaller portion sizes and reduced consumption of that food (Robinson et al., 2019; Wilkinson et al., 2012), and may therefore play a role in the effect of portion size exposure on subsequent behavior.

In the present research, we examined whether visual exposure to (Study 1) and being served (Study 2) smaller versus larger portion sizes would affect later portion size

selection for a hypothetical meal (Study 1) and consumption of an actual meal (Study 2). We hypothesized that this effect would be explained by (1) the general perception of what constitutes a normal sized portion, as shown in previous research (Robinson et al., 2019; Robinson & Kersbergen, 2018), and (2) more specific perceptions of social (both descriptive and injunctive) and personal norms about what is a normal amount to eat in that situation. Particularly, it was expected that visual and actual exposure to smaller (versus larger) food portions would result in a lower intended and actual consumption of that food 24 h later and, accompanying perceptions of a normal-sized portion, perceptions of social (both descriptive and injunctive) and personal norms. We also tested an alternative explanation; that exposure and consumption of smaller portion sizes may affect later portion selection and consumption by affecting expected satiety.

5.2. Study 1

5.2.1. Methods

5.2.1.1. Design

Study 1 was a two-session online experiment run on two consecutive days with a three-condition between-subjects design. In the first session (initial exposure phase), participants were visually exposed to images of either a relatively small portion of lasagna (smaller portion size condition), a relatively large portion of lasagna (larger portion size condition), or non-food objects (control condition, as in Robinson et al. (2016)), to which they were randomly allocated. During the next session on the following day (measurement phase), participants indicated their preferred portion size for a hypothetical lunch meal and their general perceptions of portion size normality. Furthermore, participants indicated their more specific perceptions of descriptive social norms, injunctive social norms and personal norms for portion sizes, in order to examine what these general portion size normality judgments are based on. Additionally, participants indicated their expected satiety regarding portion sizes, as an alternative explanation. A control condition (precluding exposure to portion sizes) was included in the design in order to identify the direction of potential effects. Compared to a control condition, it was expected that visual exposure to smaller (larger) food portions would result in later selection of a smaller (larger) portion size. The same evaluations were made for a different food (spaghetti), to test whether visual exposure effects transfer to an incongruent food (Robinson et al., 2016). The study was approved by the University of Liverpool research ethics committee (reference number: 3985). The

hypotheses, methodology, and main analyses strategy were preregistered on the Open Science Framework (https://osf.io/uznyr) before data collection commenced.

5.2.1.2. Participants and sample size

UK adults (aged 18+ years) were recruited via the online survey platform Prolific Academic. We aimed to recruit 330 participants (approximately 110 participants/condition), which would provide adequate power based on a Monte Carlo power analyses for indirect effects using an online application (Schoemann et al., 2017). Details of the power analyses are provided in the Supplementary materials (Methods: Study 1).

5.2.1.3. Portion size stimuli

Beef lasagna and spaghetti Bolognese were used as food stimuli (Tesco supermarket). Selection of the portion sizes for the exposure manipulation was informed by the results of an online pilot study conducted with 20 University of Liverpool employees (65% female, M age = 28.65 years, SD = 6.29) (see Supplementary materials (Methods: Study 1, Figure S5.1., and Figure S5.2.) for pilot study results). A relatively small portion (60% of reference portion: 180 g cooked lasagna, 341 kcal) and a relatively large portion (180% of reference portion: 540 g cooked lasagna, 1024 kcal) of lasagna, which were perceived to be beyond the boundaries of a normal portion by the majority of participants, were selected as stimuli for the initial exposure phase (see Figure 5.1.). Portion sizes that were outside of the range perceived as 'normal' were selected because this study aims to examine whether portion size norms adjust to these smaller (versus larger) portion sizes, initially perceived 'not normal', as one could argue that the range of portion sizes initially classed as being 'normal' in size has shifted upwards in recent decades.

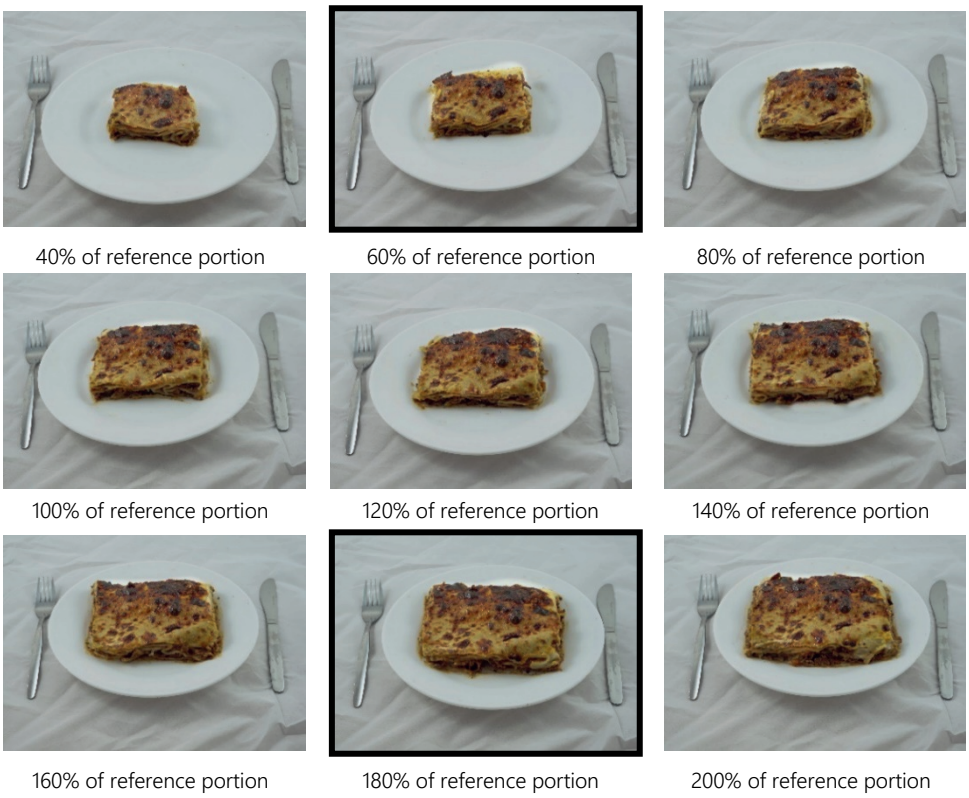

Figure 5.1. Portion size scale for lasagna ranging from 40% to 200% of the manufacturer's recommended serving with a 20% difference between portions. The highlighted portions were used as the smaller and larger portion sizes in the first session of Study 1.

5.2.1.4. Measures

5.2.1.4.1. Hypothetical portion size selection and proposed mediators

Based on the results of the pilot study, an array of nine different portion sizes per food type (lasagna, spaghetti) was selected to create a response scale for the portion selection and mediator items (Figure 5.1.). The response scales ranged from what was perceived by a majority of participants in the pilot study as 'not normal' at the scale minimum to a portion that was perceived as a 'not normal' amount to eat at the scale maximum. For each outcome and mediator item (e.g., 'how much of this (lasagna/spaghetti) would you choose to eat for lunch?'), participants responded by selecting one of the nine portion size images that were presented concurrently on screen in ascending order. The specific outcome and mediator items are listed in Table

5.1. Items were averaged into a single score for variables with multiple items (perceptions of descriptive social norms, injunctive social norms, personal norms and expected satiety). For descriptive and injunctive social norm items, the age and sex of the participants were included in the question text.

Table 5.1. Items measuring hypothetical portion size selection and proposed mediators.

Measures	Items
Hypothetical portion size selection	1. 'how much of this (lasagna/spaghetti) would you choose to eat for lunch?' (Robinson & Kersbergen, 2018)
Perceptions of general portion size normality	1. 'how much of this (lasagna/spaghetti) would you say is normal to eat for lunch?' (Robinson & Kersbergen, 2018)
Perceptions of descriptive social norms (lasagna: Cronbach's α = 0.92; spaghetti: Cronbach's α = 0.94)	1. 'how much of this (lasagna/spaghetti) do you believe other (sex) aged (age) years would choose to eat for lunch?' 2. 'how much of this (lasagna/spaghetti) do you believe most (sex) aged (age) years would choose to eat for lunch?'
Perceptions of injunctive social norms (lasagna: Cronbach's α = 0.89; spaghetti: Cronbach's α = 0.90)	1. 'how much of this (lasagna/spaghetti) do you think other (sex) aged (age) years believe that you are supposed to eat for lunch?' 2. 'how much of this (lasagna/spaghetti) do you think other (sex) aged (age) years believe that is the appropriate amount to eat for lunch?'
Personal norms (lasagna: Cronbach's α = 0.90; spaghetti: Cronbach's α = 0.91)	1. 'how much of this (lasagna/spaghetti) do you personally believe is a normal amount for you to eat for lunch?' 2. 'how much of this (lasagna/spaghetti) do you personally believe is an appropriate amount for you to eat for lunch?'
Expected satiety (lasagna: Cronbach's α = 0.90; spaghetti: Cronbach's α = 0.91)	1. 'how much of this (lasagna/spaghetti) would you need to eat to feel satisfied?' 2. 'how much of this (lasagna/spaghetti) would you need to eat to feel full?'

5.2.1.5. Procedure

Participants were invited to participate in a study about consumer perceptions and preferences (cover story). They provided informed consent and were instructed to fill in both questionnaires on a desktop or laptop computer at approximately the same time on consecutive days. The questionnaires were programmed in Qualtrics and were only made active online between 10 am and 2 pm (around a typical lunchtime). During the initial exposure phase, participants viewed an image of a portion of lasagna (either a relatively small or a large portion size) or an image of a non-food object (a printer),

depending on their assigned condition. They were instructed to either imagine eating the displayed food during lunch (portion size conditions) or to imagine using the non-food object (control condition) and to write at least five sentences about their imagined experience. Participants then rated the images on 14 dimensions unrelated to portion sizes using 7-point Likert scales (evenly randomized across different pages), and reported their age and sex. The dimensions were either linked to the experience of eating lasagna (smaller and larger portion size condition—e.g., 'as you eat the lasagna, how (colorful/fresh/crispy) is it') or to the experience of using the printer (control condition—e.g., 'as you use the printer, how (colorful/unique/futuristic) is it').

During the next session (measurement phase), participants again reported their age and sex and then completed the hypothetical portion size selection item, and proposed mediator items (norms and expected satiety, assessed on separate pages in an evenly randomized order). The same measures of hypothetical portion selection, norms, and expected satiety were taken for spaghetti (incongruent food), measured using an array of nine images of spaghetti (ranging from 40% to 200% of the manufacturer's recommended serving, with a 20% difference between portions, see Supplementary Figure S5.2.). The order in which participants completed the lasagna and spaghetti questions was (evenly) randomized. Participants then reported their hunger level at the start of the study, their liking for lasagna and spaghetti, demographic information (weight, height, and ethnicity), what they thought was the study aim, and whether they had any allergies or intolerances (see Supplementary materials (Methods: Study 1)). Thereafter, participants completed a funneled manipulation check to assess their recall of the image (including portion size) to which they were exposed (see Supplementary materials (Methods: Study 1)), and were then debriefed and reimbursed.

5.2.1.6. Planned statistical analyses

Data were analyzed using IBM SPSS Statistics 24 (IBM corp., Armonk, NY, USA). We planned a priori to exclude participants from analyses who indicated any allergies, intolerances, or dietary requirements for the foods used in the study, as well as participants who were aware of the study aims.

Separate univariate ANOVAs were performed to examine whether (1) hypothetical portion size selection, (2) perceived portion size normality, (3) perceptions of descriptive social norms, (4) perceptions of injunctive social norms, (5) personal norms, or (6) expected satiety for lasagna varied between the experimental conditions. Bonferroni-corrected pairwise comparisons were examined to probe significant effects.

As the variables (1–6) were not normally distributed, data were log-transformed with a natural logarithm before testing and inclusion in further analyses.

The PROCESS macro for SPSS (model 4) (Hayes, 2017) was used to investigate whether the effect of condition on later portion size selection could be explained by (a) general perceptions of portion size normality (testing for single mediation) and/or (b) more specific perceptions of descriptive social norms, injunctive social norms, personal norms and expected satiety (testing for multiple mediation). The percentile bootstrapping method was applied, producing 95% confidence intervals for the indirect effect, derived from 5000 bootstrap resamples. Proposed mediators were only included in mediation analyses when the conditions for mediation were met—that is, when the two components of the indirect effect of a proposed mediator were both significant in separate linear regression analyses (Yzerbyt et al., 2018).

To detect potential transfer effects, all analyses were repeated using portion size selection, norms, and expected satiety for spaghetti (incongruent food).

Pearson correlation coefficients (Spearman's correlations for sex) between potential covariates (age, sex, BMI, exposure duration, hunger, liking, and ethnicity) and the outcome variable or mediator variables were examined. Sensitivity analyses were run, which repeated the main analyses, controlling for covariates that were significantly correlated.

5.2.2. Results

5.2.2.1. Participant characteristics

In total, 338 participants completed both phases on two consecutive days. Nine participants were excluded from analyses in line with a priori exclusion criteria (see Supplementary Figure S5.3.). The analytic sample consisted of 329 participants (see Table 5.2. for participant characteristics per condition).

Table 5.2. Participant characteristics per condition (n = 329).

	Smaller portion size condition (n = 107) [b]	Larger portion size condition (n = 117) [c]	Control condition (n = 105) [d]
	Mean (SD) or number (%)	Mean (SD) or number (%)	Mean (SD) or number (%)
Age (years)	39.08 (13.35)	37.77 (11.84)	38.33 (10.84)
Sex (female)	79 (74.5%)	73 (62.4%)	61 (58.7%)
BMI (kg/m^2)	26.93 (6.18)	26.92 (6.24)	25.95 (4.97)
Exposure duration (mm:ss)	04:06 (02:00)	04:57 (04:25)	04:56 (05:21)
Hunger [a]	4.03 (2.12)	4.82 (2.46)	4.18 (2.24)
Liking [a]			
Lasagna	7.29 (1.92)	6.76 (2.37)	7.25 (1.93)
Spaghetti	7.08 (1.91)	6.74 (2.39)	7.11 (1.76)
Ethnicity (white)	102 (95.3%)	105 (89.7%)	100 (95.2%)

[a] Measured on a 9-point scale (range 1–9). [b] n = 106 for age and sex and n = 103 for BMI. [c] n = 115 for age and n = 114 for BMI. [d] n = 104 for age, sex, and BMI. Reasons for missing values were response inconsistencies between session 1 and 2 for age and sex and implausible responses for BMI (i.e., an unrealistic low or high reported weight or length).

5.2.2.2. Funneled manipulation check

Participants (324/329, 98.5%) tended to correctly identify the lasagna or non-food object they were exposed to during the first part of the study. Two participants in the smaller portion size condition, two participants in the larger portion size condition, and one participant in the control condition were not able to correctly identify the lasagna or non-food object. Likelihood ratio chi-square analyses showed no significant difference in correct identification between the visual exposure conditions, $\Lambda(2) = 0.37$, $p = 0.83$. Among participants who correctly selected lasagna in the first manipulation check question, Pearson chi-square analyses showed that a higher proportion of participants in the smaller portion size condition (67/107, 62.6%) than the larger portion size condition (33/117, 28.2%) were able to correctly identify the portion size they were exposed to, $X^2(1) = 27.30$, $p < 0.001$. Results of a Welch's t-test indicated that participants in the smaller portion size condition (M = 3.18, SD = 1.71, N = 105) remembered being exposed to a significantly smaller portion than participants in the larger portion size condition (M = 5.30, SD = 2.09, N = 115) ($t(215.57) = -8.27$, $p < 0.001$, $d = 1.10$).

5.2.2.3. Hypothetical portion size selection, norms, and expected satiety

There were no significant differences between conditions in hypothetical portion size selection, perceived portion size normality, perceptions of descriptive social norms,

perceptions of injunctive social norms, personal norms, or expected satiety regarding portions of lasagna during the second session, although all scores were in the predicted direction (Table 5.3.). A similar pattern of results was observed for spaghetti (Table 5.3.). There was a marginally significant effect of condition on perceptions of injunctive social norms for spaghetti, although there were no significant differences between the smaller portion size condition and larger portion size condition (p = 0.18), between the smaller portion size condition and control condition (p = 0.16), or between the larger portion size condition and control condition (p = 0.99). Mediation analyses were not conducted for either lasagna or spaghetti, as the conditions for mediation were not met (see Supplementary Table S5.1). The results of the sensitivity analyses are reported in Supplementary materials (Results: Study 1, Table S5.2.).

Table 5.3. Portion size selection and portion size evaluations per condition on day 2 (n = 329).

		Smaller portion size condition (n = 107)	Larger portion size condition (n = 117)	Control condition (n = 105)	Test statistic	p-value	η_p^2
		Mean (SD)	Mean (SD)	Mean (SD)			
Effect of condition on portion size selection							
Portion size selection [a]	Lasagna	3.92 (2.36)	4.07 (2.29)	3.85 (2.10)	$F(2, 326) = 0.08$	0.92	0.001
	Spaghetti	3.74 (1.92)	3.79 (1.74)	3.69 (1.73)	$F(2, 326) = 0.11$	0.90	0.001
Effect of condition on perceptions of portion size normality							
Perceptions of portion size normality [a]	Lasagna	3.57 (1.68)	3.84 (1.63)	3.70 (1.55)	$F(2, 326) = 0.77$	0.46	0.01
	Spaghetti	3.41 (1.34)	3.61 (1.35)	3.50 (1.36)	$F(2, 326) = 0.68$	0.51	0.004
Effect of condition on perceptions of descriptive norms, injunctive norms, personal norms and expected satiety							
Perceptions of descriptive norms [a]	Lasagna	3.74 (1.88)	4.23 (1.91)	3.95 (1.94)	$F(2, 326) = 1.59$	0.21	0.01
	Spaghetti	3.58 (1.60)	3.85 (1.66)	3.91 (1.64)	$F(2, 326) = 1.14$	0.32	0.01
Perceptions of injunctive norms [a]	Lasagna	3.29 (1.63)	3.65 (1.68)	3.56 (1.75)	$F(2, 326) = 0.97$	0.38	0.01
	Spaghetti	3.14 (1.41)	3.50 (1.52)	3.57 (1.50)	$F(2, 326) = 2.41$	0.09	0.02
Personal norms [a]	Lasagna	3.49 (1.85)	3.85 (1.77)	3.44 (1.71)	$F(2, 326) = 2.00$	0.14	0.01
	Spaghetti	3.36 (1.53)	3.57 (1.46)	3.40 (1.49)	$F(2, 326) = 0.80$	0.45	0.01
Expected satiety [a]	Lasagna	4.12 (1.91)	4.35 (1.92)	4.07 (1.91)	$F(2, 326) = 0.47$	0.62	0.003
	Spaghetti	3.84 (1.69)	3.94 (1.56)	3.82 (1.68)	$F(2, 326) = 0.44$	0.65	0.003

[a] Measured on a 9-point scale (range 1–9). Note: All reported means and standard deviations are untransformed scores for ease of interpretation.

5.2.2.4. Unregistered exploratory analyses

Participants in the larger portion size condition were less likely to identify the portion size they were exposed to than participants in the smaller portion size condition. Poor recall of the manipulation may have been responsible for the pattern of results from

primary analyses. Therefore, primary analyses were repeated on the subsample of participants who correctly identified the portion size they were exposed to (n = 204). As in the primary pre-registered analyses, exposure condition did not influence later portion size selection for lasagna. However, perceived portion size normality, descriptive social norms, injunctive social norms, personal norms, and expected satiety regarding portions of lasagna were significantly different between experimental conditions (see Supplementary Table S5.3.). Bonferroni-corrected pairwise comparisons showed a significant difference between the smaller portion size and larger portion size conditions regarding perceptions of portion size normality (p = 0.001), descriptive social norms (p = 0.01), injunctive social norms (p = 0.002), personal norms (p = 0.03), and expected satiety (p = 0.02), in that reported norms and expected satiety were relatively smaller in the smaller portion size condition. Differences between the larger portion size condition and the control condition were in the expected direction but did not reach criteria for statistical significance, as follows: Perceptions of portion size normality (p = 0.053), injunctive social norms (p = 0.08), and personal norms (p = 0.055). No significant differences were observed between the larger portion size condition and the control condition regarding perceptions of descriptive social norms or expected satiety (both p = 0.12). No significant differences between the smaller portion size condition and control condition were observed for any of the proposed mediators (all p-values > 0.18).

5.2.3. Discussion

Exposure to images of smaller (relative to larger) portion sizes did not affect hypothetical portion size selection or perceived normality 24 h later. However, in unplanned exploratory analyses on the subset of participants who correctly recalled the manipulation, visual exposure to smaller (compared to larger) portions of lasagna decreased perceptions of a normal-sized portion, descriptive social norms, injunctive social norms, personal norms and expected satiety regarding portions of lasagna 24 h later, although there was no significant effect of visual exposure to portion sizes on later portion selection. This pattern of results may suggest that the online portion size exposure manipulation was not salient enough, or that it may be hard to make inferences about food portion sizes from visual stimuli. Although previous studies have demonstrated immediate effects of mere visual exposure in an online setting on subsequent perceived portion size norms and intended consumption (Robinson et al., 2016), this is the first study to examine effects over a longer time period (24 h later). A stronger manipulation (via exposure to physically present portion sizes or actual consumption of different portion sizes) may be required to investigate the precise

normative mechanisms underlying this phenomenon. Therefore, Study 2 was conducted in a laboratory setting in which participants were served and then consumed either a smaller or larger portion of lasagna, before returning 24 h later to serve themselves a portion of that same food and to report their perceived portion size norms. As Study 1 provided no evidence of transfer to an incongruent food, consumption and normative evaluations were assessed only for lasagna.

5.3. Study 2

5.3.1. Methods

5.3.1.1. Design

Study 2 was a two-session laboratory-based experiment run on two consecutive days with a two-condition between-subjects design. Participants were served and then consumed a relatively small portion of lasagna (smaller portion size condition) or a relatively large portion of lasagna (larger portion size condition) in the first session (manipulation phase). During the session on the next day (measurement phase), participants were presented with a family-sized lasagna (see Figure 5.2. (c)) and were instructed to serve themselves and consume whatever they want to eat. Thereafter, participants completed the same measures of perceived portion size normality, descriptive social norms, injunctive social norms, personal norms, and expected satiety regarding portion sizes of lasagna as in Study 1. The research ethics committee of Wageningen University and Research approved the study (CoC number 09215846). The study was preregistered on the Open Science Framework (https://osf.io/7rqa4/) before data collection commenced.

(**a**) (**b**) (**c**)

Figure 5.2. Lasagna served in Study 2: (**a**) Smaller portion size (180 g cooked lasagna, 292 kcal); (**b**) larger portion size (540 g cooked lasagna, 875 kcal); and (**c**) family-sized lasagna (978 g cooked lasagna, 1584 kcal).

5.3.1.2. Participants and sample size

Sex was significantly correlated with all outcome and mediator measures in Study 1 ($p < 0.01$). Furthermore, previous research found that women are more likely to follow social norms when eating, compared to men (Bond & Smith, 1996), and it has been shown that there are differences in portion size preferences between men and women (Brunstrom, Rogers, Pothos, Calitri, & Tapper, 2008; Lewis et al., 2015). Therefore, only females were recruited in Study 2 to minimize heterogeneity in food consumption, as sex differences in portion size preference and evaluations might affect the portion size exposure manipulation. Dutch female students and employees of Wageningen University and Research were included in the study. To be eligible to participate, participants were required to be willing to eat beef lasagna, and participants who followed a diet; did not consume beef lasagna because of allergies, intolerances, or dietary specific requirements (e.g., vegetarian); or participants who were included in our pilot study were ineligible to participate.

As in Study 1, the sample size was determined based on a Monte Carlo power analyses for indirect effects using an online application (Schoemann et al., 2017). We aimed to recruit 140 participants (approximately 70 participants/condition). Details of the power analyses are provided in the Supplementary materials (Methods: Study 2).

5.3.1.3. Portion size stimuli

Beef lasagna was used as food stimuli (Aldi supermarket). Selection of the smaller and larger portion sizes (Figure 5.2.) was informed by the results of a pilot study conducted in a sample of Dutch female participants, including students (83%) and employees of Wageningen University and Research (M age = 23.80 years, SD = 4.12, n = 51; M BMI = 21.65, SD = 2.04, n = 51). As in Study 1, a relatively small portion (60% of reference

portion) and a relatively large portion (180% of reference portion) of lasagna, which were perceived to be beyond the boundaries of a normal portion by the majority of participants, were selected for the manipulation phase (see Supplementary materials (Methods: Study 2, Figure S5.1.) for pilot study results).

5.3.1.4. Measures

5.3.1.4.1. Portion size selection and consumption and proposed mediators

Consumption of lasagna in session two was calculated in grams by subtracting the post-lunch weight of the leftover family-sized lasagna from the pre-lunch weight. Portion size selection (i.e., the amount of food that participants removed from the serving tray) was measured by subtracting the post-lunch weight of the family-sized lasagna from the pre-lunch weight. Salad selection and consumption was measured in the same way.

Similar items as in Study 1 were used to measure portion size normality, descriptive social norms (Cronbach's $\alpha = 0.84$), injunctive social norms (Cronbach's $\alpha = 0.87$), personal norms (Cronbach's $\alpha = 0.91$), and expected satiety (Cronbach's $\alpha = 0.87$) in Study 2, with a mean score calculated for variables consisting of more than one item. See Table 5.1. for the specific mediator items. The only difference from Study 1 was that items measuring perceptions of descriptive social norms and injunctive social norms referred to a situation-specific referent group, 'female participants of this research study', rather than personalizing these items to their age and sex (e.g., 'how much of this lasagna do you believe other female participants of this research would choose to eat for lunch?'). Given that the results of the pilot study for Study 2 were similar to Study 1 (see Supplementary Figure S5.1.), the same 9-portion response scale for the mediator items was used in Study 2.

5.3.1.5. Procedure

Participants were invited to participate in a study about the influence of the way a lunch meal is served on their mood (cover story). Participants attended two sessions on consecutive weekdays between 12 pm and 2 pm (a typical Dutch lunchtime) and the experiment was conducted in a sensory laboratory which consisted of five cubicles. Eligible participants were asked to abstain from eating for at least two hours before each session. They provided informed consent for both sessions at the start of session 1. To bolster the cover story, participants completed mood questionnaires before and after eating lunch, including items measuring appetite and one item asking participants to report how long since they last ate (see Supplementary materials (Methods: Study

2)). Participants were instructed to press a button when they had completed the questionnaire, at which point the researcher returned with the lunch. In both conditions (small, large) the lunch was served on a standard white dinner plate (Ø 28.5 cm), consisting of lasagna and a 10 g side salad (lettuce leaves), served along with a glass of water, cutlery, and a napkin. Participants were served a portion of lasagna corresponding to the condition to which they were randomly assigned according to a predetermined computerized random sequence of conditions. All participants were told that they could consume the entire meal if they wanted to and were instructed to press a button to alert the researcher when they had finished eating. Participants then completed the same mood and appetite ratings as before lunch. On the next page of the online questionnaire, participants reported how much they liked the lasagna (see Supplementary materials (Methods: Study 2)), which was embedded alongside two filler items about the palatability of the lasagna (e.g., "how much did you like the smell of the lasagna") measured on 9-point scales ((1 (not at all) to 9 (extremely)). Items were presented in an evenly randomized order.

During the second session (scheduled for approximately the same time on the day following session one), participants first completed the same mood, appetite, and time since last eaten questionnaire items as in session one. The researcher then returned with an empty standard white dinner plate (Ø 28.5 cm), cutlery, a napkin, and a glass of water and a tray consisting of a family-sized lasagna in an aluminum container, a full bowl of salad (lettuce leaves (30 g)), and serving utensils (see Figure 5.2. (c)). The researcher informed participants that they could serve themselves whatever they wanted to eat and requested they place the tray containing the unserved food behind a hatch after serving themselves. Participants pressed the button when they finished eating, at which point the researcher returned to retrieve all remaining food, cutlery, and water, and unobtrusively measured the amount of lasagna that participants selected and consumed. Then, participants completed the same mood, appetite, and palatability rating questionnaires as in the previous session, and subsequently reported what they thought was the aim of the study (as in Study 1), and subsequently indicated their portion size norms and expected satiety. Participants' then completed the manipulation check, frequency of eating lasagna (see Supplementary materials (Methods: Study 2)), and demographic items (weight, height, age, and nationality). Thereafter, participants completed the awareness of monitoring consumption item (see Supplementary materials (Methods: Study 2)), which was embedded alongside four filler items about the participants' study experience (e.g., "did you feel bored during the study", measured on a 9-point scale ranging from 1 (not at all) to 9 (very much)).

Participants were thanked and reimbursed and after completion of all data collection, participants were debriefed about the true purpose of the study by email.

5.3.1.6. Planned statistical analyses

Data were analyzed using IBM SPSS Statistics 24 (IBM corp., Armonk, NY, USA). We planned a priori to exclude participants from analyses who were aware of the study aims or who did not follow study instructions (e.g., not adhering to abstinence requirements).

The analysis plan was the same as in Study 1, except that separate independent-sample *t* tests replaced ANOVAs for examining effects on consumption, portion size selection, and portion size evaluations. As the proposed mediator variables were not normally distributed, data were log-transformed with a natural logarithm. Additionally, as the effect of portion size served in session one on consumption and portion size evaluations the next day may have been dependent on participants' recollection of the portion size being served during the first session (as suggested by the results of Study 1), primary analyses were rerun by solely including participants who correctly identified the portion size served during session one in the analysis. We reported whether these sensitivity analyses resulted in findings that differed from the primary analyses. See Supplementary materials (Methods: Study 2) for details of additional secondary and sensitivity analyses.

5.3.2. Results

5.3.2.1. Participant characteristics

In total, 140 eligible participants completed both sessions of the experiment. Eight participants were excluded from the analyses in line with a priori exclusion criteria (see Supplementary Figure S5.4.), leaving an analytic sample of 132 participants. See Table 5.4. for participant characteristics per condition.

Table 5.4. Participant characteristics per condition (n = 132).

	Smaller portion size condition (n = 68)	Larger portion size condition (n = 64)
	Mean (SD) or Number (%)	Mean (SD) or Number (%)
Age (y)	20.75 (1.84)	21.11 (2.21)
BMI (kg/m^2)	21.71 (2.37)	22.04 (2.25)
Baseline hunger (session two) [a]	6.97 (1.46)	7.13 (1.58)
Liking (session two) [a]	6.15 (1.45)	6.02 (1.60)
Frequency of eating lasagna [a]	5.13 (0.98)	5.22 (0.93)
Awareness of monitoring consumption [a]	7.13 (1.99)	6.69 (2.22)
Nationality (Dutch)	66 (97.1%)	59 (92.2%)

[a] Measured on a 9-point scale (range 1–9).

5.3.2.2. Manipulation check

As in Study 1, Pearson chi-square analyses showed that a higher proportion of participants in the smaller portion size condition (68/68, 100%) were able to identify the portion size they consumed in session one than in the larger portion size condition (24/64, 37.5%), $X^2(1) = 60.98$, $p < 0.001$. Results of a Welch's t-test indicated that participants in the smaller portion size condition (M = 1.32, SD = 0.47) remembered being served a significantly smaller portion than participants in the larger portion size condition (M = 5.94, SD = 1.83) ($t(70.82) = -19.54$, $p < 0.001$, $d = 3.51$), however the proportions were higher than in Study 1, suggesting a better recall of portions when they are served and consumed than when visually presented online.

5.3.2.3. Consumption and portion size selection

On average, participants who were served the smaller portion size on day 1 consumed almost the entire serving (179.60 g consumed (SD = 15.94) versus 180 g served), while this was not observed in participants who were served the larger portion size on day 1 (450.51 g consumed (SD = 87.86) versus 540 g served). Results of a Welch's t-test showed that participants in the smaller portion size condition (compared to the larger portion size condition) consumed significantly less lasagna during day 1 ($t(66.96) = -24.29$, $p < 0.001$, $d = 4.34$, $n = 67$ for the smaller portion size condition (because of a missing observation)).

Participants who were served the smaller (as opposed to the larger) portion size during day 1 freely chose to select and consume a significantly smaller portion of that food the next day (see Table 5.5.). Results of secondary consumption analyses (i.e., salad consumption) are reported in the Supplementary materials (Results: Study 2, Table S5.7.).

Table 5.5. Portion size selection, consumption and portion size evaluations per condition on day 2 (n = 132).

	Smaller portion size condition (n = 68)	Larger portion size condition (n = 64)	Test statistic	p-value	d
	Mean (SD)	Mean (SD)			
Effect of condition on consumption					
Portion size selection (grams)	401.64 (115.25)	505.24 (135.00)	$t(130) = -4.75$	< 0.001	0.83
Consumption (grams)	382.57 (104.70)	471.81 (120.91)	$t(130) = -4.54$	< 0.001	0.79
Effect of condition on perceptions of portion size normality					
Perceptions of portion size normality [a]	3.04 (1.09)	3.38 (1.43)	$t(130) = -1.26$	0.21	0.22
Effect of condition on perceptions of descriptive norms, injunctive norms, personal norms and expected satiety					
Perceptions of descriptive norms [a]	2.59 (1.03)	3.06 (1.09)	$t(130) = -2.67$	0.01	0.46
Perceptions of injunctive norms [a]	2.68 (0.91)	3.18 (1.14)	$t(130) = -2.66$	0.01	0.46
Personal norms [a]	2.99 (1.14)	3.39 (1.56)	$t(130) = -1.19$	0.24	0.21
Expected satiety [a]	3.60 (1.36)	4.00 (1.63)	$t(130) = -1.25$	0.22	0.22

[a] Measured by a 9-point scale (range 1–9). Note: All reported means and standard deviations are untransformed scores for ease of interpretation.

5.3.2.4. Portion size evaluations

Contrary to our hypothesis, there was no significant difference between smaller and larger portion size conditions on perceived portion size normality, or on personal norms or expected satiety (see Table 5.5.). However, consistent with the hypotheses, participants who were served the smaller (as opposed to the larger) portion size during session one reported significantly smaller descriptive and injunctive social norms regarding portions of that food the next day (see Table 5.5.).

A mediation analyses including only perceptions of descriptive social norms and injunctive social norms was performed, as the conditions for mediation were only met for these mediators (see Supplementary Table S5.4.). The total indirect effect of portion size condition on later consumption jointly via perceptions of descriptive social norms and injunctive social norms was significant (indirect effect = 18.10, SE = 9.22, 95% CI (2.78, 38.37), proportion of total effect explained by indirect effect = 20.28%). Focusing on specific indirect effects, there was a significant indirect effect of portion size condition on later consumption via perceptions of descriptive social norms (indirect effect = 13.75, SE = 8.37, 95% CI (0.52, 32.99), proportion of total effect explained by indirect effect = 15.41%), but no specific indirect effect via injunctive social norms was observed (indirect effect = 4.35, SE = 6.74, 95% CI (−7.62, 19.68), proportion of total

effect explained by indirect effect = 4.87%). The results of the sensitivity analyses are reported in the Supplementary materials (Results: Study 2, Table S5.5.).

5.3.2.5. Recollection of portion sizes

Although the proportion of participants that correctly recalled the portion size served in session one was higher than in Study 1, the majority of participants in the larger portion size exposure condition did not correctly recall the portion size served. Primary analyses were repeated on the subsample of participants in the analyses who correctly identified the portion size served during session one (n = 92). The results were all in the predicted direction among this subsample of participants, as follows: Participants in the smaller portion size condition perceived a smaller portion size to be normal; reported a smaller perceived descriptive, injunctive, and personal portion size norm; reported expected satiety with a smaller portion size; and selected and consumed significantly less in the second session than participants in the larger portion size condition (all p-values < 0.01, see Supplementary Table S5.6.).

5.3.3. Discussion

Participants who were served a smaller (compared to a larger) portion of lasagna chose to consume a significantly smaller portion of that food the next day. This effect was mediated by differences in the perceived descriptive and injunctive social norms regarding portions of lasagna, but only changes to perceived descriptive norms showed evidence of independent mediation. Neither perceptions of portion size normality, personal norms, nor expected satiety regarding portions of lasagna the next day were significantly different between participants who were served a smaller versus a larger portion of lasagna during session one. In line with Study 1, the pattern of results differed somewhat among the subsample of participants who correctly recalled the portion size they had been served during the first session. In this subsample, being served a smaller (compared to a larger) portion of lasagna resulted in participants believing a normal portion of lasagna to be smaller the next day, and it also decreased their evaluations of personal norms and expected satiety regarding portions of that food the following day. However, as in Study 1, results of these subsample analyses should be interpreted with caution as sample sizes were unequal between conditions.

5.4. General discussion

Across two experiments, we tested whether perceptions of descriptive social norms (beliefs about what others do), injunctive social norms (beliefs about what should be done according to others), and personal norms (beliefs about what should be done

according to oneself) underlie the effect of exposure to different food portion sizes on future portion size selection and consumption of the same food. The present findings indicate that participants who were actually served a smaller (versus larger) portion size of food served themselves and consumed less of that food the next day (Study 2), whereas mere visual exposure to a smaller (versus larger) portion size of food did not affect hypothetical portion size selection the next day (Study 1). Consistent with our hypotheses, Study 2 found that the relationship between the portion size exposure condition and later consumption was partially mediated by changes in perceptions of descriptive and injunctive social norms (but not personal norms) for portions of that food, although, contrary to predictions, no significant evidence was found for the role of general perceptions of portion size normality in this relationship.

The results of the present research are consistent with previous findings, demonstrating that *consuming* smaller (versus larger) food portions decreases the amount of food that participants later freely serve themselves and consume (Robinson et al., 2019; Robinson & Kersbergen, 2018). Together, this evidence supports the proposition that downsizing commercially available food products could have effects that extend beyond the consumption of the reduced food products, by affecting future portion size preference and consumption (Robinson & Kersbergen, 2018). An alternative proposition that has been explored in other research is that visual exposure to smaller food portions via digital media may 'renormalize' small portions. A feasibility study of a social media intervention that involved exposing students to images of peers' snacks in small portion sizes resulted in participants reporting a smaller ideal snack portion size (Sharps, Hetherington, Blundell-Birtill, Rolls, & Evans, 2019). However, the present findings that mere visual exposure to images of smaller (versus larger) portions was insufficient to significantly decrease future hypothetical consumption of that food reinforces the suggestion that food portions may need to be physically present in one's environment in order to be able to adjust perceptions of a normal-sized portion and future consumption (Robinson et al., 2019). Systematic exploration of the necessary conditions for altering perceived portion size normality and future consumption would be valuable to inform effective strategies to reduce overconsumption.

The present work did not replicate earlier findings that exposure to portion sizes affects consumers' general perceptions of what is a 'normal-sized' portion. This was unexpected, as it has been repeatedly shown that exposure to a stimulus can alter people's perceptions of size normality, demonstrated in relation to food portions (Robinson et al., 2019; Robinson & Kersbergen, 2018; Robinson et al., 2016), as well as in other domains (e.g., perceptions of 'normal' body sizes) (Boothroyd, Tovée, & Pollet, 2012; Winkler & Rhodes, 2005). A possible explanation for these non-significant findings

could be that the more nuanced questions about portion size norms included in the present research (e.g., descriptive and injunctive social norms, personal norms) prompted participants to think more deeply about their beliefs about portion size, dampening the effect of prior exposure to portion sizes on their reported perceived 'portion size normality', in general terms. A different interpretation of the non-significant findings might be that the extreme small and large portion sizes included in our experiments were too different from what participants initially perceived as being 'normal' in size, as the portion sizes (both small and large) included in the initial exposure phase were selected based on their similar deviance from a normal portion.

Consistent with expectations, current findings suggest that perceptions of descriptive and injunctive social norms jointly underlie the effect of being served (but not visually exposed to) a smaller compared to a larger food portion on consumption of that food 24 h later. To our knowledge, this is the first study empirically showing that served portion sizes can signal normative information about both what others would eat (descriptive social norm) and what others believe is the appropriate amount to eat (injunctive social norm), indirectly affecting future consumption. It should be noted that next to the *combined* indirect effect of descriptive and injunctive norms, there was a *specific* indirect effect of descriptive social norms, suggesting that this factor is relatively more important than perceptions of injunctive social norms. However, when including covariates in the model, only the *total* indirect effect of both descriptive social norms and injunctive social norms remained significant and these norms were highly correlated. Therefore, results should be interpreted with a focus on the overall pattern of the joint indirect effect, which indicates that portion size norms are anchored in social groups (Hollands et al., 2015; Schwartz, 1977). Our work supports the notion that social norms can affect eating behavior (e.g., see reviews of Higgs (2015); Robinson, Thomas, et al. (2014); Stok et al. (2016)). Furthermore, our research is one of the first studies that provides empirical evidence for the proposition that social norms are embedded in physical elements of food environments, guiding eating behavior accordingly (Raghoebar, Van Rongen, et al., 2019).

Contrary to expectations, the indirect effect of portion size condition on consumption via personal norms was not supported, suggesting that exposure to portion sizes does not adjust the amount of food an individual considers to be a normal amount for *themselves* to eat. We also did not find evidence for the alternative explanation that expected satiety underlies the effect of portion size exposure on later consumption. The results of the current study may therefore indicate that portion size norms are derived from the specific eating situation (Goldstein, Cialdini, & Griskevicius, 2008; Herman & Polivy, 2005), rather than reflecting an individualized norm (e.g., this

is normal for me to eat or this is enough for me to feel satisfied), as only significant effects for social consumption norms were observed. Specifically, when participants were served a food portion size which was inconsistent with their personal norm in the present research, they may have inferred that this portion size signals what is seen by others in that context as a 'normal' or 'appropriate' amount to eat. As a result, they conform to these social norms, which might explain the indirect effects demonstrated in this and other studies (Robinson et al., 2019; Robinson & Kersbergen, 2018). In other words, serving smaller (larger) portions leads to smaller (higher) food intake, as people think others in that eating context believe that this is the normal/appropriate amount for them to eat, and this effect occurs even if the portions were initially deemed abnormal and irrespective of their own personal standards. This line of reasoning is consistent with Herman & Polivy (2005), who argue that portion sizes determined by another person represent a judgment about what one ought to eat in a specific eating situation. Future research should examine whether the observed effects extend to more realistic settings (e.g., at home) in which social norms may be less salient (Higgs, 2015). One could reason that, in a home setting, participants may be more strongly guided by a personal norm (which was not significantly affected by the portion size manipulation in the present research) than a social norm.

In the present research, a large number of participants incorrectly recalled the portion size to which they had previously been exposed. Participants who were exposed to (Study 1) or served (Study 2) larger (versus smaller) portion sizes had a poorer recall of the exposure portion size, which is in line with previous research indicating a general underestimation of especially large portion sizes (Ordabayeva & Chandon, 2016). The effects of exposure to portion sizes on norm perceptions and expected satiety were potentially stronger (and in the predicted direction) among those participants who were able to correctly identify the portion size to which they were exposed to. This finding may suggest a potential role for making people aware of the portion size as a factor to moderate the relation between portion size exposure and later portion size evaluations, although recent research has failed to demonstrate that training attentive or mindful eating successfully reduces intake (Tapper & Seguias, 2020; Whitelock et al., 2019).

Study 1 was conducted via an online survey platform, and therefore may be susceptible to bias due to lack of participant attention. This could potentially explain the observation that fewer participants in Study 1 (correct identification: 44.6%) were able to correctly identify the portion size to which they were exposed than in Study 2 (correct identification: 69.7%). The exclusion of male participants from Study 2 means that it is unclear whether our findings are generalizable to men, and future research should replicate this study including males. Another limitation of this research is that

the social and personal norm measures were not validated, although these instruments were developed based on the general norm measure used in Robinson & Kersbergen (2018). Hunger was measured retrospectively in Study 1 and this is a limitation of the current research, although this method has been used previously (Robinson et al., 2016). Lasagna and spaghetti were selected as stimuli in the present experiments, as they are commonly consumed and are widely available in mainstream supermarkets in both the UK and the Netherlands. However, we did not assess participants' familiarity with the foods in either study, or their frequency of consumption in Study 1, and we therefore cannot conclude that the foods were equally as well-known across the studies. It is possible that these factors moderate the effect of portion size exposure on future portion size preferences and this could explain the different pattern of results between the studies, but this remains a question for future research. The current research does not permit conclusions about whether exposure to smaller versus larger portion sizes would affect participants' urge to compensate for a small portion size by eating additional food, but this would be a valuable direction for future research. Although there were no significant effects of visual exposure to portion sizes on normative evaluations of an 'incongruent' food in Study 1, future research should test these 'transfer' effects in a laboratory-based setting using actual food. Finally, it is unclear whether the effects that portion size had on social norms in the present studies were context specific (i.e., specific to portion size evaluations when eating in laboratory) or whether they would transfer and influence perceived social norms in other contexts (i.e., outside of the laboratory setting).

5.5. Conclusion

Being served (but not being visually exposed to) smaller food portions decreases consumers' perceptions of social norms regarding both what others would serve themselves (descriptive) and what they believe is an appropriate amount to eat (injunctive), which reduces consumption of that food 24 h later.

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Chapter 6

General discussion

"Our societies are complex and interrelated. Health cannot be separated from other goals. The inextricable links between people and their environment constitute the basis for a socioecological approach to health…"

– The Ottawa Charter for Health Promotion, World Health Organization (1986) p. 2

6.1. General aim

The general aim of this dissertation was to improve the understanding of how physical cues in micro food environments determine our dietary decisions. We posited that physical and social aspects of food environments are intertwined, particularly by proposing that social norms are inferred from physical cues in food environments. We further proposed that social norm interpretations mediate the effect of food environment exposure on food consumption. The relevant alternative explanations to the social norm account were also taken into consideration in this dissertation. Consequently, this dissertation contributed to the understanding of the causal mechanisms explaining the effect of physical cues in micro food environments on food consumption. In this final chapter, I first briefly summarize and discuss the main results of the presented work (Section 6.2.), after which I provide theoretical reflections (Section 6.3.) and methodological reflections (Section 6.4.) on our work, followed by some directions for future research (Section 6.5.), the implications for policy and practice (Section 6.6.), and the final conclusion (Section 6.7.).

6.2. Summary of main findings

Beginning with the end: Taken together, the findings in this dissertation demonstrate that people may infer descriptive and/or injunctive norms from different physical cues in food environments (in the absence of other people), suggesting that social norms are widely (physically) embedded in food environments. Our work further suggests that both descriptive and injunctive norms may mediate the causal relationship between physical cues and food consumption, although perceived social norms did not consistently result in norm-congruent behavior or did not consistently act as a mediator in the effect of physical cues on consumption. Our work thus provides empirical support for the notion that physical and social aspects of food environments are intertwined, but the impact and form (type of norm) of that interaction are not straightforward. This section summarizes the main findings regarding social norms, the findings regarding alternative explanations to the social norm account are discussed in Section 6.3.3.

To provide a foundation for the experimental designs applied in the studies in

later chapters, in **Chapter 2** an inventory was created of physical cues in food environments potentially communicating social norms. We qualitatively analyzed a set of photographs taken in different self-service food environments (e.g., worksite restaurants, roadside shops) using strategies from photo documentation, semiology, and grounded theory, after which we cross-validated our findings among laypeople. Perceptions of *descriptive* norms (beliefs about what other people do in a given situation) and *injunctive* norms (beliefs about what should be done according to other people in a given situation) were distinguished in our analysis. We structurally linked a great variety of physical cues to either or both descriptive and injunctive norm connotations (e.g., 'others have taken', 'appropriate to take', respectively). For example, 'food traces' and 'the presence or absence of serving cutlery' were considered to bear a descriptive and an injunctive norm, respectively. In light of this initial photo study, which adopted mainly an interpretative approach, we posited that social norms are widely and physically embedded in food environments and may guide food consumption. The causal effect of physical cues in food environments on perceived social norms and food consumption still remained unclear however. Therefore, we adopted an experimental approach and examined the effect of a set of three such identified physical cues on social norm interpretations and food consumption in subsequent studies – specifically, we tested the effect of a cover (Chapter 3), relative availability (Chapter 4) and portion sizes (Chapter 5).

In **Chapter 3**, across three experimental studies, we zoomed in on a physical cue connected to available foods, namely, the presence or absence of a cover on snack bowls, presumably illustrating an injunctive norm. Regarding the direct effect, the three studies provided evidence that a snack bowl presented with (versus without) a cover can decrease the likelihood of people taking snacks in both field and lab contexts, thus functioning as a barrier to consumption and challenging the dominant view that people simply consume whatever is available to them. Further, this research empirically supports the proposition that social norms in generic terms can be inferred from physical cues surrounding foods – specifically, we demonstrated that the presence (versus the absence) of a cover on snack bowls may decrease participants' perceptions of social norms about taking snacks.

In **Chapter 4,** we examined the effect of offering an increased proportion of plant-based relative to animal source foods as an example of a physical cue potentially being interpreted as a social norm encouraging plant-based food consumption among non-vegetarians, thereby separating descriptive from injunctive norm interpretations in the norm measure (deepening/advancing the approach adopted in Chapter 3). Two different experimental manipulations that included different foods, both simulating

(online) supermarket settings, provided support for the proposition that spatial design – assortment structures specifically – may shift (or shape) the ideas of non-vegetarians about what other people typically choose. We particularly showed that descriptive (but not injunctive) norms about 'normal' consumption can be inferred from the number of plant-based foods available. However, the direction of the descriptive norm effect remains unclear, as we observed conflicting descriptive norm interpretations of the availability manipulation in the online setting compared to the lab-in-the-field setting. In the online setting, against our predictions, individuals interpreted the relatively high availability of plant-based (versus animal source) foods as plant-based foods being less often chosen by others. Conversely, as predicted, in the lab-in-the-field setting, a trend was observed of individuals interpreting the relatively greater availability of plant-based foods as indicating that these foods were more often chosen by others, and they reported a lower likelihood of others choosing an animal source food. Moreover, we did not observe a direct effect of exposure to a relatively greater availability of plant-based (versus animal source) foods on food choice.

Chapter 5 provides first support for the notion not only that social norms are embedded in physical food environments (primarily shown in the previous chapters), but also that perceived descriptive and injunctive norms may jointly underlie the relationship between physical cues in food environments and (later) food consumption. This was shown across two experimental manipulations testing the influence of being visually exposed to, or actually being served, smaller (versus larger) portion sizes on consumption of that food 24 h later, thereby measuring either hypothetical portion size selection or actual portion size selection and food intake, rather than a food choice task such as mainly included in the previous chapters. The results showed that being served (but not being visually exposed to) smaller (versus larger) portion sizes resulted in individuals perceiving that others (a) would serve themselves a relatively smaller portion size (perceived descriptive norm) and (b) believe that a relatively smaller portion size is the appropriate amount to eat (perceived injunctive norm); this reduced portion size selection and consumption of that same food a day later when they could decide the portion size themselves.

6.3. Theoretical reflections

6.3.1. Shifting consumption by (re)shaping environments

This dissertation starts from the growing recognition that consumption behavior can be influenced by the arrangement of physical cues in micro food environments in which

consumption takes place (e.g., see systematic reviews by Bianchi, Garnett, et al. (2018); Hollands et al. (2015); Hollands et al. (2019)). Consistent with this previous work, our findings confirm that our dietary decisions can be shifted by changing physical cues in external environments. Particularly, we showed that people's decision to take a snack was affected by the presence versus the absence of a cover on snack bowls (Chapter 3) – with people being less likely to take a snack in the presence of a cover. Moreover, people's consumption amount was affected by the portion size (small versus large) that they were served the previous day (Chapter 5) – with people self-serving and consuming a smaller portion of food when they were previously served a smaller portion size. Together, these findings show individuals' sensitivity and reactivity to presumably unobtrusive cues in the environment.

The findings in this dissertation also indicate that various subgroups may react differently to a similar physical cue in food environments, as no evidence for a direct effect was observed (Chapter 4). Specifically, we found that the relationship between the proportion of physically present plant-based foods available and food choice was moderated by an individual-level factor: people's affective connection toward meat. Among the subgroup of participants showing high meat attachment patterns (moderator), the availability of an increased proportion of physically present plant-based (versus animal source) foods increased the likelihood of a person choosing a plant-based food option. This finding is consistent with earlier research stating that other individual differences (such as sociodemographic background and a priori preferences) may influence the relationship between physical cues in food environments and behavior (Kamphuis et al., 2006; Lakerveld et al., 2018; Swinburn et al., 2011; Venema, 2020). The finding, however, conflicts with the idea that people with strong a priori preferences are less affected by changes in physical micro environments, whereas 'inconsistent choosers' without such strong a priori preferences are considered to be more susceptible to environmental changes (Goldin, 2015; Venema, 2020; Venema et al., 2019). Meat attachment may be regarded as such an indicator of a person's a priori preferences, especially as previous scholars showed that people who were more attached to meat consumption were less willing to change their eating habits and shift toward a more plant-based diet (Graça, Calheiros, et al., 2015). Following this rationale, one would expect that a person showing a high meat attachment pattern would choose an animal source food option over a plant-based food option, regardless of the arrangement of physical cues in food environments (Venema, 2020; Venema et al., 2019). Although far more research into this topic is needed, our results suggest that the environment in which the choice is made can certainly affect the dietary decisions of people with strong a priori preferences. Such a

pattern of results was also observed in previous research showing that a relatively increased availability of vegetarian meals in college cafeterias led to more vegetarian sales, particularly among people who were less likely to choose a vegetarian meal prior to the availability intervention (Garnett et al., 2019).

To conclude, the findings in this dissertation indicate that dietary decisions may be affected (shifted) by the environments in which consumption occurs, but may not affect everyone. The observed influence of the arrangement of physical aspects of food environments in determining consumption behavior has led to many intervention strategies purposely restructuring (redesigning) physical micro environments to shape desired behaviors. Such intervention strategies, also described as choice architecture or nudge interventions, aim specifically to implement physical cues in food environments in such a way that individuals are more likely to make a particular choice (e.g., see systematic reviews by Bianchi, Garnett, et al. (2018); Vecchio & Cavallo (2019)). The studies in this dissertation were performed mainly to fundamentally understand how these environmental changes work rather than to encourage desired behavioral outcomes (at scale), and we cannot assume that the results of our small-scale lab (and some field) studies will generalize to more real-world settings (Marteau et al., 2020). Therefore, future research needs to replicate our studies in several naturalistic environments over a prolonged period, measuring their influence on healthy and sustainable consumption behaviors (and estimating their effect sizes).

6.3.2. Shifting social norms by (re)shaping environments

As emphasized by many scholars (e.g., Lakerveld et al. (2018); Marteau et al. (2020); Szaszi et al. (2018)), to date it remains unclear how physical cues in micro food environments actually affect consumption – i.e., these questions of mediation (or underlying causal processes), also characterized as *how* questions, are largely under-researched (Zanna & Fazio, 1982). The current dissertation uniquely contributes to this emerging research focus by demonstrating through qualitative and quantitative research that physical cues in micro food environments can be interpreted as a social norm, in the absence of other people, suggesting that social norms are widely and physically embedded in physical aspects of food environments (Chapters 2–5). In Chapter 2 for example, we described and illustrated how physical cues may carry social norm connotations; for instance, crumbs (a consumption trace) may symbolize a descriptive norm representing that it may be normal to take food as others had done so, in similar ways as, for example, a red traffic light may symbolize danger representing that one needs to stop. In Chapter 3, we confirmed empirically the social norm

interpretation of physical cues by demonstrating that people perceived a snack bowl presented with a cover as a decreased social norm to take snacks, whereas an increased social norm to take snacks was inferred from a snack bowl presented without a cover. Moreover, we showed empirically that interpretations of what is done by others (descriptive norms) and what is approved by others (injunctive norms) are perceived as two distinct, but also related, types of norms that may be associated with similar or different physical cues in food environments. To illustrate, the results in Chapter 5 emphasize that portion sizes may be perceived as what others both do and approve (i.e., as both a descriptive and an injunctive norm), thereby dictating similar conduct, whereas the results in Chapter 4 show that the proportion of (plant-based) foods available in assortment structures is interpreted solely as a descriptive norm, not as an injunctive norm. Taken together, based on our findings and in conformity with our hypotheses, this dissertation provides first evidence for the proposition that physical aspects of the material world may act as an embodiment of social norms. Specifically, and in line with suggestions by Burger et al. (2010), De Ridder et al. (2013), and Prinsen et al. (2013), we have shown that descriptive and injunctive norms may be communicated indirectly via physical cues in food environments. In other words, differentiations in the arrangement of physical cues in food environments may shift an individual's perception of what the social norm is in that specific context: I like to call these *social contextual norm cues,* and I use this term in the remainder of this final chapter.

We further investigated whether perceived social norms may explain the causal relationship between physical cues and food consumption, as a novel empirically tested mechanism potentially explaining how physical food environments lead to eating. Our work suggests that both types of social norms may act as a mediator in this relationship, particularly by showing that being served smaller (versus larger) food portions affects an individual's perceived descriptive norm about what others would serve themselves and their perceived injunctive norm about what others believe is an appropriate amount to eat, thereby reducing their consumption of that food 24 h later (Chapter 5). Following reinforcement learning theory, an individual acts in a given environment in which a set of possible actions is available. Each action may produce one or more possible outcomes that are associated with a reward value, and each action may change the environmental state, with an individual's overall aim to maximize reward by their actions (Dayan & Niv, 2008; Marteau et al., 2020). In line with this perspective, it may be speculated that individuals followed the social consumption norms inferred from the portion size to achieve social approval (or to avoid social disapproval) and to behave effectively. These reward values are, respectively, based on social norm theory

stating that injunctive norm following is inherently rewarding as it is associated with the interpersonal goal of maintaining and building social relationships, whereas descriptive norm following is associated with an intrapersonal goal of choosing correctly (Cialdini et al., 1990; Cialdini & Trost, 1998; Jacobson et al., 2011; Klucharev, Hytönen, Rijpkema, Smidts, & Fernández, 2009; Marteau et al., 2020).

However, we have to admit that perceived social norms inferred from physical cues did not mediate the observed effect of physical cues on behavior (Chapter 3) or consistently result in congruent behavioral patterns (as the mediating pathway disappeared when covariates were included in the model, Chapter 4). Several reasons may be responsible for this inconsistency in norm congruent behavior, and I outline three such possible main explanations below, being aware of other potential explanations (e.g., norm uncertainty and individual characteristics). First, further arguing from reinforcement learning theory, one may reason that the increased relative availability of plant-based foods being interpreted as a descriptive consumption norm did not consistently result in norm congruent behavior because the reward value of norm following was not deemed important by some individuals or because they had a weak identification with the norm referent group (Higgs, 2015). Some people may therefore not have felt the urge to behave in accord with the descriptive consumption norm (e.g., choosing a plant-based food option over an animal source food option) to create a certain impression on others who value characteristics of plant-based food consumption – the need to belong and identification with the referent group needs to be examined in further research (Baumeister & Leary, 1995; Higgs, 2015). Second, it may also be possible that other reward values (possibly associated with alternative actions such as choosing an animal source food option) were stronger in dictating the behavior of some participants – for example, a priori preferences for animal source foods; although we reasoned in Section 6.3.1. that the dietary decisions of people with such strong a priori preferences may still be affected by physical cues in food environments. Future research should further examine the role of a priori preferences in the effect of physical cues on social norm interpretations and consumption, especially as we observed in Chapter 4 that the mediating pathways of descriptive norms disappeared when we controlled for such influences (e.g., meat attachment and liking ratings), suggesting that the social norm effect is nullified when a person's preferences are taken into account. According to Sunstein (2017), a priori preferences are one of the key reasons for the ineffectiveness of approaches that steer people in certain directions (i.e., nudges). Third, and finally, from a different perspective, many eating behaviors consist of habits (Van't Riet, Sijtsema, Dagevos, & De Bruijn, 2011) – frequently repeated behaviors that have become automatically triggered by a particular situational cue

(Orbell & Verplanken, 2010; Wood & Rünger, 2016) – and may be another explanation for the absence of consistent norm congruent behavior observed in Chapter 4. Meat consumption, for example, has a strong habitual nature (Rees et al., 2018) – e.g., evening meals automatically triggering the inclusion of meat as a main meal component. It may therefore be argued that a single exposure occasion to the availability manipulation is not sufficient to influence food choice, although this seemed to be adequate to shift perceived descriptive norms. Repeated exposure to a changed environment seems a promising way to break/change habits in the long term, as individuals are more likely to maintain habits in stable contexts (and they may thus potentially change their habits in a changed environment that reflects a different consumption norm) (Kwasnicka, Dombrowski, White, & Sniehotta, 2016; Verplanken, Walker, Davis, & Jurasek, 2008).

To conclude, in attempts to rearrange food environments to enable healthy and sustainable consumption, our findings highlight the importance of taking the social norm interpretation of physical cues into account. Our work thus provides a basis for further research into interventions, especially given that these cues have the power to shift (or shape) social consumption norms that may potentially (but not consistently) shift consumption. Social norm interpretations may therefore be one of the potential explanations of the causal relationship between physical cues in food environments and food consumption.

6.3.3. Alternative explanations to the social norms account

We tested a mixture of (sometimes somewhat competing) mechanisms potentially explaining the effect of physical cues on consumption. We examined mainly different perceptions of the environment as potential explanatory mechanisms, which are psychological in nature and based on the theoretical consideration that behavior is an outcome of a complex bidirectional interaction between the individual and their (changing) environment (Marteau et al., 2020). We therefore took the relationship among both types of social norms into consideration in our mediation models (when applicable), as well as the relationship with other relevant alternative accounts. For example, perceptions of effort and salience are often proposed as key mechanisms in this domain (e.g., Hunter et al. (2018); Knowles et al. (2019); Knowles et al. (2020); Maas et al. (2012)). We observed that the tested alternative explanations to the social norm account did not explain the causal relationship between physical cues and consumption in Chapter 4 (testing perceived salience) and Chapter 5 (testing personal norms, expected satiety, and generic perceptions of portion size normality), although

perceived social norms did. However, the absence of social norms as a mediator in Chapter 3 may be explained by the influence of such alternative explanations. Specifically, although people perceived a snack bowl presented with (versus without) a cover as a generic social norm signaling that it was less normal and appropriate to take snacks, only perceptions of salience mediated the effect of the cover manipulation on consumption. Snacks were rated as less visible or salient when the cover was present (versus absent), and this resulted in a lower likelihood of consumption. The observed (mediating) effect is in line with previous research showing comparable results for snacks presented with (versus without) a layer of wrapping (Knowles et al., 2020). Such an impact of food salience on consumption may be plausible as, in many situations, the first interaction people have with a food is visual (i.e., through their eyes) (Delwiche, 2012; Wadhera & Capaldi-Phillips, 2014). One may argue that seeing snacks serves as a cue to consume and that the arrangement of physical cues in food environments may thus support (or impair) people's self-regulation strategies to inhibit (or stimulate) snack consumption. We also found that the arrangement of physical cues may affect a person's perceived effort to obtain foods, as the presence (versus the absence) of a cover increased the perceived effort to obtain snacks, again in line with previous findings by Knowles et al. (2020). However, an increased perceived effort due to the presence of a cover (Chapter 3) or a layer of wrapping (as observed in previous research by Knowles et al. (2020)) did not explain the effect on likelihood of consumption, suggesting that an increased perceived effort required to obtain snacks does not function as a barrier to consumption (i.e., consuming snacks may be worth the effort).

In Chapter 4, we argued that perceived salience of the desired foods (e.g., plant-based foods) is a prerequisite for descriptive norms to be perceived, rather than a separate mechanism affecting behavior – this accords with social norm theory stating that social norms need to be salient (i.e., focal in attention) to affect behavior (Cialdini et al., 1991; Cialdini et al., 1990). Together, this may imply that some explanatory mechanisms do not operate in isolation, but rather are interrelated (or a prerequisite for other mechanisms to be influential), particularly as many tested mechanisms in our studies were highly correlated (Chapters 3–5). This is in line with suggestions by Marteau et al. (2020), who proposed that the effects of choice architecture interventions cannot be explained by a single theory. Future research should investigate the variability among the included correlated mechanisms to disentangle which mechanisms relate to one another and which mechanisms are unique. Furthermore, we acknowledge that there may be other mechanisms that are relevant for choice architecture effects – such as, for example, (expected) liking for the target option in the availability effect or bite size in the effect of portion size on (later) consumption

(Kerameas, Vartanian, Herman, & Polivy, 2015; Pechey et al., 2020). However, it may be too comprehensive to consider all potential mechanisms in one research project.

To conclude, the findings of this dissertation specifically expanded the (dominant) view that the perceived salience of foods and the perceived effort required to obtain foods are the key mechanisms explaining the effect of physical cues in food environments on consumption (e.g., Hunter et al. (2018); Knowles et al. (2019); Knowles et al. (2020); Maas et al. (2012)), by showing the potential (and additional) role of social norms in this effect.

6.4. Methodological reflections

The focus on the causal pathways – specifically on social norms and their alternative explanations – of the effect of physical cues in micro food environments on consumption is a theoretical strength of the current dissertation, which attempts to fill an important research gap. The hypotheses tested in this dissertation were similar across studies, but we tested the hypotheses under different circumstances (e.g., including different cues, environments, and target groups) in order to replicate our findings conceptually (i.e., validate the underlying theory) (Earp & Trafimow, 2015; Nosek et al., 2012; Schmidt, 2009). This may also be observed as a theoretical strength of this dissertation, as we attempted to show a similar effect with various operationalizations to provide confidence in its conceptual interpretation (Nosek et al., 2012). However, this dissertation is also subject to several methodological limitations. The first relates to the partial view of the environment that we investigated across our studies, as each study was focused on a specific physical cue in the environment (e.g., portion sizes). Consumption behavior normally occurs in more complex environments in which varying (sometimes competing) cues are present in a similar situation. The external validity of our studies, particularly of our lab studies, may therefore be questioned, as it remains unclear whether some of our conclusions may be applied outside the context of our lab settings (although we attempted to increase their ecological validity by using an ambiance room (Chapter 3) or a lab-in-the-field context (Chapter 4)). Chapter 2 illustrates the complexity of such outside-the-home food environments, as we structurally linked descriptive and injunctive norms to a great variety of physical cues, often present in one food environment (e.g., worksite restaurants), and some cues (e.g., the last product left) were even associated with both descriptive and injunctive norms dictating incongruent behavior. In the studies in Chapter 4, we found that a single element in the food environment (for instance, the relative availability of a specific food) may be associated with a similar norm (descriptive

norms in this chapter) but may dictate contradictory conduct. Specifically, in our online study, the increased availability of plant-based foods was perceived as a descriptive norm signaling that these more greatly available foods were the favorite choice of others, whereas, in our lab-in-the-field study, the accordingly limitedly available animal source foods were perceived as more often chosen by others. These examples illustrate the complexity of the environments in which we live and function, and future research needs to investigate what norms will be followed when different norms are present in a similar situation. Rather than social norms being communicated indirectly via physical cues, they may be communicated directly, for example via actual human behavior (Higgs, 2015). It would be interesting to examine which norm would be followed if different (competing) norms were communicated via physical cues and via the actual behavior of other people present in food environments. To illustrate, consider the example of a snack bowl being presented with a cover at a checkout corner of a petrol station shop (a social contextual norm cue discouraging consumption), and imagine one observes that other customers in this shop are taking snacks from the covered snack bowl (a descriptive norm encouraging consumption). Following social norm theory (Cialdini et al., 1991; Cialdini et al., 1990), one may reason that the individual is likely to follow the dictates of the type of norm that is most salient, even when other types of norms dictate contradictory behaviors. Regarding the illustrated example, one may reason that the behavior of other customers is more salient, although this needs to be investigated in future research.

The second limitation of this dissertation concerns the general applicability of the results from the included samples to the wider target population (Firestone, 1993; Polit & Beck, 2010). Although we did not specifically aim for such a generalization, it is as yet unclear whether other (untested) samples could also interpret such social contextual norm cues in food environments and whether they comply with such norms. This may be perceived as a limitation of the current dissertation, as it is likely that other samples not included in our studies would react differently to social contextual norm cues. To illustrate, in Chapters 4 and 5, for example, the samples drawn from the target population included only women – of course this is not representative of the target population. Most research in this domain focusing on social norms has included females (Higgs, 2015), and it has been shown that females (compared to males) are more likely to adhere to social norms when eating (Bond & Smith, 1996), although a systematic examination of the effect of sex on social consumption norms is lacking (Higgs, 2015). It may thus be likely that our results would be different if males were included. Likewise, in previous research it was indicated that young people are more sensitive to social norms than older adults (Stok et al., 2016). Therefore, it would be

interesting to examine whether different target groups (e.g., different sex and age groups) may vary in the extent to which they interpret social norms from physical cues in food environments and their compliance with such norms. The results of the current dissertation are also limited in their generalization to other contexts, although this was again not specifically aimed for. Given that social norms are context specific, it is presumable that different contexts may vary in the extent to which social norms are embedded in these contexts and in the extent to which these social contextual norm cues determine dietary decisions. The research in this dissertation needs to be understood mainly in a Dutch cultural outside-the-home context. It would be valuable to replicate our studies in more collectivist contexts, which presumably have different social norms and a different arrangement of food environments. To illustrate, everyday food strategies in such a collectivist society (e.g., Thailand) may be characterized by street food and public eating (Yasmeen, 2000), whereas private eating patterns may be observed as more common everyday food strategies in individualist societies such as the Netherlands. One may speculate that norm following is more important in such collectivist cultures, as there is more emphasis on group behavior, although this remains an empirical research question, as well as the extent to which social norms are identified in these environments. Likewise, our results may not be generalizable to the home context, as social norms in these contexts may be less salient and one may reason that consumption is more strongly guided by personal (rather than social) norms in such a home environment, compared to food environments where there is more uncertainty about normal and appropriate consumption (Higgs, 2015). This reasoning accords with the results in Chapter 5, showing that portion size norms are derived from the lab setting (an outside-the-home context), rather than reflecting an individualized norm (e.g., this is normal for me to eat or this is enough for me to feel satisfied), as we observed significant (mediating) effects only for social consumption norms, and this effect occurred irrespective of an individual's own personal norms.

The third limitation of this dissertation pertains to the validity of the social norm measure. Although the instruments were based on social norm theory developed by Cialdini et al. (1990), preferably distinguishing between descriptive and injunctive norms, and we (mostly) observed a high level of internal consistency between the included items, it should be noted that we did not validate the items prior to use and we relied on retrospective self-report (further compromising the validity of the measure) (Lange & Dewitte, 2019). To illustrate, it is probably unlikely that participants had the same understanding of concepts such as 'the appropriate amount to eat' as operationalized in one of the items to measure injunctive norms in Chapter 5, as the term 'appropriate' can be defined as 'suitable or proper in the circumstances', which is

quite an abstract concept open to an individual's personal interpretations. However, this is not that problematic in the current dissertation as we were interested in *perceptions* of social norms rather than the *actual* norm. Alternatively, participants' behavior may have been biased by demand and/or experimenter effects (Robinson, Kersbergen, Brunstrom, & Field, 2014) – e.g., participants may have reported their perceived social norms in accordance with their interpretations of the experiment's purpose. However, in Chapters 3–5 we initially blinded participants to the study hypothesis by using a cover story and measured their awareness of the study aims at the end of the experiment (Robinson, Bevelander, Field, & Jones, 2018). To overcome these limitations of the current social norm measure, future research may consider assessing repeated measures of social norms over sustained periods (e.g., in the form of diary studies) or more implicit measures of social norms such as using the implicit association test.

6.5. Directions for future research

Throughout this final chapter, I have already outlined some avenues for further research related to the studies conducted in this dissertation. In this section, I further describe two relevant directions for future research. The first research line that I would like to discuss is fundamental in nature and pertains to the investigation of the working mechanisms by which social norm interpretations are enacted. It is often assumed (rather than empirically demonstrated) that physical cues in food environments influence behavior by targeting nonconscious processes occurring outside an individual's awareness (Marteau et al., 2020). Also, it has been shown that people are mostly unaware of the influence of social norms on their behavior (Nolan et al., 2008). Previous studies attempting to explain such working mechanisms that activate and shape behavior by an intervention are often grounded in dual-process models of behavior (e.g., Marteau (2017); Van Gestel, Adriaanse, & De Ridder (2020)), conceptualizing behavior as controlled by conscious and nonconscious (interacting) processes (Hollands, Marteau, & Fletcher, 2016; Marteau et al., 2020). In recent years, dual-process dichotomies have received increased criticism because the assumption that psychological phenomena can be divided into either of the two types lacks, for example, empirical support and there is a lack of internal consistency of the underlying dimensions (Melnikoff & Bargh, 2018). Rather, it has been discovered that most processes contain a mixture of conscious and nonconscious features (Melnikoff & Bargh, 2018). However, to date, the empirical assessment of the features of conscious and nonconscious processing that may be associated with the activation of social norm

interpretations and food consumption is largely lacking (Hollands et al., 2016; Hollands et al., 2015), as in our dissertation. The conceptual framework developed by Hollands et al. (2016), describing the processes by which interventions may trigger behavioral responses, may be used to investigate such underlying mechanisms. Inspired by this framework, future research should examine the nature of the processes by which physical cues in food environments may activate social norm interpretations and food consumption (Hollands et al., 2016).

The second direction outlines the need for longitudinal studies examining how social contextual norm cues change over time and their impact on consumption. In our current studies, we revealed that perceived social norms about normal and appropriate consumption may be affected by the arrangement of physical cues in (created) food environments, but it remains unknown how these perceived social norms evolve over time in naturalistic food environments. It has been suggested that changes in food environments are accompanied by changes in social standards existing around consumption. These eating appropriateness standards are considered to be shaped socially and culturally, both by people in the environment and by physical cues in these environments (De Ridder et al., 2013). In line with this reasoning, it may be proposed that social contextual norm cues evolve over time in accord with changes in the availability and accessibility of healthy and sustainable foods. A recent correlational study (performed in a naturalistic environment on a more macro contextual level) showed that, in a neighborhood where more fast food outlets were available, residents were more likely to perceive a stronger social norm (both descriptive and injunctive) signaling that fast food consumption is common and appropriate in that neighborhood (Van Rongen et al., 2020). Although it remains unclear from that cross-sectional study how perceived social norms evolve over time in these neighborhoods, the results of that study thus suggest that exposure to fast food outlets in neighborhoods is correlated with social norms about fast food consumption in these neighborhoods. The results further imply that these perceived social norms may mediate the relationship between the availability of fast food outlets in neighborhoods and fast food consumption (Van Rongen et al., 2020). In accord with these findings, focusing on specific physical food environments, we propose that social contextual norm cues nowadays signal that the consumption of less healthy and less sustainable foods is normal and/or appropriate and that this may be one of the explanations for the currently observed consumption patterns often including less healthy and less sustainable foods in Western society (Swinburn et al., 2019; Willett et al., 2019; World Health Organization, 2020). Therefore, it would be relevant to conduct longitudinal studies examining how perceptions of social norms in physical food environments

change over time and their relationship with consumption. It may also be relevant to investigate this in relation to the recent trend of meat substitutes gaining more shelf space in Dutch supermarkets (ABN AMRO, 2019; NOS, 2019). May it, for instance, be a reasonable scenario that animal source food selection in supermarkets was perceived as more common in the past (or nowadays) and may it be experienced as (slightly) less normal in the future (or nowadays) given the increased emphasis on healthier and more sustainable assortment structures? Another interesting direction for future research would be to examine how social contextual norm cues (over time) are affected by more superordinate (macro) levels of influence operating within the wider society (sectors), such as food marketing, food production, pricing strategies, laws, and policies (Story et al., 2008). For example, recently, positive effects on healthy food purchases were found when environmental cues (specifically, colored arrows and frames stimulating healthier food choices) were combined with pricing strategies (specifically, salient discounts and/or price increases) (Hoenink et al., 2020). Future research might extend these findings by examining how social contextual norm cues are affected by such pricing strategies, investigating their influence on perceived social norms and dietary decisions.

6.6. Implications for policy and practice

How can (should) policymakers interpret and use the finding that social contextual norm cues are embedded in food environments and may potentially affect food consumption? First, awareness among policymakers should be increased, given that social norms are presumably widely embedded in physical aspects of food environments (in the absence of other people). This seems particularly important given that food environments in Western society are often accused of containing aspects presumably encouraging relatively less healthy and less sustainable dietary decisions (e.g., the easy accessibility of less healthy and less sustainable foods) (Egger & Swinburn, 1997; Lakerveld & Mackenbach, 2017; Rutter et al., 2017; Swinburn et al., 1999; Swinburn et al., 2011). Awareness of the social norm interpretation of such physical cues in food environments can improve (or optimize) the development of effective so-called choice architecture (or nudge) intervention strategies attempting to encourage healthy and sustainable diets, specifically by improving (or optimizing) the design and implementation of such strategies (Marteau et al., 2020; Szaszi et al., 2018). The importance of such an awareness is emphasized by the findings in Chapter 4, providing explanations for why the arrangement of physical cues in food environments may result in desired or undesired effects. Particularly, we demonstrated that a single element in the food environment (the relative availability of a specific food in that chapter) may

lead to contradictory interpretations of social norms in online and lab contexts, specifically dictating the consumption of the non-targeted (undesired) food in the online context and the targeted (desired) food in the lab context. Policymakers should therefore be made aware – e.g., be trained by experts – that they may signal a certain social norm in specific environments by deciding the specific (re)arrangement of physical cues in these environments. Also, policymakers (e.g., institutions and governments) and scholars performing randomized controlled trials in this domain are recommended to assess the social norm interpretation of physical cues in food environments when testing the effectiveness of such choice architecture (or nudge) interventions; this would be helpful in determining whether the physical cues signal what they are supposed to signal. This seems especially important given that some individuals seem flexible in adapting their dietary decisions to the specific social contextual norm cue to which they are exposed, as illustrated in Chapter 5, showing that the social contextual norm cue (the served portion size in that chapter) may determine the amount that they consume 24 h later.

Regarding existing food policies, for example the national governmental policies in the Netherlands (for an overview see Djojosoeparto, Kamphuis, & Poelman (2020)), current food provision policies aimed at creating healthier food environments are often focused on food availability (e.g., the product range being offered) and food accessibility (e.g., placement of products). For example, The Netherlands Nutrition Centre has developed guidelines for healthier canteens (including worksite, school, and sports canteens), aiming to support stakeholders (e.g., directors, caterers, and canteen employees) to make their food provision healthier. To do so, three health levels have been defined (specifically bronze, silver, and gold), each level incrementally corresponding to increases in the availability and accessibility of healthier products. These guidelines may also be used as a starting point for policymakers in this domain (Netherlands Nutrition Centre, 2020; Veldhuis, Mensink, & Wolvers, 2017). In applying the findings of this dissertation to such guidelines, it is recommended to extend the focus on food availability and accessibility to the signals that are conveyed by, or connected to, available foods. For example, as discussed in Chapter 3, snacks presented in a snack bowl with (versus without) a cover may be interpreted as less salient, subsequently decreasing their likelihood of intake, and the portion sizes being served may be interpreted as a social norm (both descriptive and injunctive) influencing consumption at a later point in time (Chapter 5). Furthermore, as argued previously, changes in the relative availability of foods may also have unintended (adverse) effects, further highlighting the necessity of considering the signals surrounding available foods in initiatives aimed at supporting the development of healthier canteens and food

environments. Particularly, it is important that changes in food availability and accessibility in environments are implemented in such a way that they are interpreted as planned (intended), thereby making their desired behavior salient (focal in attention), rather than unintendedly forcing the notion that the undesired behavior is normal or acceptable. Actually, the (social norm) interpretation of physical cues may purposely be used to improve the effectiveness of such environmental strategies. To go one step further, it may even be suggested that entire adjustments in the availability and accessibility of foods are not necessary when the signals conveyed by, or connected to, available foods are taken into consideration. Ideally, in future, relevant stakeholders should be provided with certain instructions (implementation tools) on how to make changes effectively in physical cues in food environments, resulting in their intended interpretation and subsequent behavior – this may be part of current implementation strategies (see for example Evenhuis et al. (2020)).

6.7. Conclusion

This dissertation aimed to improve the understanding of how physical cues in micro food environments determine dietary decisions, by providing initial support for the proposition that physical and social aspects of food environments are intertwined. The results in this dissertation specifically suggest that physical cues in micro food environments may be interpreted as a descriptive and/or injunctive norm about normal and appropriate consumption. Particularly, the results indicate that physical cues may signal (a) social norms in generic terms about whether it is normal and/or appropriate to take food in that context (as illustrated by the presence of a cover), (b) descriptive norms about what other people typically choose in that context (as illustrated by the proportion of (plant-based) foods available), and (c) both descriptive and injunctive norms about how much others would eat and what they believe is the appropriate amount to eat in that context (as illustrated by the served portion sizes). These – what I like to call – *social contextual norm cues* seem to be widely embedded in (self-service) food environments. The findings in this dissertation further provide some preliminary support for the proposition that perceived descriptive and injunctive norms may mediate the effect of physical cues in micro food environments (specifically, served portion sizes) on (later) food consumption. Until now, empirical support for the social norm account and its embedding in food environments was largely lacking. In addition to previously considered explanatory mechanisms – such as perceived salience of foods and the perceived effort required to obtain foods – this dissertation thus contributes to this domain by showing preliminary evidence of the role of descriptive and injunctive

norms as a potential explanatory mechanism of the effect of physical cues in micro food environments on food consumption.

Supplementary materials

Chapter 2

Table S2.1. Physical cue overview showing different levels of abstraction.

Higher level physical cue category	Physical cue subcategory	Specific physical cue
Physical cues associated with descriptive social norm connotations		
Consumption traces	Food traces	Bread butt
		Crumbs
		Cut off slice of unit product
		Food traces
		Gravy edge in pan
		Gravy stains
		Greasy glow on empty part of plate
		Sauce edge in pan
		Sauce stain
		Soup stain
	Usage traces	Dented bottle
		Open cap
		Partly open flap
		Serving fork placed under product
		Bottles placed upside down
	Missing piece	Missing part of a product
		Missing pieces of a pre-cut product
	Products fallen over	Products fallen over products in container
		Products fallen over on shelf
Emptiness	Completely empty	Empty bowl
		Empty container
		Empty shelf
	Empty place	Empty place in container with products
		Empty place in shelf with products
		Empty place of stacked plates
		Empty place of stacked plates with products
		Empty place on counter with products
		Empty place on plate with product
		Empty place on tray with products
Height of stacks	Different height of stacks	Different height of stacked bowls
		Different height of stacked plates
		Different height of stacked products

Neatness of presentation	Messy presentation	Messy placement of cake server
		Messy placement of container
		Messy placement of forks
		Messy presentation of empty bowls
		Messy presentation of portion packs
		Messy presentation of products
		Messy presentation of serving cutlery
		Messy presentation of stacked plates
	Tidy presentation	Tidy presentation of products
		Tidy/clean presentation of serving spoons

Physical cues associated with injunctive social norm connotations

Approachability	Two-sided approachability	Counter approachable from two sides
		Freezer approachable from two sides
Color	Green color	Green colored containers
	Red color	Red colored arrow
		Red colored cabinet
Direction signal	Product name placement	
	Arrow on door	
Distance	Relatively large distance	Relatively large distance to products
	Relatively small distance	Relatively small distance to products
Handgrip	Handle	Handle on door
		Handle on flap
		Handle on lid
	Rotary knob	
Packaged product	Packaged product	Packaged product
		Product on takeaway plate
Presence of tableware	Presence of serving cutlery	Presence of bread knife
		Presence of cake server
		Presence of serving fork
		Presence of serving spoon
		Presence of serving tongs
		Presence of tea towel around product
	Presence of crockery	Presence of stacked plates
		Presence of empty serving bowls
		Presence of plates
		Presence of spoons

Covered/uncovered presentation	Covered presentation	Closed funnel
		Container closed with a flap
		Container closed with a lid
		Freezer closed with doors
		Heated cabinet closed with a door
		Pan closed with a lid
		Plastic wrap on product plate
		Products covered by glass dome
		Refrigerator closed with doors
		Flap on pan
		Flaps in cabinet
		Flaps in refrigerator
	Uncovered (open) presentation	Open containers
		Open bowls
Unit size determination	Fixed unit size	Fixed size of bowl
		Fixed size of cake server
		Fixed size of serving spoon
		Fixed unit size of products
		Unit size product cut in half
		Fixed size of pre-cut product
	Unfixed unit size	Squeeze bottle
		Unfixed unit size of products
Transparent/un-transparent presentation	Transparent presentation	Transparent funnel
		Transparent flap
	Un-transparent presentation	Un-transparent bowls
		Un-transparent lid
		Un-transparent container
		Un-transparent pan

Physical cues associated with both descriptive and injunctive social norm connotations

Availability	Relatively high availability[1]	High availability of product
	Relatively low availability[1]	Low availability of product
		Low number of stacked plates
	Only product available [1,2]	
Fullness	Incompletely filled[1]	Incompletely filled bowls with products
		Incompletely filled container with tableware
		Incompletely filled funnel with products
		Partly empty bottle
		Lower height of products in front
	Completely filled[1,2]	Completely filled container with products
		Completely filled counter with products
		Intact pre-cut product

Notable presentation	Upright standing product plates[1,2]	
	Elevated presentation[2]	Elevation of container Elevation of plate
	Forward-tilted presentation[2]	Forward-tilted containers Forward-tilted product plates
	Shortened container[2]	
Placement	Middle placement[1]	Bowl in the middle Container in the middle Middle placement of products in cabinet Middle placement of products in container Middle placement of products in freezer Middle placement of products in shelf Middle shelf in refrigerator Middle shelf in stand Middle placement of plates
	Under counter placement[2]	Crockery placed under the counter Products placed under the counter
	Eye level placement[2]	
	Tray level placement[2]	Tray level placement of container
	Double placement[1,2]	Double product placement Doubled size of container with products

[1] Descriptive social norm connotation. [2] Injunctive social norm connotation.

Table S2.2. Physical cue codes occurring 10 or more times.

Physical cues	Frequency
Photo A	
Covered presentation[1]	98
Tidy presentation[1]	59
Serving cutlery[1]	34
Attractive presentation	20
Clear name tag	17
Less attractive presentation	16
Dirty serving cutlery	16
Usage traces[1]	12
Photo B	
Less attractive presentation	44
Messy presentation[1]	39
Presence of serving cutlery[1]	38
Uncovered (open) presentation[1]	31
Tidy presentation[1]	24
Relatively high availability[1]	15
Variety of choice	13
Hot food	10

[1]Physical cues that corresponded with the identified subtle social norm cues in Study 1.

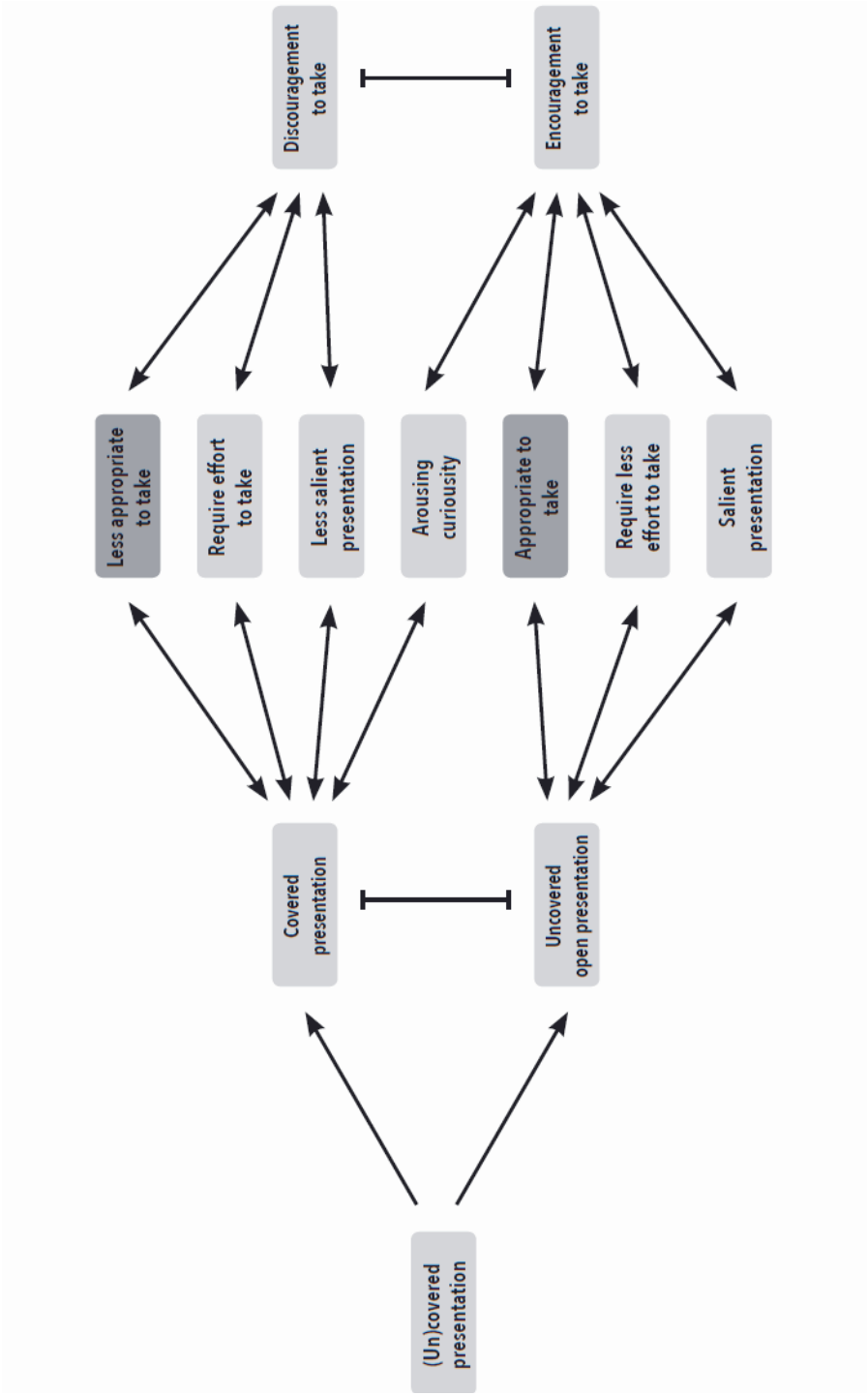

Figure S2.1. Cue-connotation structure of (un)covered presentation (dark colored connotations are associated with social norms).

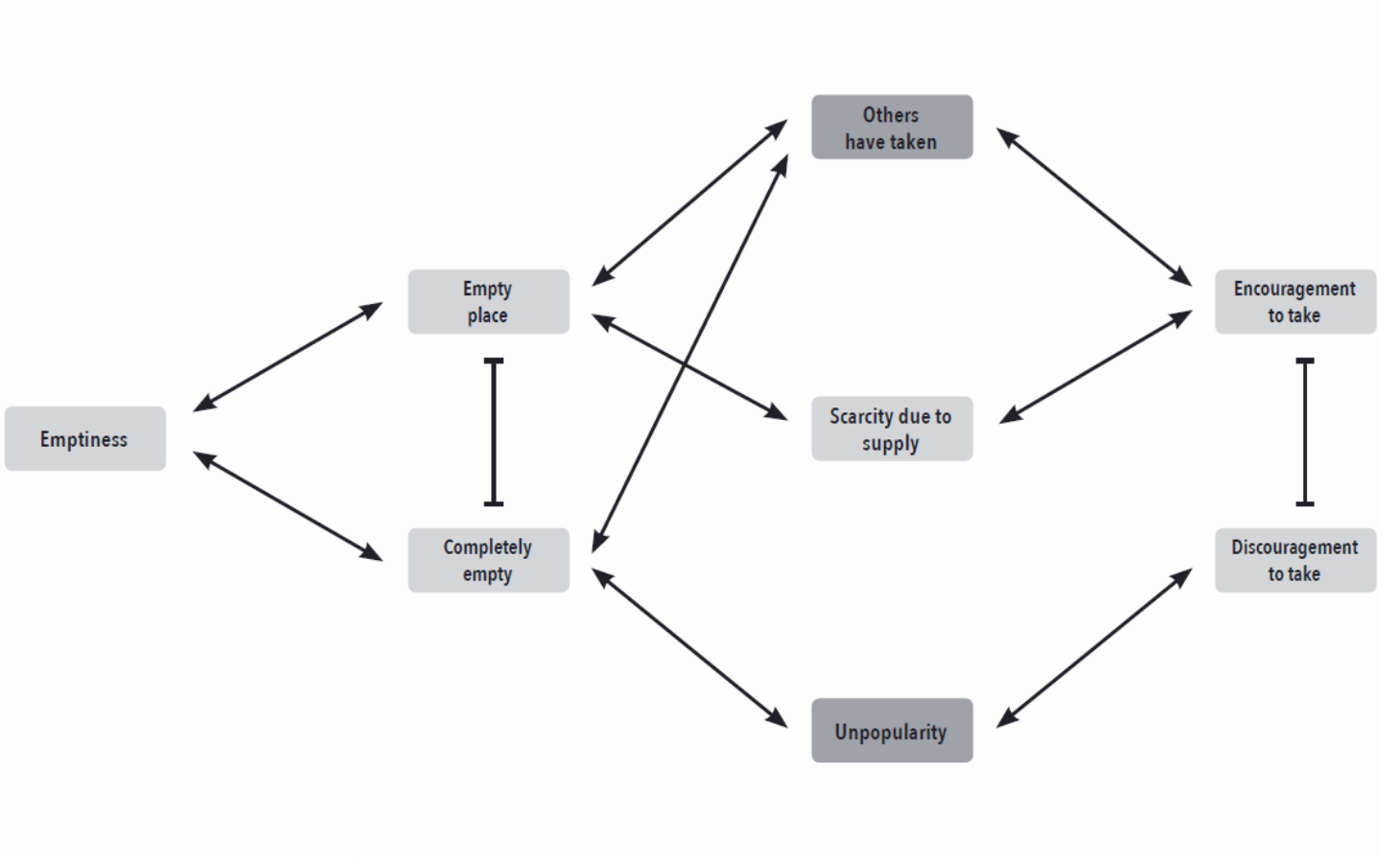

Figure S2.2. Cue-connotation structure of emptiness (dark colored connotations are associated with social norms).

Chapter 3

Methods

Study 2

Desire

Desire to eat the offered snacks was measured by asking (Stok et al. (2015), 'how much do you desire to eat [snacks] at the moment?' (1: not desire at all to 7: very much desire).

Study 3

Ambiance room

To increase their ecological validity, the experiments were conducted in an ambiance room mimicking naturalistic settings while being highly controllable. The ambiance of a grand café was mimicked in the current study by depicting photos of a grand café setting on video screens, playing background music, and the presence of houseplants and four unrelated magazines (e.g., National Geographic and Elsevier) on the table. For evaluation purposes, seven items relating to the experience of the ambiance room were used (e.g., 'the ambiance room stimulated my senses' (1: strongly disagree to 7: strongly agree), but the results were not included as they fell outside the scope of this study.

Specific liking, desire, attractiveness, and participation reward

Specific liking for the eaten snacks was measured by asking (Maas et al. (2012), 'how tasty or non-tasty did you find the [snacks] served with the coffee?' (1: very non-tasty to 7: very tasty). Participants who did not eat any snacks could tick the option 'I did not eat [snacks]'. Desire to eat the offered snacks was measured using two items that were averaged (Cronbach's α=0.96) (Stok et al. (2015)), including the item described in Supplementary materials (Methods: Study 2) and 'how much do you want to eat [snacks] at the moment?' (1: not wanting at all to 7: very much wanting). Perceptions of attractiveness was measured by stating, 'the [snacks] looked attractive' (1: strongly disagree to 7: strongly agree). As a reward for participation, participants' choice between a small bag of small gingerbread cookies and a small pack of fruit biscuits was observed. A dichotomous variable for small bags of small gingerbread cookies (yes/no) was created.

Results

Study 2

Desire

An ANCOVA testing the effect of condition on desire to eat the offered snacks, with presence of others and overall liking for the offered snacks as covariates, showed no significant difference between participants in the discouraging condition (M = 3.90, SD = 2.26, n = 29) and the control condition (M = 3.36, SD = 2.00, n = 33), $F(1, 57) = 0.75$, $p = 0.39$, $\eta_p^2 = 0.01$, $n = 61$.

Study 3

Specific liking, desire, attractiveness, and participation reward

An ANCOVA testing the effect of condition on specific liking for the eaten snacks, with general liking as a covariate, showed no significant effect (n = 97, see Supplementary Table S3.4.).

An ANCOVA testing the effect of condition on desire to eat the offered snacks, with hunger state and general liking as covariates, showed no significant effect (n = 150, see Supplementary Table S3.4.).

An ANCOVA testing the effect of condition on perceptions of attractiveness, with general liking as a covariate, showed a significant effect (n =150, see Supplementary Table S3.4.). *Post hoc* tests (Bonferroni) demonstrated that participants in the discouraging condition (M_{adj} = 4.98) reported a significantly lower attractiveness of the snacks than participants in the encouraging condition (M_{adj} = 5.84), p = 0.001 and participants in the control condition (M_{adj} = 5.69), p = 0.01. No differences in perceptions of attractiveness were observed between the control condition and the encouraging condition, p = 1.00.

Pearson chi-square analyses showed no significant difference in the chosen participation reward between the conditions. To predict the likelihood of participants choosing a small bag of small gingerbread cookies as a reward for participation based on the condition to which they were assigned (all three levels of condition were dummy coded), two binary logistic regression analyses were performed controlling for sex, hunger state, and general liking (n = 150). Sex, hunger state, and general liking were entered in block 1, and two dummy variables of condition were entered in block 2 (the encouraging condition and the control condition in the first analysis and the encouraging condition and the discouraging condition in the second analysis). No significant differences were observed (all p's > 0.60).

Table S3.1. Means, SDs, and statistics for descriptive variables per condition in the full sample (n = 194, Study 2).

	Discouraging condition (n = 95) [b]	Control condition (n = 99) [c]	Test statistic	p-value	η_p^2
	Mean (SD) or Number (%)	Mean (SD) or Number (%)			
Age (y)	45.57 (14.85)	44.78 (16.72)	$F(1, 188) = 0.12$	0.73	0.001
Sex (female)	16 (16.8%)	15 (15.2%)	$X^2(1) = 0.10$	0.75	-
Hunger state [a]	3.06 (1.79)	3.37 (1.88)	$F(1, 192) = 1.39$	0.24	0.01
Healthy eating goal [a]	5.04 (1.66)	4.94 (1.67)	$F(1, 192) = 0.19$	0.67	0.001
Weight goal [a]	4.76 (1.74)	4.67 (1.85)	$F(1, 192) = 0.13$	0.72	0.001
General liking snacks [a]	4.78 (1.81)	4.78 (1.68)	$F(1, 192) = 0.00$	1.00	0.001
Rush state [a]	3.98 (2.06)	4.35 (1.80)	$F(1, 192) = 1.82$	0.18	0.01
Presence of others (no)	83 (88.3%)	75 (76.5%)	$X^2(1) = 4.56$	0.03	-

[a] Measured on a 7-point scale (range 1–7). [b] n = 92 for age and n = 94 for presence of others (one participant misinterpreted the question and reported that the experimenters were present outside the shop). [c] n = 98 for age and presence of others (one participant did not know whether other people were present in the line at the checkout corner). Age values were missing because of an unrealistically high reported age.

Table S3.2. Means, SDs, and Pearson's correlations between main variables under study (n = 62, Study 2).

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Age (y, n = 60)	-												
2. Sex (female) [b]	0.19	-											
3. Hunger state [a]	-0.12	0.09	-										
4. Healthy eating goal [a]	0.12	0.10	-0.00	-									
5. Weight goal [a]	0.10	0.18	0.00	0.70**	-								
6. General liking snacks [a]	0.16	0.14	0.07	0.28*	0.14	-							
7. Rush state [a]	-0.24	0.08	-0.06	-0.05	-0.05	-0.18	-						
8. Presence of others (no, n = 61) [b]	0.17	-0.18	0.04	0.09	0.01	0.09	-0.15	-					
9. Perceptions of social norms [a]	-0.09	-0.06	0.00	-0.04	-0.03	0.09	-0.06	0.03	-				
10. Perceptions of effort (item 1) [a]	0.24	-0.13	0.01	0.10	-0.01	0.13	0.05	0.02	-0.50**	-			
11. Perceptions of effort (item 2) [a]	0.18	0.12	0.13	-0.25	-0.05	0.02	-0.22	-0.02	-0.25*	0.10	-		
12. Perceptions of salience [a]	-0.10	0.01	0.01	0.10	0.02	-0.01	0.29*	-0.20	-0.08	-0.07	0.46**	-	
13. Desire [a]	0.21	0.00	0.15	0.20	0.15	0.56**	0.02	0.03	0.04	-0.26*	0.02	0.10	-
Mean (or number)	40.95	11	3.58	5.05	4.66	5.26	4.10	53	4.05	5.03	5.03	5.60	3.61
SD (or %)	15.73	17.7%	1.97	1.69	1.86	1.59	2.10	86.9%	1.61	1.98	1.96	1.48	2.12

* $p < 0.05$. ** $p < 0.001$. [a] Measured on a 7-point scale (range 1–7). [b] Spearman correlation.

Table S3.3. Means, SDs, and Pearson's correlations between main variables under study (n = 151, Study 3).

Variable	1	2	3	4	5	6	7	8	9	10	11	12	14	15	16
1. Age	-														
2. Sex (female) [b]	-0.03	-													
3. Hunger state [a]	0.06	0.04	-												
4. Healthy eating goal [a]	0.20*	0.31**	-0.02	-											
5. Weight goal (n = 150) [a]	0.13	0.25**	-0.01	0.42**	-										
6. General liking snacks (n = 150) [a]	0.10	0.20*	0.15	0.17*	0.26**	-									
7. Amount of intake	-0.07	-0.06	0.33**	-0.06	-0.06	0.33**	-								
8. Likelihood of taking (yes) [b]	-0.10	0.02	0.36**	0.00	0.02	0.24**	0.84**	-							
9. Perceptions of social norms (n = 150) [a]	0.17*	-0.01	0.06	0.05	-0.01	0.15	0.29**	0.22**	-						
10. Perceptions of effort [a]	-0.05	0.08	-0.03	-0.07	0.01	-0.09	-0.27**	-0.20*	-0.64**	-					
11. Perceptions of salience (n = 149) [a]	0.08	0.11	0.04	0.12	0.04	0.13	0.26**	0.29**	0.35**	-0.38**	-				
12. Specific liking eaten snacks (n = 97) [a]	-0.07	0.08	-0.16	0.10	0.07	0.39**	0.24*	-	-0.00	-0.09	0.18	-			
14. Desire [a]	-0.02	0.02	0.46**	-0.06	0.03	0.43**	0.56**	0.60**	0.02	-0.08	0.19*	0.31**	-		
15. Perceptions of attractiveness [a]	0.15	0.07	0.12	0.09	0.11	0.27**	0.29**	0.42**	0.33**	-0.43**	0.36**	0.30**	0.38**	-	
16. Participation reward (small gingerbread cookies) [b]	-0.01	0.21*	0.22**	0.01	0.04	0.23**	0.30**	0.31**	0.09	-0.06	0.24**	0.11	0.40**	0.24**	-
Mean (or number)	23.83	95	3.51	5.75	4.73	5.57	8.57	99	4.94	2.51	5.54	5.78	3.48	5.50	112
SD (or %)	8.17	62.9%	1.50	0.92	1.52	1.17	12.54	65.6%	1.04	1.64	1.21	0.98	1.70	1.21	74.2%

* $p < 0.05$. ** $p < 0.001$. [a] Measured on a 7-point scale (range 1–7). [b] Spearman correlation.

Table S3.4. Means, SDs, and statistics for specific liking, desire, attractiveness, and participation reward per condition (n = 151, Study 3).

	Discouraging condition (n = 50) [b]	Control condition (n = 49) [c]	Encouraging condition (n = 52) [d]	Test statistic	p-value	η_p^2
	Mean (SD) or Number (%)	Mean (SD) or Number (%)	Mean (SD) or Number (%)			
Specific liking eaten snacks [a]	5.77 (.97)	5.88 (1.22)	5.71 (.77)	$F(2, 93) = 0.43$	0.65	0.01
Desire [a]	3.13 (1.70)	3.67 (1.72)	3.63 (1.66)	$F(2, 145) = 0.43$	0.65	0.01
Perceptions of attractiveness [a]	4.92 (1.26)	5.71 (1.29)	5.87 (.84)	$F(2, 146) = 8.12$	< 0.001	0.10
Participation reward (small gingerbread cookies)	34 (68.0%)	38 (77.6%)	40 (76.9%)	$X^2(2) = 1.49$	0.47	-

[a] Measured on a 7-point scale (range 1–7). [b] n = 22 for specific liking. [c] n = 33 for specific liking. [d] n = 42 for specific liking.

Table S.3.5. Component paths of the indirect effect of condition on likelihood of intake for perceptions of social norms, effort, and salience (*n* = 151, Study 3).

	Effect of condition on the proposed mediator	Effect of the proposed mediator on likelihood of intake
	***B* (95% CI)**	***B* (95% CI)**
Perceptions of social norms [a]	*B1* = 0.54 (0.14, 0.93) *B2* = 0.85 (0.46, 1.23) *B3* = 0.31 (-0.08, 0.70)	0.48 (1.15, 2.28)
Perceptions of effort	*B1* = -2.63 (-3.07, -2.19) *B2* = -2.54 (-2.97, -2.11) *B3* = 0.09 (-0.34, 0.52)	-0.35 (0.57, 0.87)
Perceptions of salience [b]	*B1* = 0.60 (0.12, 1.07) *B2* = 0.74 (0.27, 1.20) *B3* = 0.14 (-0.33, 0.61)	0.57 (1.30, 2.42)

[a] *n* = 150 for perceptions social norms and *n* = 149 for perceptions of salience.

Note. B1 = discouraging condition versus control condition, *B2* = discouraging condition versus encouraging condition and *B3* = control condition versus encouraging condition.

Chapter 4

Methods

Study 1

Monte Carlo power analysis for indirect effects

A Monte Carlo power analysis for indirect effects was performed through an online application (Schoemann et al., 2017). The results show that a power of 0.80 ($p < 0.05$) is reached with 143 participants in a model with two parallel mediators. Building on the correlations indicated in previous studies (Raghoebar, Haynes, et al., 2019; Raghoebar et al., 2020a), we assumed correlations of r = 0.4 between the independent variable X, and the mediators M, and the dependent variable Y. We assumed correlations of r = 0.45 between the mediators M and the dependent variable Y, and correlations of r = 0.5 between the mediators themselves. As we planned to include three mediators in our analyses (i.e., perceptions of salience, descriptive norms, and injunctive norms) and to exclude participants who identified the study aim, we increased the sample size to 200 participants (roughly 100 participants in each condition).

Online pilot study: Food options

In total, 123 Dutch students and employees of Wageningen University and Research consented to participate in the online pilot study and gave permission to use the obtained data, of which 100 participants were included in the analytic sample (88% students, 83% female, M age = 23.66 years, SD = 5.41)[7]. Participants who considered themselves as vegetarians were ineligible to participate in the study. Seven different front of pack images of plant-based burgers (e.g., lentil burgers and vegetable burgers) and 13 different front of pack images of animal source burgers (e.g., beef burgers and chicken burgers) were included in the pilot study. All products were from the same Dutch private label brand and included two units (i.e., burgers). Participants were instructed to imagine themselves eating the shown burgers with a bun while rating the different burgers on liking ('how tasty do you think this burger is?' (1: Not at all tasty to 7: Extremely tasty) and familiarity ('how familiar are you with this burger?' ranging from

[7] Participants who did not complete the questionnaire were excluded from analyses (n =11), as well as participants who indicated that they considered themselves as vegetarians (n = 9) and participants who indicated any allergies or intolerances for the shown burgers (n = 3).

1: Not at all familiar to 7: Extremely familiar). The order of presentation of categories (plant-based food products and animal source food products) was (evenly) randomized using Qualtrics, as well as the order of presentation of images within each category. Two different options per category that scored highest on liking and familiarity items were selected for inclusion in the experiment, thereby variety within each category was ensured (e.g., when two different beef burgers scored highest within the animal source foods category, only the beef burger that scored highest was included in the experiment). The plant-based burgers included were vegetarian grilled burgers (based on soy protein and wheat protein: 180 g, 279 kcal; M liking = 4.46 (SD = 1.28), M familiarity = 2.49 (SD = 1.70)) and vegetable burgers (vegetable mix including carrots, garden peas, corn and bell pepper: 200 g, 340 kcal; M liking = 4.54 (SD = 1.40), M familiarity = 2.76 (SD = 1.95)). The animal source burgers included were beef hamburgers (200 g, 530 kcal; M liking = 5.49 (SD = 1.21), M familiarity = 5.42 (SD = 1.77)) and chicken burgers (205 g, 584 kcal; M liking = 5.13 (SD = 1.29), M familiarity = 4.42 (SD = 2.05)).

Hunger, liking, familiarity, and frequency of meat consumption

Hunger was measured by asking: 'How hungry do you feel right now?' (1: Not at all hungry to 7: Extremely hungry).

Liking was measured by asking: 'How tasty do you think this [food option] is?' (1: Not at all tasty to 7: Extremely tasty). Two single scores were calculated, with the scores including the sum of (a) two liking ratings of plant-based foods and (b) two liking ratings of animal source foods.

Familiarity was measured by asking: 'How familiar are you with this [food option]?' (1: Not at all familiar to 7: Extremely familiar). Two single scores were calculated, with the scores including the sum of (a) two familiarity ratings of plant-based foods and (b) two familiarity ratings of animal source foods.

Frequency of meat consumption was measured by asking (De Boer et al., 2007): 'How many days per week do you usually eat your main meal with meat (including chicken)?' (0: Never to 7: Daily).

Exclusion criteria

The quality control question stated (Feitosa et al., 2015): 'For quality control purposes, please enter 'D' as the answer to this question' (answer options: A, B, C, D, E, F, G). A dichotomous variable was created with two categories: correct and incorrect.

Awareness of the study aim was measured by asking (Raghoebar, Haynes, et al., 2019): 'What do you think the aim of the study was?' (open-ended question).

Participants who connected the increased availability of products to food choice or salience and normality measures were identified as having guessed the study aim (independently rated by two researchers with 100% agreement).

Study 2

Monte Carlo power analysis for indirect effects

A Monte Carlo power analysis for indirect effects was performed through an online application (Schoemann et al., 2017). The results showed that a power of 0.85 ($p < 0.05$) is reached with 315 participants in a model with two parallel mediators. Building on the correlations indicated in Study 1 (Supplementary Table S4.1.), we assumed correlations of r = 0.3 between the independent variable X, and the mediators M, and the dependent variable Y. We assumed correlations of r = 0.30 between the mediators M and the dependent variable Y, and correlations of r = 0.40 between the mediators themselves. As we planned to include three mediators in our analyses (i.e., perceptions of salience, descriptive norms, and injunctive norms), and to exclude participants who considered themselves as vegetarians and who identified the study aim, we expected a medium effect size.

Online pilot study: Food options

The online pilot study followed the same procedure as the pilot study described for Study 1. In total, 80 Dutch students and employees of Wageningen University and Research consented to participate in the pilot study and gave permission to use the obtained data, of which 60 female participants were included in the analytic sample (86.7% students, M age = 23.50 years, SD = 4.26)[8]. Participants who considered themselves as vegetarians were ineligible to participate in the study. Three different front of pack images of plant-based pasta sauces (e.g., Basilico with basil) and three different front of pack images of animal source pasta sauces (e.g., Bolognese with beef) were included in the pilot study. All products were from the same A-label brand (Grand'Italia) and contained the same amount (260 g). Participants were instructed to imagine themselves eating the shown pasta sauces with pasta (carbohydrates) while rating the pasta sauces on liking and familiarity items. Two different options per category that scored highest on these items were selected for inclusion in the

[8] Participants who did not complete the questionnaire were excluded from analyses (n = 3), as well as male participants (n = 12), participants who indicated to consider themselves as vegetarians (n = 3) and participants who indicated any allergies or intolerances for the shown pasta sauces (n = 2).

experiment. The plant-based pasta sauces included were Basilico with basil (tomato sauce with basil: 260 g, 187 kcal; M liking = 5.72 (SD = 1.20), M familiarity = 4.73 (SD = 2.01)) and Toscana with sundried tomatoes (tomato sauce with sundried tomatoes: 260 g, 231 kcal; M liking = 5.02 (SD = 1.35), M familiarity = 3.02 (SD = 1.89)). The animal source pasta sauces included were Bolognese with beef (tomato sauce with beef: 260 g, 265 kcal; M liking = 4.92 (SD = 1.20), M familiarity = 3.78 (SD = 1.98)) and Carbonara with pancetta (cream sauce with bacon: 260 g, 569 kcal; M liking = 4.10 (SD = 1.62), M familiarity = 3.35 (SD = 1.95)).

Results

Study 1

Sensitivity analysis

Only results of primary analyses that were significantly impacted by the inclusion of significantly correlated covariates were reported (see Supplementary Table S4.1. for the correlations).

The results of an ANCOVA showed that the significant effect of condition on descriptive norms regarding plant-based foods disappeared ($F(1, 175) = 1.75$, $p = 0.19$, $\eta_p^2 = 0.01$) when we controlled for sex, education, liking for plant-based and animal source foods, familiarity with plant-based foods, meat attachment, and frequency of meat consumption.

The results of a linear regression showed that the effect of condition on perceptions of descriptive norms regarding plant-based foods was no longer significant ($B = -0.41$, 95% CI (-1.03, 0.20)) when we controlled for sex, education, liking for plant-based and animal source foods, familiarity with plant-based foods, meat attachment, and frequency of meat consumption; nor were the results of a logistic regression examining the effect of descriptive norms regarding plant-based foods on hypothetical food choice any longer significant ($B = 0.13$, 95% CI (0.88, 1.48)) when we controlled for sex, liking for plant-based and animal source foods, familiarity with plant-based foods, meat attachment, and frequency of meat consumption. Consequently, conditions for mediation were no longer met.

Study 2

Additional mediation results

Relative to the increased animal source foods condition, physical exposure to an equal availability of plant-based and animal source foods did not indirectly affect food choice through perceptions of descriptive norms regarding either plant-based (relative indirect effect = 0.08, SE = 0.07, 95% CI (-0.03, 0.25)) or animal source foods (relative indirect effect = 0.04, SE = 0.06, 95% CI (-0.06, 0.16)). Relative to the control condition, physical exposure to an increased availability of plant-based foods did not indirectly affect food choice through perceptions of descriptive norms regarding either plant-based (relative indirect effect = 0.06, SE = 0.06, 95% CI (-0.06, 0.20)) or animal source foods (relative indirect effect = 0.10, SE = 0.07, 95% CI (-0.01, 0.25)).

Sensitivity analysis

Only results of primary analyses that were significantly impacted by the inclusion of significantly correlated covariates were reported (see Supplementary Table S4.3. for the correlations).

The results of an ANCOVA and post-hoc Bonferroni-corrected pairwise comparisons examining the effect of condition on perceptions of descriptive norms regarding animal source foods showed that, when we controlled for liking for, and familiarity with, animal source foods, the effect between the control condition and the plant-based foods condition became marginally significant (in addition to the significant effect between the increased animal source versus the plant-based foods condition). Compared to participants in the control condition, participants who were physically exposed to an increased availability of plant-based foods reported a marginally significantly lower descriptive norm regarding animal source foods (p = 0.09).

The results of a multiple linear regression examining the effect of condition on perceptions of descriptive norms regarding animal source foods showed that, when we controlled for liking for, and familiarity with, animal source foods, the effect between the control condition and the plant-based foods condition became significant *(B3* = -0.67, 95% CI (-1.27, -0.07)). However, the results of a logistic regression showed that the effect of descriptive norms regarding plant-based foods on food choice was no longer significant (B = -0.07, 95% CI (0.80, 1.08)) when we controlled for liking for plant-based and animal source foods, familiarity with plant-based and animal source foods, meat attachment, and frequency of meat consumption; nor were the results of a logistic regression examining the effect of descriptive norms regarding animal source foods on

food choice any longer significant (*B* = -0.01, 95% CI (0.84, 1.17)) when we controlled for liking for plant-based and animal source foods, familiarity with plant-based and animal source foods, meat attachment, and frequency of meat consumption. Consequently, conditions for mediation were no longer met.

Probing the significant interaction between condition (increased animal source versus plant-based foods condition) and meat attachment on food choice showed that, when we controlled for liking for plant-based and animal source foods, familiarity with plant-based and animal source foods, and frequency of meat consumption, among participants who reported a high meat attachment (1 SD above the mean), increasing the availability of plant-based (versus animal source) foods marginally significantly (rather than significantly) increased the likelihood of selecting a plant-based food option (*B* = 1.19, SE = 0.65, 95% CI (-0.07, 2.46), *p* = 0.06). Conversely, among participants who reported a low meat attachment (1 SD below the mean), increasing the availability of plant-based (versus animal source) foods marginally significantly decreased the likelihood of selecting a plant-based food option (*B* = -1.34, SE = 0.70, 95% CI (-2.71, 0.04), *p* = 0.06).

Table S4.1. Pearson correlations between primary variables (n = 184, Study 1).

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Age (y)	-																	
2. Sex (female) [a]	.10	-																
3. Nationality (Dutch) [a]	-.09	-.02	-															
4. Education (academic education) [a]	.50**	.13	-.06	-														
5. Hunger	.07	-.06	-.06	.06	-													
Liking:																		
6. Plant-based foods	.00	.20**	-.03	.02	.10	-												
7. Animal source foods	-.25**	-.13	-.10	-.14	.02	-.16*												
Familiarity:																		
8. Plant-based foods	.07	-.05	.05	.06	.08	.39**	-.03	-										
9. Animal source foods	-.04	-.12	.04	.05	.02	.04	.31**	.25**	-									
10. Meat attachment	-.14	-.36**	.06	-.10	.13	-.50**	.35**	-.17*	.11	-								
11. Frequency of meat consumption	-.17*	-.27**	.15*	-.21**	-.06	-.47**	.27**	-.29**	.02	.62**	-							
12. Hypothetical food choice [a]	.01	.26**	-.03	.11	-.06	.34**	-.18*	.27**	-.06	-.35**	-.32**	-						
Perceptions of salience:																		
13. Plant-based foods	.08	.11	-.07	.02	.18*	.34**	-.21**	.17*	-.09	-.28**	-.18*	.25**	-					
14. Animal source foods	-.09	-.01	-.10	.06	.00	-.10	.24**	-.06	.26**	.30**	.17*	-.17*	-.05	-				
Perceptions of descriptive norms:																		
15. Plant-based foods	.12	.32**	-.02	.20**	.09	.43**	-.30**	.18*	-.10	-.35**	-.27**	.28**	.27**	-.09	-			
16. Animal source foods	-.04	.02	.01	.03	-.06	-.14	.39**	-.07	.30**	.21**	.19**	-.28**	-.18*	.42**	-.31**	-		
Perceptions of injunctive norms:																		
17. Plant-based foods	.01	.07	-.01	.07	.09	.29**	-.10	.16*	.09	-.18*	-.15*	.28**	.27**	-.07	.42**	-.24**	-	
18. Animal source foods	-.12	-.15*	.10	-.05	-.00	-.18*	.27**	-.03	.23**	.23**	.14	-.14	.03	.20**	-.18*	.35**	.02	-
Mean (or number)	27.30	58	173	53	3.40	7.52	10.88	4.87	10.51	4.52	5.72	24	7.78	9.60	6.31	10.25	6.13	7.72
SD (or %)	9.26	31.5%	94.0%	28.8%	1.60	2.60	1.77	3.18	2.97	1.15	1.70	13.0%	2.33	2.16	2.42	1.84	2.77	2.87

* $p < 0.05$. ** $p < 0.01$. [a] Spearman correlation.

Table S4.2. Individual components of the indirect effect of condition on hypothetical food choice for perceptions of salience, descriptive norms, and injunctive norms (n = 184, Study 1).

	Condition–mediator relationship [a]	Mediator–hypothetical food choice relationship [b]
	B (95% CI)	*B* (95% CI)
Perceptions of salience		
Plant-based foods	-0.33 (-1.00, 0.35)	0.33 (1.14, 1.71)
Animal source foods	0.18 (-0.45, 0.81)	-0.23 (0.65, 0.97)
Perceptions of descriptive norms		
Plant-based foods	-0.85 (-1.54, -0.15)	0.34 (1.17, 1.69)
Animal source foods	0.40 (-0.13, 0.94)	-0.42 (0.52, 0.84)
Perceptions of injunctive norms		0.30 (1.15, 1.59)
Plant-based foods	0.02 (-0.79, 0.82)	
Animal source foods	-0.21 (-1.04, 0.63)	-0.14 (0.75, 1.00)

[a] Linear regression. [b] Logistic regression.

Table S4.3. Pearson correlations between primary variables (n = 276, Study 2).

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. Age (y)	-																		
2. Time of the day	0.03	-																	
3. Nationality (Dutch) [a]	-0.10	0.07	-																
4. Education (academic education) [a]	-0.27**	-0.04	0.05	-															
5. Hunger	0.02	0.08	0.01	0.03	-														
Liking:																			
6. Plant-based foods	0.11	0.01	0.02	0.02	0.18**	-													
7. Animal source foods	0.00	0.08	0.07	-0.14*	0.13*	0.09	-												
Familiarity:																			
8. Plant-based foods	0.19**	-0.03	0.15*	-0.06	0.08	0.46**	0.07	-											
9. Animal source foods	-0.03	0.02	0.13*	-0.03	0.10	0.11	0.53**	0.37**	-										
10. Meat attachment	-0.09	0.17**	-0.01	-0.11	0.07	-0.03	0.28**	-0.12*	0.08	-									
11. Frequency of meat consumption	-0.14*	0.08	-0.09	-0.08	0.03	-0.03	0.17**	-0.11	0.04	0.58**	-								
12. Food choice [a]	0.05	-0.03	0.03	0.09	0.01	0.37**	-0.46**	0.21**	-0.26**	-0.29**	-0.22**	-							
Perceptions of salience:																			
13. Plant-based foods	0.21**	0.01	0.06	-0.02	0.14*	0.46**	-0.15*	0.29**	0.01	-0.16**	-0.18**	0.33**	-						
14. Animal source foods	-0.03	0.03	0.04	-0.01	0.18**	-0.04	0.35**	-0.10	0.23**	0.05	0.05	-0.26**	0.01	-					
Perceptions of descriptive norms:																			
15. Plant-based foods	0.20**	-0.07	0.04	-0.02	0.13*	0.35**	-0.10	0.38**	0.05	-0.08	-0.10	0.20**	0.56**	-0.01	-				
16. Animal source foods	-0.03	-0.09	0.03	-0.05	0.05	0.08	0.34**	0.04	0.31**	0.06	-0.01	-0.17**	0.07	0.31**	0.00	-			
Perceptions of injunctive norms:																			
17. Plant-based foods	0.22**	-0.07	-0.01	-0.14*	0.11	0.32**	-0.00	0.40**	0.12	-0.05	-0.12	0.08	0.45**	0.02	0.63**	0.02	-		
18. Animal source foods	0.08	0.01	0.04	-0.11	0.08	0.04	0.29**	0.05	0.30**	0.06	-0.05	-0.16**	0.08	0.29**	-0.02	0.57**	0.23**	-	
19. Perceived autonomy	-0.01	0.00	-0.04	-0.05	0.12*	0.38**	0.21**	0.18**	0.23**	-0.01	-0.10	0.14*	0.19**	0.19**	0.16**	0.26**	0.18**	0.13*	-
Mean (or number)	47.22	13:49	268	19	3.36	9.69	8.99	6.91	7.78	4.29	5.69	149	8.95	9.22	9.00	9.34	8.21	8.39	5.67
SD (or %)	15.38	2:09	97.1%	6.9%	1.68	2.61	2.95	3.67	3.80	1.02	1.68	54.0%	2.59	2.47	2.41	2.26	2.72	2.59	1.07

* $p < 0.05$. ** $p < 0.01$. [a] Spearman correlation.

Table S4.4. Individual components of the indirect effect of condition on food choice for perceptions of salience, descriptive norms, and injunctive norms (*n* = 276, Study 2).

	Condition–mediator relationship [a]	Mediator–food choice relationship [b]
	B **(95% CI)**	***B*** **(95% CI)**
Perceptions of salience		
Plant-based foods	*B1* = 0.21 (-0.55, 0.98)	
	B2 = 0.08 (-0.68, 0.83)	0.30 (1.21, 1.50)
	B3 = 0.14 (-0.61, 0.88)	
Animal source foods	*B1* = 0.28 (-0.45, 1.01)	
	B2 = 0.29 (-0.43, 1.01)	-0.23 (0.71, 0.88)
	B3 = -0.01 (-0.72, 0.70)	
Perceptions of descriptive norms		
Plant-based foods	*B1* = 0.85 (0.14, 1.55)	
	B2 = 0.50 (-0.20, 1.20)	0.16 (1.06, 1.31)
	B3 = 0.35 (-0.34, 1.03)	
Animal source foods	*B1* = -0.89 (-1.54, -0.23)	
	B2 = -0.25 (-0.90, 0.41)	-0.15 (0.77, 0.96)
	B3 = -0.64 (-1.28, 0.001)	
Perceptions of injunctive norms		
Plant-based foods	*B1* = 0.46 (-0.34, 1.26)	
	B2 = 0.08 (-0.71, 0.87)	0.05 (0.97, 1.15)
	B3 = 0.38 (-0.40, 1.16)	
Animal source foods	*B1* = -0.44 (-1.20, 0.32)	
	B2 = 0.03 (-0.72, 0.79)	-0.13 (0.80, 0.97)
	B3 = -0.48 (-1.22, 0.27)	

[a] Multiple linear regression. [b] Logistic regression. Note: *B1* = increased animal source foods condition versus increased plant-based foods condition. *B2* = increased animal source foods condition versus control condition. *B3* = control condition versus increased plant-based foods condition.

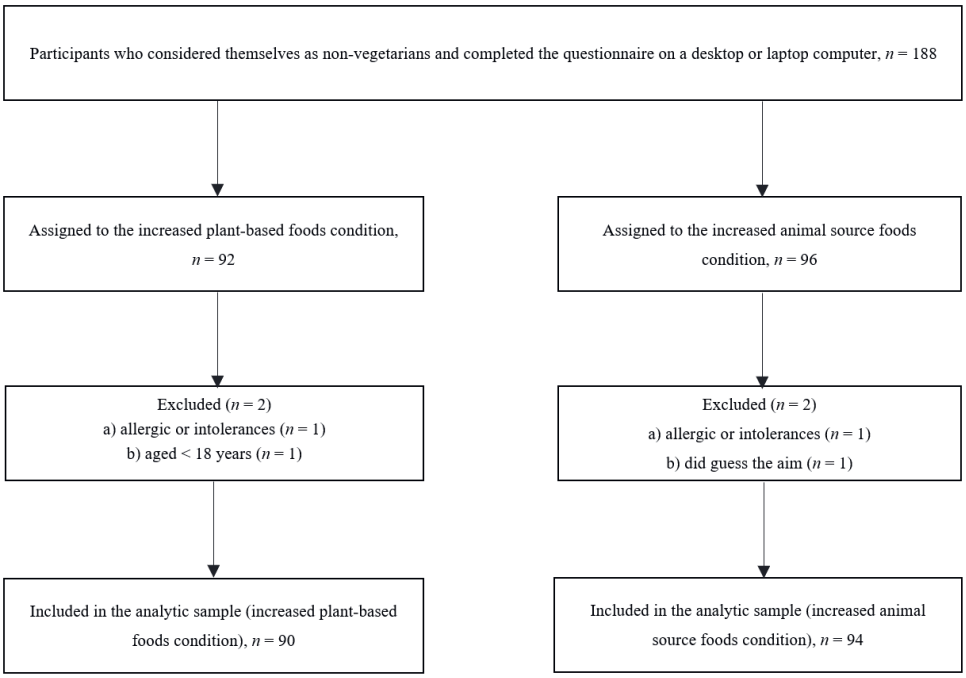

Figure S4.1. Participant flowchart (Study 1).

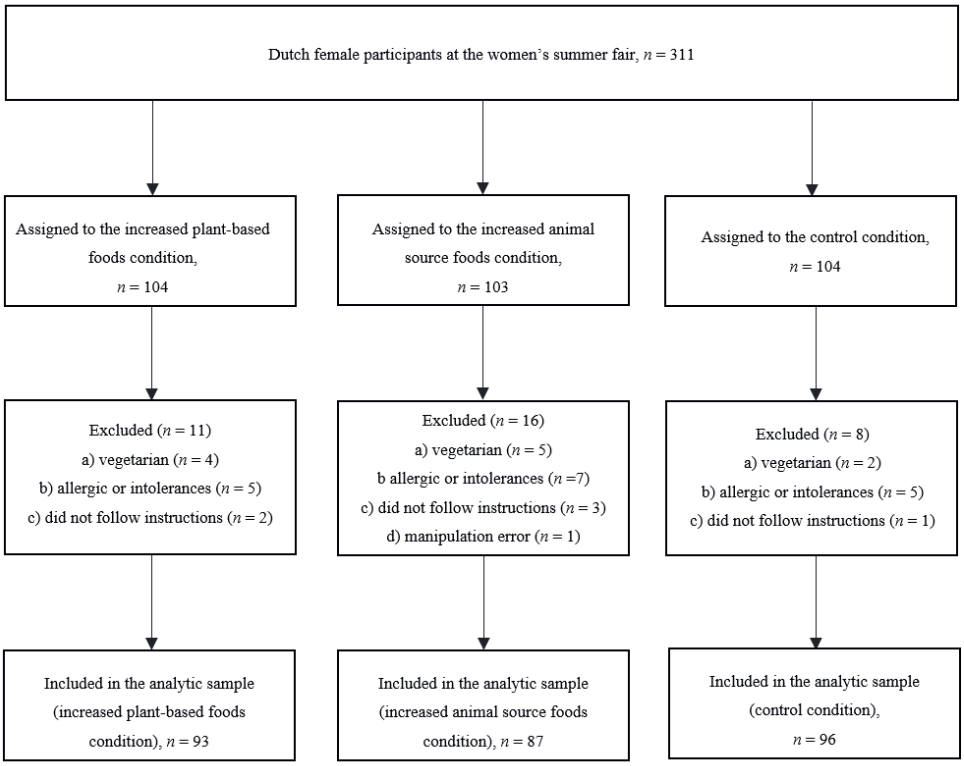

Figure S4.2. Participant flowchart (Study 2). The main reason for exclusion because of noncompliance with the instructions was quitting during the experiment and/or being incapable of filling in the questionnaire. The exclusion because of a manipulation error was caused by an incorrect presentation of the availability manipulation given the condition to which the participant was assigned.

Chapter 5

Methods

Study 1

Power analysis

The sample size was determined based on a Monte Carlo power analysis for indirect effects using an online application (Schoemann et al., 2017). Power estimations indicate that in a model with two parallel mediators, a power of .80 with an alpha level of $p < 0.05$ is reached with 235 participants, assuming correlations of r = 0.3 between the independent variable X, the dependent variable Y and the mediators M. However, four parallel mediators were included in the analysis (three different norm measures and the satiety measure) and we planned to exclude participants who guessed the study aims, hence the sample size was increased to 330 participants (approximately 110 participants/condition).

Pilot study: Portion size stimuli selection

An online pilot study conducted with 20 University of Liverpool employees (65% female, M age = 28.65 years, SD = 6.29) was used to select portion size stimuli for the exposure manipulation. Participants viewed standardized images of 27 different portion sizes of each food ranging from 40% to 300% of a reference portion in 10% increments in an online questionnaire programmed in Qualtrics. The reference portion was equal to the manufacturer's recommended serving (300 g cooked lasagna (569 kcal) and 210 g cooked spaghetti (506 kcal)). Whether participants first evaluated lasagna or spaghetti was evenly randomized across participants, as was the portion size presentation sequence within each food type. For each portion size, participants indicated whether they perceived it to be a 'normal' or 'not normal' amount to eat (order of response options was evenly randomized). A relatively small portion (60% of reference portion: 180 g cooked lasagna, 341 kcal) and a relatively large portion (180% of reference portion: 540 g cooked lasagna, 1024 kcal) of lasagna that were perceived to be beyond the boundaries of a normal portion by the majority of participants were selected as stimuli for the initial exposure phase (see Figure 5.1. (main manuscript file), and see Supplementary Figure S5.1. and S5.2. for the pilot study results). Portion sizes that were outside of the range perceived as 'normal' were selected because this study aims to examine whether portion size norms adjust to these initially perceived 'not normal' smaller (versus larger) portion sizes as one could argue that the range of portion sizes initially classed as being 'normal' in size has been shifted upwards in recent decades.

Hunger and liking

Hunger was measured with one item (Robinson et al., 2016): 'think back to just before you were about to start the questionnaire today. How hungry were you?', with responses reported on a 9-point Likert scale ranging from 1 (not at all hungry) to 9 (extremely hungry).

Liking was measured with one item for the two foods separately: 'how much do you like (lasagna/spaghetti)?', with responses collected on 9-point Likert scales ranging from 1 (not at all) to 9 (very much).

Funneled manipulation check

First, participants were asked 'what image did you view in yesterday's questionnaire?', to which they responded by selecting one image from six images (three images of non-food objects: the printer image plus two filler images, and three food images: an image of lasagna plus two filler images). Participants who selected the image of lasagna in the first question were asked 'what portion size did you view in yesterday's questionnaire?', to which they responded by selecting one of the nine portion size images (as in Robinson & Kersbergen (2018)). Participants who correctly selected the 'printer' image in response to the first question, and participants in either portion size condition who both (a) selected the 'lasagna' image in the first question and (b) selected a portion that was either the same size or one size smaller or larger than the portion that they viewed in the first session, were coded as correctly recalling the manipulation.

Exclusion criteria for analysis

Awareness of the aims of the study was measured with the following open-ended question: 'what do you think the aims of the study were?' Responses were independently coded by two researchers as being aware or unaware of the aims of the study (100% agreement between researchers). Participants who linked the portion size they were exposed to in session one to portion size selection or normality measures during session two were categorized as having identified the aim of the study.

Food allergies or intolerances were assessed with the open-ended question: 'do you have any allergies, intolerances or specific dietary requirements (e.g., vegetarian)?'

Study 2

Power analysis

The sample size was determined based on a Monte Carlo power analysis for indirect effects using an online application (Schoemann et al., 2017). Power estimations indicate

that in a model with two parallel mediators, a power of 0.80 ($p < 0.05$) is reached with 99 participants. Based on the correlations observed in Study 1 and in previous research (Robinson & Kersbergen, 2018), correlations of r = 0.4 were assumed between the independent variable X, and the mediators M, and the dependent variable Y. Correlations of r = 0.5 were assumed between the mediators M and the dependent variable Y, as well as between the mediators themselves. However, four parallel mediators were included in the analysis and we planned to exclude participants who guessed the study aims, hence the sample size was increased to 140 participants (approximately 70 participants/condition).

Pilot study: Portion size stimuli selection

An online pilot study conducted with Dutch female participants was used to select portion size stimuli for the exposure manipulation, following a similar procedure to the pilot study prior to Study 1. Participants viewed standardized images of 30 different portion sizes ranging from 10% to 300% of the reference portion. The range of portions presented in the pilot study was extended to a minimum of 10% of the reference portion (compared to a minimum of 40% in the pilot study for Study 1) to avoid a floor effect, as in the pilot study for Study 1 participants' perceived 'normal' range of portions was located at the lower end of the scale. In total, 102 participants completed the pilot study, of which 52 participants were included in analyses.[9] The analytic sample comprised of Dutch female participants, including students (83%) and employees of Wageningen University and Research (M age = 23.80 years, SD = 4.12, n = 51; M BMI = 21.65, SD = 2.04, n = 51). A relatively small portion (60% of reference portion) and a relatively large portion (180% of reference portion) of lasagna that were perceived to be beyond the boundaries of a normal portion by the majority of participants were selected for the manipulation phase (see Supplementary Figure S5.1. for pilot study results). The beef lasagna served in Study 2 (Figure 5.2. (main manuscript file)) was similar in appearance to the beef lasagna shown in the pilot study and Study 1, although the nutritional value (kcal) somewhat differed (reference portion (Aldi supermarket): 300 g cooked lasagna (486 kcal)).

[9] Participants who did not follow instructions by using a mobile phone instead of a laptop or desktop computer (n = 17), males (n = 1) and participants who indicated they were following a diet or did not consume lasagna because of allergies, intolerances or dietary specific requirements (e.g., vegetarian) (n = 32) were excluded from analyses.

Filler task: mood questionnaires

To bolster the cover story, participants completed mood questionnaires before and after eating lunch. The 8-item filler mood questionnaire was programmed on Qualtrics and included items about participants' current mood (e.g., "how relaxed do you feel right now?"), items measuring appetite, and one item asking participants to report how long since they last ate. Questionnaire items were presented in an evenly randomized order.

Hunger, liking, frequency of consumption, and awareness of monitoring consumption

Hunger was measured with two items that were averaged into a single score (Robinson & Kersbergen, 2018) (Cronbach's $\alpha = 0.89$): 'how hungry do you feel right now?' (with responses on a 9-point scale ranging from 1 (not at all hungry) to 9 (extremely hungry)) and 'how full do you feel right now?' (reverse coded, with responses on a 9-point scale ranging from 1 (not at all full) to 9 (extremely full)).

Liking of lasagna was measured with one item (as in Robinson & Kersbergen (2018)): 'how much did you like the lasagna?' (with responses on a 9-point scale ranging from 1 (not at all tasty) to 9 (extremely tasty)).

Frequency of eating lasagna was measured with one item (as in Robinson & Kersbergen (2018)): 'how often do you eat lasagna?' (with responses on a 9-point scale ranging from 1 (never) to 9 (everyday)). Participants' awareness that their consumption was being monitored by the researcher was assessed with one item (as in Robinson & Kersbergen (2018)): 'did you feel that the amount of lasagna you were eating was measured by the researcher' (with responses on a 9-point scale ranging from 1 (not at all) to 9 (very much)).

Manipulation check

As in Study 1 participants were asked: 'how much of this lasagna were you served yesterday?' and were instructed to select one of the nine lasagna portion images (see Figure 5.1. (main manuscript file)). Participants who selected a portion that was either the same size or one size smaller or larger than the portion that they consumed in the first session were coded as correctly recalling the manipulation.

Exclusion criteria for analysis

Awareness of the aims of the study was assessed using the same methodology as in Study 1. Agreement for coding decisions between two independent researchers was 100%.

Adherence to abstinence requirements was measured with the following item: 'how long ago did you last eat?' (options: 30 minutes ago, 1 hour ago, 1.5 hour ago, 2 hours ago, 2.5 hours ago, 3 hours ago and longer than 3 hours ago).

Additional planned analysis strategy

As secondary analysis, two separate independent-sample *t*-tests were performed to examine the effect of portion size condition on (1) salad consumption during day 1 and (2) salad consumption during day 2. As part of the sensitivity analysis, linear regression modelling was included to test whether the effect of portion size condition on consumption during the second session was dependent on awareness of consumption being monitored by the researcher (to explore demand characteristics). Portion size condition was entered in the first step of a forced entry model and in the second step mean centered awareness of participants and mean centered condition * awareness of participants interaction was entered.

Results

Study 1

Sensitivity analysis

The statistical significance of the results did not differ after inclusion of covariates that were significantly correlated with outcome or potential mediator variables (see correlations in Supplementary Table S5.2.), except for the effect of condition on perceptions of injunctive social norms for incongruent foods (spaghetti). An ANCOVA testing this effect including sex, exposure duration and hunger as covariates, showed no significant effect ($F(2, 321) = 0.41$, $p = 0.67$, $\eta p^2 = 0.003$, $n = 327$).

Study 2

Secondary consumption analysis

Participants who were served the smaller (as opposed to the larger) portion size consumed marginally significantly more salad during session one, while salad consumption during session two did not significantly differ between participants in the smaller and larger portion size condition (see Supplementary Table S5.7.).

Sensitivity analysis

The statistical significance of the results did not differ after inclusion of covariates that were significantly correlated with outcome or potential mediator variables (see correlations in Supplementary Table S5.5.), except for the specific mediating role of descriptive social norms in the effect of portion size condition on later consumption. After controlling for age, baseline hunger (session two), liking (session two) and frequency of eating lasagna, mediation analysis still indicated a significant total indirect effect of portion size condition on later consumption via perceptions of descriptive social norms and injunctive social norms (indirect effect = 15.87, SE = 7.40, 95% CI (3.11, 31.88), proportion of total effect explained by indirect effect = 18.93%). However, both specific indirect effects were non-significant (descriptive social norms: indirect effect = 11.44, SE = 7.37, 95% CI (-0.32, 27.85), proportion of total effect explained by indirect effect = 13.64%; injunctive social norms: indirect effect = 4.43, SE = 6.54, 95% CI (-7.36, 19.15), proportion of total effect explained by indirect effect = 5.28%).

To explore the role of demand characteristics, we tested whether the effect of portion size condition on later consumption was dependent on participants' awareness of their consumption being monitored by the researcher. Consistent with primary analyses, portion size condition significantly predicted later consumption ($\beta = 0.37$, $p < 0.001$), and neither consumption the next day nor the effect of condition on next day consumption was impacted by how aware participants were of their consumption being monitored by the researcher (awareness of monitoring consumption: $\beta = 0.17$, $p = 0.52$; interaction: $\beta = -0.04$, $p = 0.87$).

Table S5.1. Component paths of the indirect effect of condition on portion size selection for each proposed mediator (n = 329, Study 1).

		Relation between condition and proposed mediator	Relation between proposed mediator and portion size selection
		B **(95% CI)**	***B*** **(95% CI)**
Perceptions of portion size normality	Lasagna	0.02 (-0.04, 0.09)	0.18 (0.15, 0.22)
	Spaghetti	0.01 (-0.04, 0.07)	0.24 (0.20, 0.27)
Perceptions of descriptive social norms	Lasagna	0.03 (-0.05, 0.10)	0.14 (0.10, 0.17)
	Spaghetti	0.05 (-0.02, 0.11)	0.14 (0.11, 0.17)
Perceptions of injunctive social norms	Lasagna	0.03 (-0.04, 0.10)	0.12 (0.09, 0.16)
	Spaghetti	0.06 (-0.001, 0.13)	0.15 (0.11, 0.18)
Personal norms	Lasagna	-0.003 (-0.07, 0.07)	0.24 (0.21, 0.27)
	Spaghetti	0.01 (-0.05, 0.07)	0.26 (0.23, 0.28)
Expected satiety	Lasagna	-0.01 (-0.07, 0.06)	0.23 (0.20, 0.25)
	Spaghetti	-0.01 (-0.07, 0.06)	0.24 (0.21, 0.26)

B = unstandardized regression coefficient. CI = confidence interval.

Table S5.2. Pearson's correlations between main variables (n = 329 [c], Study 1).

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Age (n = 325)	-																			
2. Sex (female, n = 327) [b]	.02	-																		
3. BMI (kg/m², n = 321)	.08	.02	-																	
4. Exposure duration (mm:ss)	.04	-.09	.05	-																
5. Hunger [a]	-.15**	-.06	.09	.06	-															
6. Overall-liking (lasagna) [a]	-.01	.07	.09	.04	.08	-														
7. Overall-liking (spaghetti) [a]	-.02	-.01	.07	.05	.18**	.48**	-													
8. Ethnicity (white) [b]	-.14*	-.03	-.06	.05	.04	-.02	-.11*	-												
9. Portion size selection (lasagna) [a]	-.07	-.21**	.14*	.04	.25**	.31**	.20**	.08	-											
10. Perceptions of portion size normality (lasagna) [a]	.00	-.26**	-.01	.10	.09	.07	-.04	.04	.50**	-										
11. Perceptions of descriptive social norms (lasagna) [a]	.02	-.60**	-.02	.08	.15**	.04	.04	.05	.44**	.60**	-									
12. Perceptions of injunctive social norms (lasagna) [a]	.04	-.52**	-.09	.09	.13*	-.00	-.04	.00	.36**	.64**	.81**	-								
13. Personal norms (lasagna) [a]	-.04	-.27**	.08	.04	.21**	.11*	.01	.03	.74**	.71**	.57**	.57**	-							
14. Expected satiety (lasagna) [a]	-.02	-.24**	.14*	.08	.20**	.15**	.07	.08	.74**	.63**	.51**	.47**	.81**	-						
15. Portion size selection (spaghetti) [a]	-.11*	-.29**	.16**	.08	.20**	.14*	.26**	.06	.68**	.43**	.38**	.30**	.60**	.57**	-					
16. Perceptions of portion size normality (spaghetti) [a]	.02	-.28**	-.04	.09	.11*	.01	.01	.05	.42**	.62**	.51**	.50**	.56**	.49**	.61**	-				
17. Perceptions of descriptive social norms(spaghetti) [a]	-.00	-.56**	-.08	.06	.10	.02	.05	.01	.34**	.49**	.79**	.71**	.44**	.38**	.46**	.66**	-			
18. Perceptions of injunctive social norms (spaghetti) [a]	.01	-.51**	-.09	.12*	.12*	-.02	.02	-.04	.29**	.50**	.69**	.73**	.47**	.37**	.43**	.63**	.86**	-		
19. Personal norms (spaghetti) [a]	-.09	-.31**	.05	.09	.17**	.01	.05	.02	.55**	.58**	.50**	.48**	.72**	.61**	.78**	.75**	.61**	.60**	-	
20. Expected satiety (spaghetti) [a]	-.09	-.31**	.15**	.11	.20**	.03	.07	.08	.55**	.50**	.45**	.41**	.64**	.72**	.78**	.66**	.55**	.50**	.81**	-
Mean (or number)	38.38	213	26.61	04:40	4.36	7.09	6.97	307	3.95	3.71	3.95	3.50	3.60	4.19	3.74	3.51	3.78	3.40	3.45	3.87
SD (or %)	12.03	65.1%	5.84	04:10	2.30	2.10	2.05	93.3%	2.25	1.62	1.91	1.69	1.78	1.91	1.79	1.35	1.64	1.49	1.49	1.63

* $p < 0.05$. ** $p < 0.01$. [a] Measured by a 9-point scale (range 1-9). [b] Spearman correlation. [c] n unless otherwise stated. Note: All reported means and standard deviations are untransformed scores for ease of interpretation.

Table S5.3. Portion size selection and portion size evaluations per condition on day 2 in the subsample of participants who correctly recalled the manipulation they were exposed to (n = 204, Study 1).

	Smaller portion size condition (n = 67)	Larger portion size condition (n = 33)	Control condition (n = 104)	Test statistic	p-value	η_p^2
	Mean (SD)	Mean (SD)	Mean (SD)			
Effect of condition on portion size selection						
Portion size selection [a]	3.60 (2.20)	4.55 (2.35)	3.84 (2.11)	$F(2, 201) = 1.74$	0.18	0.02
Effect of condition on perceptions of portion size normality						
Perceptions of portion size normality [a]	3.28 (1.49)	4.45 (1.44)	3.71 (1.55)	$F(2, 201) = 6.63$	0.002	0.06
Effect of condition on perceptions of descriptive norms, injunctive norms, personal norms and expected satiety						
Perceptions of descriptive norms [a]	3.46 (1.90)	4.65 (1.69)	3.94 (1.95)	$F(2, 201) = 5.08$	0.01	0.05
Perceptions of injunctive norms [a]	3.01 (1.56)	4.27 (1.70)	3.57 (1.76)	$F(2, 201) = 5.88$	0.003	0.06
Personal norms [a]	3.33 (1.91)	4.17 (1.50)	3.44 (1.71)	$F(2, 201) = 3.72$	0.03	0.04
Expected satiety [a]	3.77 (1.89)	4.76 (1.60)	4.06 (1.91)	$F(2, 201) = 3.77$	0.03	0.04

[a] Measured by a 9-point scale (range 1-9). Note: All reported means and standard deviations are untransformed scores for ease of interpretation.

Table S5.4. Component paths of the indirect effect of condition on consumption day 2 for each proposed mediator (n = 132, Study 2).

	Relation between condition and proposed mediator	Relation between proposed mediator and consumption
	B **(95% CI)**	***B*** **(95% CI)**
Perceptions of portion size normality	0.08 (-0.05, 0.21)	33.44 (17.96, 48.91)
Perceptions of descriptive social norms	0.18 (0.05, 0.32)	42.23 (24.28, 60.18)
Perceptions of injunctive social norms	0.16 (0.04, 0.28)	37.77 (18.94, 56.60)
Personal norms	0.09 (-0.06, 0.24)	40.59 (27.01, 54.18)
Expected satiety	0.09 (-0.05, 0.23)	28.59 (15.51, 41.67)

B = unstandardized regression coefficient. CI = confidence interval.

Table S5.5. Pearson's correlations between main variables (n = 132, Study 2).

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Age	-												
2. BMI (kg/m^2)	.07	-											
3. Baseline hunger (session two) [a]	.08	.02	-										
4. Liking (session two) [a]	-.17*	-.09	.16	-									
5. Frequency of eating lasagna [a]	.11	-.04	.08	-.05	-								
6. Awareness of monitoring consumption [a]	.13	.04	-.03	-.02	.12	-							
7. Nationality (Dutch) [b]	.12	.00	-.09	-.04	.08	-.09	-						
8. Consumption (grams)	.18*	-.04	.28**	.20*	.24**	.09	-.01	-					
9. Perceptions of portion size normality [a]	.02	-.12	.04	.13	.05	.12	-.06	.35**	-				
10. Perceptions of descriptive social norms [a]	-.01	.02	.12	.17*	-.01	.07	.03	.38**	.73**	-			
11. Perceptions of injunctive social norms [a]	.04	-.04	.09	.04	.03	.09	-.07	.33**	.70**	.70**	-		
12. Personal norms [a]	.00	-.13	.14	.17	.07	.17*	-.04	.46**	.82**	.71**	.75**	-	
13. Expected satiety [a]	-.10	-.04	.15	.11	.04	.14	-.05	.36**	.68**	.62**	.66**	.81**	-
Mean (or number)	20.92	21.87	7.05	6.08	5.17	6.92	125	425.84	3.20	2.82	2.92	3.18	3.80
SD (or %)	2.03	2.31	1.51	1.52	.95	2.11	94.7%	121.00	1.27	1.08	1.05	1.37	1.50

* $p < 0.05$. ** $p < 0.01$. [a] Measured by a 9-point scale (range 1-9). [b] Spearman correlation. Note: All reported means and standard deviations are untransformed scores for ease of interpretation.

Table S5.6. Portion size selection, consumption and portion size evaluations per condition on day 2 in the subsample of participants who correctly recalled the manipulation they were exposed to (n = 92, Study 2).

	Smaller portion size condition (n = 68)	Larger portion size condition (n = 24)	Test statistic	p-value	d
	Mean (SD)	Mean (SD)			
Effect of condition on consumption					
Portion size selection (grams)	401.64 (115.25)	520.10 (173.19)	$t(90) = -3.77$	< 0.001	0.89
Consumption (grams)	382.57 (104.70)	468.28 (139.47)	$t(90) = -3.15$	< 0.01	0.75
Effect of condition on perceptions of portion size normality					
Perceptions of portion size normality [a]	3.04 (1.09)	4.04 (1.60)	$t(90) = -3.07$	< 0.01	0.81
Effect of condition on perceptions of descriptive norms, injunctive norms, personal norms and expected satiety					
Perceptions of descriptive norms [a]	2.59 (1.03)	3.58 (1.09)	$t(90) = -3.93$	< 0.001	0.94
Perceptions of injunctive norms [a]	2.68 (0.91)	3.90 (1.17)	$t(90) = -4.85$	< 0.001	1.24
Personal norms [a]	2.99 (1.14)	4.15 (1.68)	$t(90) = -3.21$	< 0.01	0.89
Expected satiety [a]	3.60 (1.36)	4.77 (1.43)	$t(90) = -3.43$	< 0.01	0.85

[a] Measured by a 9-point scale (range 1-9). Note: All reported means and standard deviations are untransformed scores for ease of interpretation.

Table S5.7. Additional consumption results per condition (n = 132, Study 2).

	Smaller portion size condition (n = 68) [b]	Larger portion size condition (n = 64) [c]	Test statistic	p-value	d
	Mean (SD)	Mean (SD)			
Salad consumption day 1 (grams)	9.24 (2.05)	8.44 (2.71)	$t(117.34) = 1.90$ [a]	0.06	0.33
Salad consumption day 2 (grams)	15.96 (8.58)	16.24 (8.01)	$t(127) = -0.19$	0.85	0.03

[a] Results of a Welch's t-test. [b] n = 67 for salad consumption day 2 (because of unusual observations). [c] n = 62 for salad consumption day 2 (because of missing and usual observations).

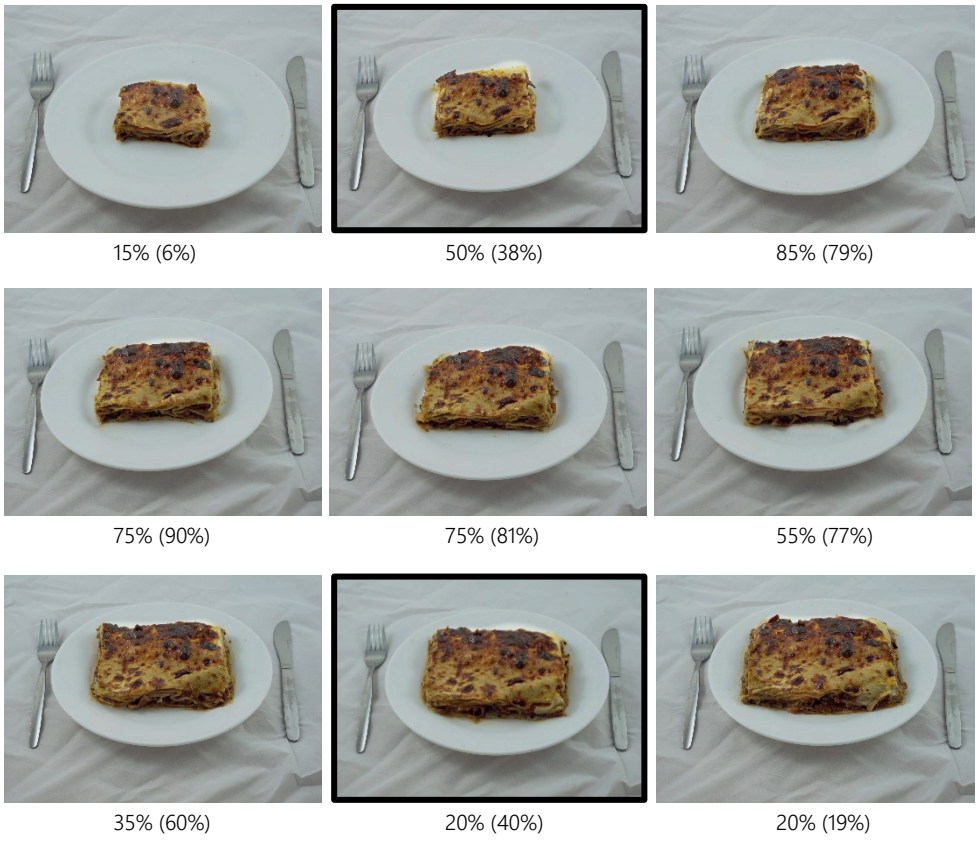

Figure S5.1. Portion size scale for lasagna based on pilot study results of Study 1 (Study 2). The percentages below the portions reflect the proportion of participants judging the portion as a 'normal' amount to eat. Results of Study 2 are shown between brackets.

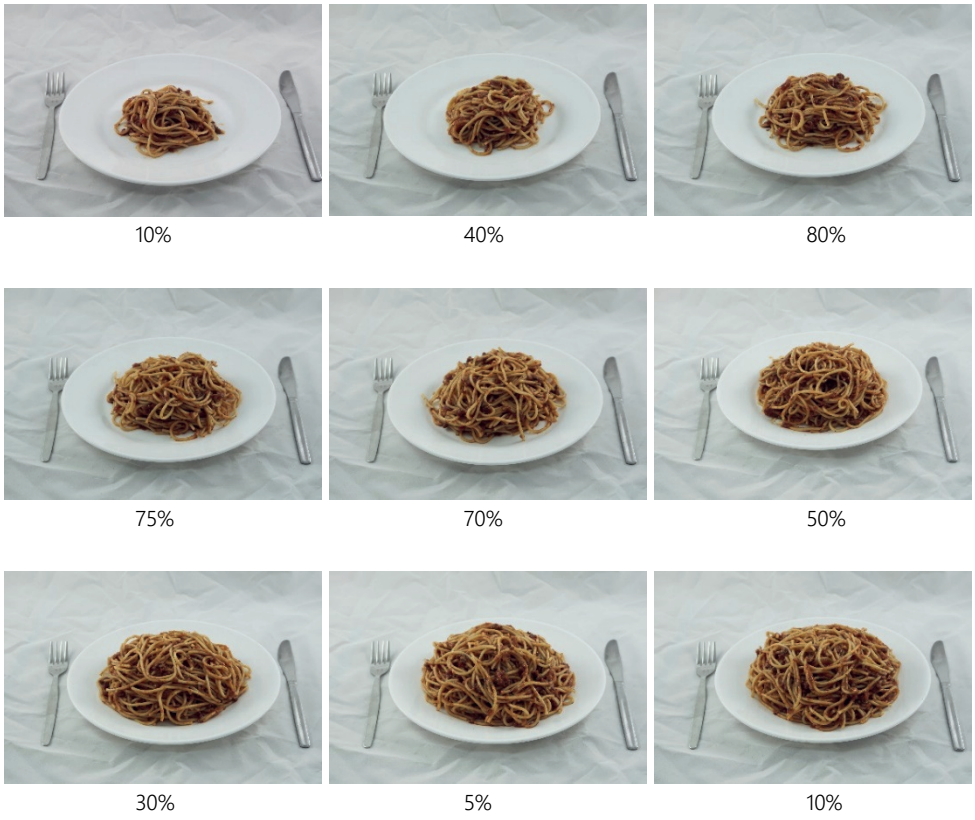

Figure S5.2. Portion size scale for spaghetti based on pilot study results of Study 1. The percentages below the portions reflect the proportion of participants judging the portion as a 'normal' amount to eat.

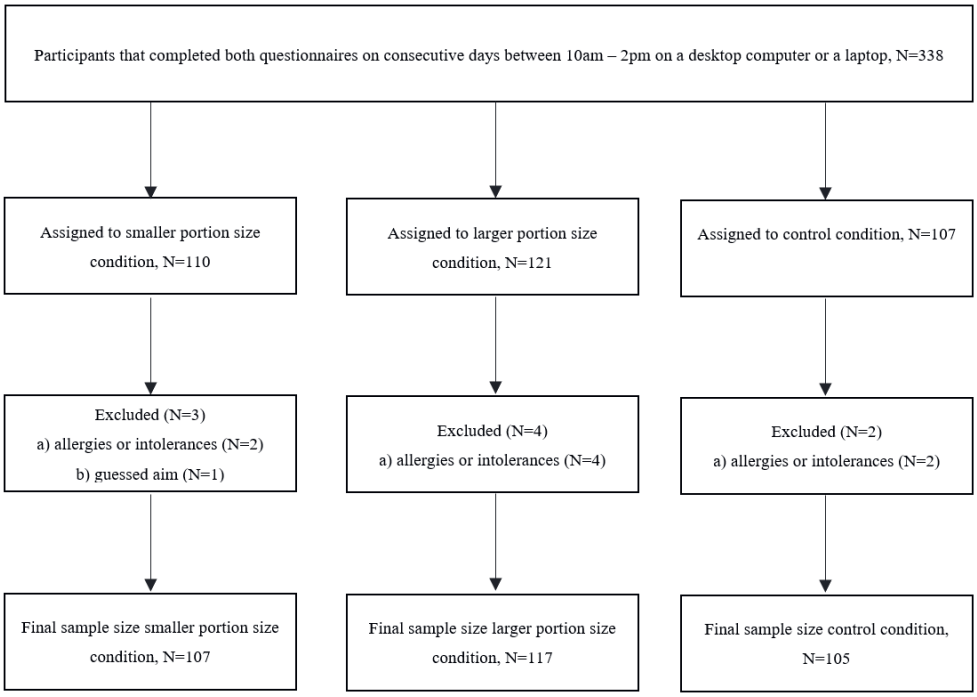

Figure S5.3. Flowchart of participants (Study 1).

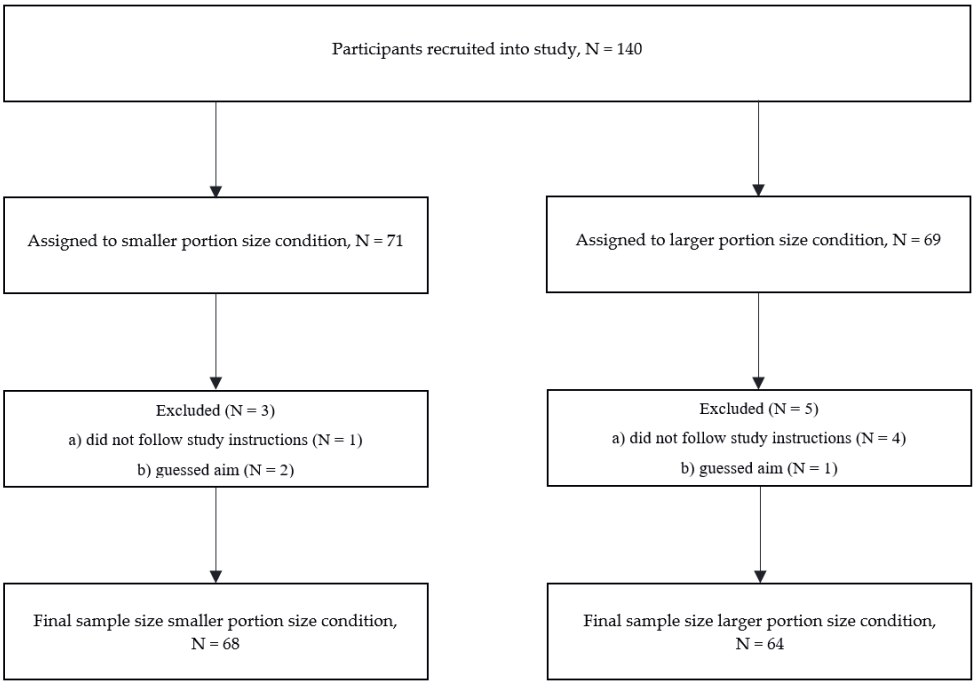

Figure S5.4. Flowchart of participants (Study 2). Reasons for exclusion because of not following study instructions included (1) not filling in the last questionnaire after consumption during session two (*n* = 1, smaller portion size condition), (2) not adhering to abstinence requirements (*n* = 3, larger portion size condition) and (3) only consuming 12 g of lasagna during session two which indicated either a measurement error or an unusual value (*n* = 1, larger portion size condition).

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Summary

In large parts of the Western world, people navigate through (live and function in) a range of food environments that may be characterized by some, or a set of, aspects (i.e., cues) within those environments that presumably encourage undesired dietary decisions, such as the abundance, easy accessibility, or strong promotion of relatively less healthy and less sustainable foods. Indeed, large numbers of people in Western society suffer from (preventable) diet-related chronic diseases, and there is proof of diet-related environmental damage. Consequently, the currently observed consumption patterns in the Netherlands, which deviate from national and global dietary guidelines, are often described as a normal response to an abnormal environment. It is as yet poorly understood how physical cues in micro food environments actually contribute to our dietary decisions however. In this dissertation, we specifically posit that physical and social aspects of food environments are intertwined, particularly by proposing that social norms are physically embedded in food environments. To our knowledge, studies empirically testing the role of social norms as an underlying mechanism of the effect of physical cues in food environments on consumption are largely lacking. Insight into such a knowledge gap may increase the understanding of the causal mechanisms explaining why we eat food that is available in physical micro food environments. This may improve (or optimize) the development of effective intervention strategies encouraging healthy and sustainable diets.

The general aim of this dissertation is to improve the understanding of how physical cues in micro food environments determine our dietary decisions. Specifically, we aim to demonstrate that social norms are inferred from physical cues in food environments. We further aim to demonstrate that social norm interpretations mediate the effect of food environment exposure on food consumption. The social norm interpretation is tested among a range of different physical cues, each chapter focusing on a specific physical cue (Chapters 3–5), thereby aiming to distinguish between perceived *descriptive* norms (beliefs about what other people do in a given situation) and perceived *injunctive* norms (beliefs about what should be done according to other people in a given situation). The relevant alternative explanations to the social norm account, known from the literature, are also taken into consideration in this dissertation. Consequently, this dissertation contributes to the understanding of the causal mechanisms explaining the effect of physical cues in micro food environments on food consumption.

Chapter 2 provides a foundation for the experimental designs applied in Chapters 3–5. To do so, an inventory was created of physical cues in Dutch outside-the-home food environments potentially communicating social norms. A set of

photographs taken in different self-service food environments (Study 1, 40 photographs, e.g., taken in worksite restaurants, roadside shops) was qualitatively analyzed using strategies from photo documentation, semiology, and grounded theory, and the findings were then cross-validated among laypeople (Study 2, *n* = 173). A great variety of physical cues were structurally linked to either or both descriptive and injunctive norm connotations (e.g., 'others have taken', 'appropriate to take', respectively). For example, 'food traces' and 'the presence or absence of serving cutlery' were considered to bear a descriptive and an injunctive norm, respectively. In light of this initial photo study, which adopted mainly an interpretative approach, it was posited that social norms are widely and physically embedded in food environments and may guide food consumption. The causal effect of physical cues in food environments on perceived social norms and food consumption still remained unclear however. Therefore, we adopted an experimental approach and examined the effect of a set of three such identified physical cues on social norm interpretations and food consumption in subsequent studies – specifically, we tested the effect of a cover (Chapter 3), relative availability (Chapter 4), and portion sizes (Chapter 5).

Chapter 3, across two quasi-experimental field studies (Study 1, 40 observation periods; Study 2, *n* = 711) and a lab experiment (Study 3, *n* =151), zooms in on a physical cue connected to available foods: the presence or absence of a cover on snack bowls, presumably illustrating an injunctive norm. Regarding the direct effect, the three studies provided evidence that a snack bowl presented with (versus without) a cover can decrease the likelihood of people taking snacks in both field and lab contexts, thus functioning as a barrier to consumption and challenging the dominant view that people simply consume whatever is available to them. Further, this research empirically supports the proposition that social norms in generic terms can be inferred from physical cues surrounding foods – specifically, we demonstrated that the presence (versus the absence) of a cover on snack bowls may decrease participants' perceptions of social norms about taking snacks. The results further suggested that perceived salience of snacks is decreased when the cover on snack bowls is present (versus absent), whereas perceived effort to obtain snacks is increased; these are the alternative explanations tested in these studies. Remarkably, only perceptions of salience mediated the effect of the cover manipulation on likelihood of consumption.

Chapter 4 examines the effect of offering an increased proportion of plant-based relative to animal source foods as an example of a physical cue potentially being interpreted as a social norm encouraging plant-based food consumption among non-vegetarians, thereby separating descriptive from injunctive norm interpretations in the norm measure (deepening/advancing the approach adopted in Chapter 3). Both an

online experiment (Study 1, *n* = 184) and a lab-in-the-field experiment (Study 2, *n* = 276) were performed, with different experimental manipulations simulating (online) supermarket settings and including different foods. These studies provided support for the proposition that spatial design – assortment structures specifically – may shift (or shape) the ideas of non-vegetarians about what other people typically choose. We particularly showed that descriptive (but not injunctive) norms about 'normal' consumption can be inferred from the number of plant-based foods available. However, the direction of the descriptive norm effect remains unclear, as we observed conflicting descriptive norm interpretations of the availability manipulation in the online setting compared to the lab-in-the-field setting. In the online setting, against our predictions, individuals interpreted the relatively high availability of plant-based (versus animal source) foods as plant-based foods being less often chosen by others. Conversely, as predicted, in the lab-in-the-field setting, a trend was observed of individuals interpreting the relatively greater availability of plant-based foods as indicating that these foods were more often chosen by others, and they reported a lower likelihood of others choosing an animal source food. Moreover, we did not observe a direct effect of exposure to a relatively greater availability of plant-based (versus animal source) foods on food choice and perceived salience of the plant-based and the animal source foods (an alternative explanation to the social norm account). Interestingly, among the subgroup of participants showing high meat attachment patterns (moderator), our results suggested that the availability of an increased proportion of physically present plant-based (versus animal source) foods increased the likelihood of a person choosing a plant-based food option.

Chapter 5 provides first support for the notion not only that social norms are embedded in physical food environments (primarily shown in the previous chapters), but also that perceived descriptive and injunctive norms may jointly underlie the relationship between physical cues in food environments and (later) food consumption. This was shown across an online experiment (Study 1, *n* = 329) and a lab-based experiment (Study 2, *n* = 132) testing the influence of being visually exposed to, or actually being served, smaller (versus larger) portion sizes on consumption of that food 24 h later. In those experiments, either hypothetical portion size selection or actual portion size selection and food intake were measured, rather than a food choice task such as mainly included in the previous chapters. The results showed that being served (but not being visually exposed to) smaller (versus larger) portion sizes resulted in individuals perceiving that others (a) would serve themselves a relatively smaller portion size (perceived descriptive norm) and (b) believe that a relatively smaller portion size is the appropriate amount to eat (perceived injunctive norm); this reduced portion size

selection and consumption of that same food a day later when they could decide the portion size themselves. We did not observe a direct effect of exposure to portion size on any of the alternative explanations tested in this chapter, specifically personal norms for portion size, expected satiety beliefs, and generic perceptions of portion size normality.

In conclusion, this dissertation provides initial support for the proposition that physical and social aspects of food environments are intertwined. The results specifically suggest that physical cues in micro food environments may be interpreted as a descriptive and/or injunctive norm about normal and appropriate consumption. Particularly, the results indicate that physical cues may signal (a) social norms in generic terms about whether it is normal and/or appropriate to take food in that context (as illustrated by the presence of a cover), (b) descriptive norms about what other people typically choose in that context (as illustrated by the proportion of (plant-based) foods available), and (c) both descriptive and injunctive norms about how much others would eat and what they believe is the appropriate amount to eat in that context (as illustrated by the served portion sizes). These – what I like to call – *social contextual norm cues* seem to be widely embedded in (self-service) food environments. The findings in this dissertation further provide some preliminary support for the proposition that perceived descriptive and injunctive norms may mediate the effect of physical cues in micro food environments (specifically, served portion sizes) on (later) food consumption. Until now, empirical support for the social norm account and its embedding in food environments was largely lacking. In addition to previously considered explanatory mechanisms – such as perceived salience of foods and the perceived effort required to obtain foods – this dissertation thus contributes to this domain by showing preliminary evidence of the role of descriptive and injunctive norms as a potential explanatory mechanism of the effect of physical cues in micro food environments on food consumption.

Samenvatting

In grote delen van de westerse wereld navigeren mensen door (leven en functioneren in) een verscheidenheid aan eetomgevingen die worden gekenmerkt door een aantal aspecten (d.w.z. cues) binnen die omgevingen die vermoedelijk ongewenste voedingsbeslissingen aanmoedigen. Zoals een overvloed aan, gemakkelijke toegang tot, of een sterke promotie van relatief minder gezonde en minder duurzame voeding. Grote aantallen mensen in de westerse samenleving lijden dan ook aan (vermijdbare) voedingsgerelateerde chronische ziekten, en er is bewijs van voedingsgerelateerde milieuschade. De huidige waargenomen consumptiepatronen in Nederland, die afwijken van nationale en internationale voedingsrichtlijnen, worden daarom vaak omschreven als een normale reactie op een abnormale omgeving. Momenteel begrijpen we echter slecht hoe fysieke cues in micro eetomgevingen (bijv., een self-service restaurant) daadwerkelijk bijdragen aan onze voedingsbeslissingen. In dit proefschrift stellen we specifiek dat fysieke en sociale aspecten van eetomgevingen met elkaar verweven zijn, met name door te stellen dat sociale normen fysiek ingebed zijn in eetomgevingen. Voor zover we weten ontbreken studies die empirisch de rol van sociale normen testen als een onderliggend mechanisme van het effect van fysieke cues in eetomgevingen op consumptie. Inzicht in een dergelijke kennisklоof kan het begrip vergroten van de causale mechanismen die verklaren waarom we voeding eten dat beschikbaar is in fysieke micro eetomgevingen. Tevens kan deze kennis de ontwikkeling van effectieve interventiestrategieën die gezonde en duurzame diëten aanmoedigen verbeteren (of optimaliseren).

Het algemene doel van dit proefschrift is om het begrip te vergroten van hoe fysieke cues in micro eetomgevingen onze voedingsbeslissingen bepalen. Concreet willen we aantonen dat sociale normen worden afgeleid uit fysieke cues in eetomgevingen. We willen verder aantonen dat interpretaties van sociale normen het effect van blootstelling aan eetomgevingen op voedselconsumptie mediëren. De interpretatie van sociale normen is getest aan de hand van een reeks verschillende fysieke cues, waarbij elk hoofdstuk zich richt op een specifieke cue (Hoofdstukken 3-5). Daarbij wordt getracht onderscheid te maken tussen waargenomen descriptieve normen (opvattingen over wat andere mensen doen in een bepaalde situatie) en waargenomen injunctieve normen (opvattingen over wat volgens andere mensen in een bepaalde situatie zou moeten worden gedaan). De relevante alternatieve verklaringen voor de sociale norm verklaring, bekend uit de literatuur, zijn ook in beschouwing genomen in dit proefschrift. Daarom draagt dit proefschrift bij aan het begrijpen van de causale mechanismen die het effect van fysieke cues in micro eetomgevingen op voedselconsumptie verklaren.

Hoofdstuk 2 biedt een basis voor de experimentele designs die in

hoofdstukken 3–5 toegepast zijn. Hiervoor is een inventarisatie gemaakt van fysieke cues in Nederlandse out-of-home eetomgevingen die mogelijk sociale normen communiceren. Een reeks foto's genomen in verschillende self-service eetomgevingen (Studie 1, 40 foto's, bijvoorbeeld genomen in bedrijfsrestaurants en on-the-go shops) werd kwalitatief geanalyseerd met behulp van strategieën uit foto documentatie, semiologie en gefundeerde theorie. De bevindingen werden vervolgens kruislings gevalideerd onder 'leken' (Studie 2, n = 173). Een grote verscheidenheid aan fysieke cues werd structureel gelinkt aan descriptieve norm connotaties (bijv., 'anderen hebben gepakt') en/of injunctieve normconnotaties (bijv., 'gepast om te pakken'). Ter illustratie, zo werden 'voedselsporen' en de 'aan- of afwezigheid van serveerbestek' respectievelijk geassocieerd met een descriptieve en een injunctieve norm. In het kader van deze eerste foto studie, die voornamelijk een interpretatieve benadering hanteerde, werd gesteld dat sociale normen op grote schaal en fysiek ingebed zijn in eetomgevingen en voedselconsumptie mogelijk kunnen sturen. Het causale effect van fysieke cues in eetomgevingen op waargenomen sociale normen en voedselconsumptie bleef echter nog onduidelijk. Daarom hanteerden we een experimentele benadering en onderzochten we het effect van een set van drie van dergelijke geïdentificeerde fysieke cues op interpretaties van sociale normen en voedselconsumptie in de volgende studies – specifiek testten we het effect van een deksel (Hoofdstuk 3), relatieve beschikbaarheid (Hoofdstuk 4) en portiegroottes (Hoofdstuk 5).

Hoofdstuk 3 zoomt in op een fysieke cue verbonden aan beschikbare voedingsmiddelen: de aan- of afwezigheid van een deksel op snackkommen, wat vermoedelijk een injunctieve norm illustreert. Dit werd onderzocht in twee quasi-experimentele veldstudies (Studie 1, 40 observatieperiodes; Studie 2, n = 711) en een laboratoriumexperiment (Studie 3, n = 151). De drie studies leverden bewijs voor een direct effect dat laat zien dat een snackkom gepresenteerd met (versus zonder) een deksel de kans kan verkleinen dat mensen snacks pakken in zowel veld- als laboratoriumcontexten. De deksel fungeert dus als een belemmering voor consumptie en betwist de heersende opvatting dat mensen gewoon consumeren wat voor hen beschikbaar is. Verder ondersteunt dit onderzoek empirisch de stelling dat sociale normen in generieke termen kunnen worden afgeleid uit fysieke cues rond eten – in het bijzonder hebben we aangetoond dat de aanwezigheid (versus de afwezigheid) van een deksel op snackkommen de perceptie van sociale normen over het pakken van snacks kan verminderen onder de deelnemers. De resultaten suggereerden verder dat de waargenomen saillantie van snacks afneemt wanneer de deksel op de snackkomen aanwezig (versus afwezig) is, terwijl de waargenomen inspanning om snacks te pakken

verhoogd is; dit zijn de alternatieve verklaringen die in deze studies zijn getest. Het is opvallend dat alleen percepties van saillantie het effect van de deksel manipulatie op de waarschijnlijkheid van consumptie medieert.

Hoofdstuk 4 onderzoekt het effect van het aanbieden van een groter aandeel plantaardige voedingsmiddelen in vergelijking met dierlijke voedingsmiddelen. Dit wordt gezien als een voorbeeld van een fysieke cue die mogelijk wordt geïnterpreteerd als een sociale norm die plantaardige voedselconsumptie onder niet-vegetariërs aanmoedigt. Daarbij onderscheiden we descriptieve en injunctieve norminterpretaties in de norm meting (om de aanpak van Hoofdstuk 3 te verfijnen). Zowel een online experiment (Studie 1, n = 184) als een laboratorium-in-het-veldexperiment (Studie 2, n = 276) werden uitgevoerd, met verschillende experimentele manipulaties die (online) supermarktomgevingen simuleerden en die verschillende voedingsmiddelen includeerden. Deze studies ondersteunden de stelling dat ruimtelijke inrichting – specifiek assortimentsstructuren – de ideeën van niet-vegetariërs over wat andere mensen doorgaans kiezen, kan veranderen (of vormen). We hebben in het bijzonder laten zien dat descriptieve (maar niet injunctieve) normen over 'normale' consumptie kunnen worden afgeleid uit het aantal beschikbare plantaardige voedingsmiddelen. De richting van het descriptieve normeffect blijft echter onduidelijk, aangezien we tegenstrijdige descriptieve norm interpretaties van de beschikbaarheidsmanipulatie in de online setting observeerden in vergelijking met de laboratorium-in-het-veldsetting. Tegen onze voorspellingen in, interpreteerden individuen in de online setting de relatief hoge beschikbaarheid van plantaardige (versus dierlijke) voedingsmiddelen als plantaardige voedingsmiddelen dat minder vaak door anderen werden gekozen. Omgekeerd, in lijn met onze voorspelling, werd in de laboratorium-in-het-veldsetting een trend waargenomen waarbij individuen de relatief hoge beschikbaarheid van plantaardige voedingsmiddelen interpreteerden als een indicatie dat deze voedingsmiddelen vaker door anderen werden gekozen, en zij rapporteerden een kleinere kans dat anderen een dierlijk voedingsmiddel zouden kiezen. Bovendien zagen we geen direct effect van blootstelling aan een relatief hoge beschikbaarheid van plantaardige (versus dierlijke) voedingsmiddelen op de voedselkeuze en op de waargenomen saillantie van de plantaardige en dierlijke voedingsmiddelen (een alternatieve verklaring voor de sociale norm verklaring). Interessant is dat onder de subgroep van deelnemers die hoge vleeshechtingpatronen vertoonden (moderator), onze resultaten suggereerden dat de beschikbaarheid van een groter aandeel van fysiek aanwezig plantaardige (versus dierlijke) voedingsmiddelen de kans vergroot dat iemand voor een plantaardige optie kiest.

Hoofdstuk 5 biedt eerste support voor het idee dat sociale normen niet alleen

zijn ingebed in fysieke eetomgevingen (voornamelijk aangetoond in de voorgaande hoofdstukken), maar ook dat waargenomen descriptieve en injunctieve normen gezamenlijk de relatie tussen fysieke cues in eetomgevingen en (latere) voedselconsumptie kunnen mediëren. Dit werd aangetoond in een online experiment (Studie 1, n = 329) en een laboratoriumexperiment (Studie 2, n = 132). We hebben de invloed getest van het visueel worden blootgesteld aan (Studie 1), of daadwerkelijk worden geserveerd van (Studie 2), kleinere (versus grotere) portiegroottes op de consumptie van datzelfde voedingsmiddel 24 uur later. In de experimenten werd ofwel een hypothetische selectie van portiegrootte gemeten (Studie 1), ofwel een daadwerkelijke selectie van portiegrootte en daadwerkelijke voedselinname (Studie 2), in plaats van een voedselkeuzetaak zoals voornamelijk gemeten in de voorgaande hoofdstukken. De resultaten toonden aan dat het serveren van (maar niet visueel blootgesteld worden aan) kleinere (versus grotere) portiegroottes ertoe leidde dat individuen dachten dat anderen (a) zichzelf een relatief kleinere portiegrootte zouden serveren (waargenomen descriptieve norm) en (b) geloven dat een relatief kleinere portiegrootte de gepaste hoeveelheid is om te eten (waargenomen injunctieve norm); dit resulteerde in een kleinere portiegrootte selectie en verminderde consumptie van datzelfde voedingsmiddel een dag later, toen de deelnemers zelf hun portiegrootte konden bepalen. We hebben geen direct effect waargenomen van blootstelling aan portiegrootte op een van de alternatieve verklaringen die in dit hoofdstuk zijn getest, namelijk persoonlijke normen voor portiegrootte, verwachte verzadigingsovertuigingen en generieke percepties van wat een normale portiegrootte is.

Concluderend biedt dit proefschrift eerste support voor de stelling dat fysieke en sociale aspecten van eetomgevingen met elkaar verweven zijn. De resultaten suggereren specifiek dat fysieke cues in micro eetomgevingen kunnen worden geïnterpreteerd als een descriptieve en/of injunctieve norm over normale en gepaste consumptie. In het bijzonder geven de resultaten aan dat fysieke cues (a) sociale normen kunnen communiceren in generieke termen over of het normaal en/of gepast is om in die context eten te pakken (zoals geïllustreerd door de aanwezigheid van een deksel), (b) descriptieve normen kunnen communiceren over wat andere mensen doorgaans kiezen in die context (zoals geïllustreerd door het aandeel (plantaardige) voedingsmiddelen dat beschikbaar is), en (c) zowel descriptieve normen en injunctieve normen kunnen communiceren over hoeveel anderen zouden eten en wat volgens hen de gepaste hoeveelheid is om te eten in die context (zoals geïllustreerd door de geserveerde portiegroottes). Deze – wat ik graag noem – sociale contextuele norm cues lijken breed ingebed in (self-service) eetomgevingen. De bevindingen in dit

proefschrift bieden verder voorlopig support voor de stelling dat waargenomen descriptieve en injunctieve normen het effect van fysieke cues in micro eetomgevingen (specifiek geserveerde portiegroottes) op (latere) voedselconsumptie kunnen mediëren. Tot nu toe ontbrak empirische support voor de sociale norm verklaring en de inbedding ervan in eetomgevingen grotendeels. Naast eerder overwogen verklarende mechanismen – zoals waargenomen saillantie van voedingsmiddelen en de waargenomen inspanning die nodig is om voedingsmiddelen te verkrijgen – draagt dit proefschrift dus bij aan dit domein door voorlopig bewijs te tonen van de rol van descriptieve en injunctieve normen als een mogelijk verklarend mechanisme voor het effect van fysieke cues in micro eetomgevingen op voedselconsumptie.

Dankwoord

"Geef een oprechte 'dank-je-wel' aan de mensen die een verschil maken in jouw leven. Waardeer het mooie om je heen."

– Dank je wel, Voor Positiviteit (2019) p. 2

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About the author


How physical cues in micro food environments
influence consumption:
A social norm account

Curriculum Vitae

Sanne Raghoebar was born on August 12, 1991 in Blaricum, the Netherlands. She received her secondary school diploma from Maaswaal College in Wijchen (2008). After following the first year of the Bachelor Engineering at the Avans University of Applied Sciences in Den Bosch, Sanne completed the Bachelor Food and Business at the HAN University of Applied Sciences in Nijmegen (2009–2013). In the second year of the Bachelor she did an internship at the journals Food Hospitality, VMT and Voeding Nu as a food writer and in the final year of her Bachelor she did an internship at Foodinc. as a market researcher. Thereafter, Sanne started with the Master Management, Economics and Consumer Studies at Wageningen University and Research, with a specialization in Marketing and Consumer Behavior (2013–2015). Her Master thesis was focused on the impact of self-crafting vegetable snacks on children's vegetable consumption; an experimental study testing the IKEA-effect in children. Thereafter, Sanne did an internship at Iglo as a marketer. After obtaining her Master's degree in 2015, Sanne started as a PhD candidate at the Strategic Communication Group at Wageningen University and Research of which the results are described in this dissertation (2015–2020). Her PhD research was part of a five-year VIDI project of professor Emely de Vet, who initiated the chair group of Consumption and Healthy Lifestyles in 2019; Sanne continued her PhD project at this chair group. In addition, Sanne was member and chair of the PhD Council of the Wageningen School of Social Sciences (2015–2016). In 2018, Sanne did a three-month research visit at the Appetite and Obesity Group at the University of Liverpool, United Kingdom. Further, she was involved in teaching and supervising BSc and MSc students, and presented her work at several (inter)national conferences. Currently, Sanne continues her journey at Wageningen University & Research as a Postdoctoral researcher at both the chair groups Consumption and Healthy Lifestyles and Education and Learning Sciences (September 2020–present). Her Postdoc project is focused on shifting towards more healthy and sustainable eating and learning behaviors among youngsters.

Publications in peer-reviewed journals

Raghoebar, S., Van Kleef, E., & De Vet, E. (2020). Increasing the proportion of plant-based foods available to shift social consumption norms and food choice among non-vegetarians. *Sustainability, 12*(13), 1–22. https://doi.org/10.3390/su12135371

Raghoebar, S., Haynes, A., Robinson, E., Van Kleef, E., & De Vet, E. (2019). Served portion sizes affect later food intake through social consumption norms. *Nutrients*, *11*(12), 1–17. https://doi.org/10.3390/nu11122845

Raghoebar, S.*, Van Rongen, S.*, Lie, R., & De Vet, E. (2019). Identifying social norms in physical aspects of food environments: A photo study. *Appetite, 143*, 2–10. https://doi.org/10.1016/j.appet.2019.104414. * Both first authors.

Raghoebar, S., van Kleef, E., & de Vet, E. (2017). Self-crafting vegetable snacks: Testing the IKEA-effect in children. *British Food Journal, 119*(6), 1301–1312. https://doi.org/10.1108/BFJ-09-2016-0443

Presentations at (inter)national conferences

Raghoebar, S. (2020, August). *Increasing the proportion of plant-based foods available to shift social consumption norms and food choice among non-vegetarians*. Paper presented at the European Health Psychology Society (EHPS), Online.

Raghoebar, S. (2020, January). *How do served portion sizes affect later food intake? The role of social consumption norms*. Paper presented at the Association for Researchers in Psychology and Health (ARPH), Egmond aan Zee, the Netherlands.

Raghoebar, S. (2019, December). *Social consumption norms underlying the effect of portion size on later food intake*. Paper presented at the ASPO (Associatie van Sociaal Psychologische Onderzoekers), Wageningen, the Netherlands.

Raghoebar, S. (2019, September). *Social and personal consumption norms underlying the effect of portion size on later food intake*. Poster presented at the European Health Psychology Society (EHPS), Dubrovnik, Croatia.

Raghoebar, S. (2019, June). *Can physical elements in food environments communicate social norms about snack intake?* Paper presented at the WINK Nudging and Beyond Conference, Utrecht, the Netherlands.

Raghoebar, S. (2019, January). *Unravelling the psychological mechanisms underlying the effect of portion size on later food intake.* Poster presented at the Association for Researchers in Psychology and Health (ARPH), Egmond aan Zee, the Netherlands.

Raghoebar, S. (2018, April). *To eat or not to eat: following the subtly communicated social norm.* Paper presented at the British Feeding and Drinking Group (BFDG), Lyon, France.

Raghoebar, S., & van Rongen, S. (2018, February). *Exploring how physical cues in food environments communicate social norms: A photo study.* Paper presented at the Etmaal conference, Ghent, Belgium.

Raghoebar, S. (2018, January). *To eat or not to eat: following the subtly communicated social norm.* Paper presented at the Association for Researchers in Psychology and Health (ARPH), Tilburg, the Netherlands.

Raghoebar, S., & Van Rongen, S. (2017, August). *Usability and validity of visual research methodology to identify social cues related to eating.* Poster presented at the European Health Psychology Society (EHPS), Padova, Italy.

Raghoebar, S. (2016, September). *The impact of self-crafting vegetable snacks on children's vegetable liking and consumption.* Paper presented at the European Health Psychology Society (EHPS), Aberdeen, Scotland.

Sanne Raghoebar
Wageningen School of Social Sciences (WASS)
Completed Training and Supervision Plan

Name of the learning activity	Department/Institute	Year	ECTS*
A) Project related competences			
Research proposal writing	WUR	2015	3.0
Writing a blog for the Marketing and Consumer Behavior blog	MCB, WUR	2017	0.1
Developing online lecture series	WUR	2017	0.3
Research visit Liverpool	Institute of Psychology, Health, and Society, University of Liverpool, UK	2018	6.0
B) General research related competences			
Introduction course	WASS	2015	1.0
Psychology of health and environmental behavior: Categorization and evaluation	WASS	2015	0.5
Sensory perception and food preference: Affective drivers of food choice	VLAG	2016	1.1
Behavioral and experimental economics, UEC51306	WUR	2016	2.0
Planning health promotion programmes: An intervention mapping approach'	CREATE, Padova, Italy	2017	0.8
Improving behavior change intervention effectiveness	EHPS, Dubrovnik, Croatia	2019	0.2
Introduction to data science with R and Rstudio for the social sciences	Summer School Radboud University, Nijmegen	2019	2.0
Food environments and public health: Interdisciplinary perspectives and prospects	KNAW, Amsterdam	2019	0.5
'The impact of self-crafting vegetable snacks on children's vegetable liking and consumption'	EHPS, Aberdeen, United Kingdom	2016	1.0
'Exploring how physical cues in food environments communicate social norms: A photo study'	NEFCA Etmaal, Ghent, BE	2018	1.0
'To eat or not to eat: following the subtly communicated injunctive social norm'	BFDG, Lyon, France	2018	1.0
'Can physical elements in food environments communicate social norms about snack intake?'	WINK Nudging conference, Utrecht	2019	1.0
'Social and personal consumption norms underlying the effect of portion size on later food intake'	BFDG, Swansea, United Kingdom	2019	1.0
'How do served portion sizes affect later food intake? The role of social consumption norms'	ARPH, Egmond aan Zee	2020	1.0
'Increasing the proportion of plant-based foods available to shift social consumption norms and food choice among non-vegetarians'	EHPS, online	2020	1.0

Name of the learning activity	Department/Institute	Year	ECTS*
C) Career related competences/personal development			
PhD council (chair)	WASS	2015-2016	4.0
Teaching assistant BSc and MSc courses and supervision BSc and MSc theses	COM and CHL, WUR	2016-2020	4.0
Advanced speaking skills	Wageningen in'to languages	2016	1.0
Training communicating with children	Wetenschapsknooppunt, WUR	2017	0.5
Programme and organizing committee of the ASPO conference 2019	ASPO, Wageningen	2019	1.0
Organizing workshops about consumer behavior	Libelle Zomerweek, Almere	2019	1.0
Total			**36.0**

*One credit according to ECTS is on average equivalent to 28 hours of study load

Colophon

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