SOCIAL CONTEXTUAL INFLUENCES ON UNHEALTHY FOOD CONSUMPTION: A PSYCHOLOGICAL APPROACH

SOFIE VAN RONGEN

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Propositions

1. The physical availability of foods does not merely permit what we eat, but it signals what we find normal to eat.
   (this thesis)

2. The perception of having less than others has greater influence on our eating behaviour than what we actually have.
   (this thesis)

3. A combination of a scarcity mindset and future time perspective is crucial for completing a PhD trajectory.

4. Publishing non-significant results from well-conducted studies is crucial for advancing scientific knowledge.

5. All empirical studies should be preregistered, not only experimental studies.

6. It is the duty of the government to intervene in the food environment because not everyone is able to make responsible choices.

7. In the fight against corona, the call to work from home contrasts with the necessity to adopt a healthy lifestyle.

Propositions belonging to the thesis, entitled

SOCIAL CONTEXTUAL INFLUENCES ON UNHEALTHY FOOD CONSUMPTION: A PSYCHOLOGICAL APPROACH

Sofie van Rongen
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Social contextual influences on unhealthy food consumption:

A psychological approach

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Social contextual influences on unhealthy food consumption:

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CHAPTER 1

GENERAL INTRODUCTION

1.1 Introduction

The social, economic, and physical environments strongly influence what people eat, yet it remains largely unknown how, why, and under what circumstances these contextual factors drive individual food consumption. This thesis investigates psychological explanations for how the physical food environment and socioeconomic context may steer unhealthy food consumption. In acknowledgement of the importance of a better understanding of individual processes within these contexts, the focus of the thesis is on psychological, interpretative processes and how these may influence eating behaviour. This thesis provides new insights into social influences embedded within food environments and into socioeconomic contextual influences that may contribute to a different response to unhealthy food environments. Part 1 focuses on the potential role of social norm perceptions in the relationship between the physical food environment and consumption. Part 2 focuses on experiences of scarcity and relative deprivation as potential explanations for the influence of the socioeconomic context on consumption, in light of socioeconomic disparities in diet.

1.2 Unhealthy diets

Diet-related diseases such as obesity, diabetes, and cardiovascular diseases are approaching epidemic levels in developed and developing countries (Blüher, 2019; Caballero, 2007; Gaziano, Bitton, Anand, Abrahams-Gessel, & Murphy, 2010). According to recent World Health Organization global estimates for 2016, of adults aged 18 years and over, 39% were overweight and 13% were obese (WHO, 2020). As this trend is clearly caused by modern diets that are high in refined grains, trans fat, sodium, and added sugars, many interventions, at policy or at individual level, have been initiated to help people to eat more healthily (Jacobson, Krieger, & Brownell, 2018; Mozaffarian, 2016). However, the exact drivers of unhealthy food consumption are not yet fully understood. Individual factors, such as innate appetite and impulsive responses, food knowledge and skills, and taste preferences, have been well-researched in food choice research (Symmank et al., 2017), but other factors that are external to the individual are increasingly recognized as essential determinants of dietary patterns (Blüher, 2019; Brug, 2008).

It has been clearly established that there are socioeconomic differences in consumption patterns (Darmon & Drewnowski, 2008; Galobardes, Morabia, & Bernstein, 2001; Yau, Adams, White, & Nicolaou, 2019) and consequently in rates of diet-related diseases (McLaren, 2007; Psaltopoulou et al., 2017). People with lower socioeconomic backgrounds tend to consume relatively less fruit, fewer vegetables, and more trans fats, sugars, and refined grains (Giskes, Turrell, van Lenthe, Brug, & Mackenbach, 2006; Livingstone et al.,

2017). To explain these differences in dietary patterns, many studies have focused on objective factors specifically related to socioeconomic living conditions, primarily financial resources available for healthy eating (Darmon & Drewnowski, 2015; Waterlander, de Mul, Schuit, Seidell, & Steenhuis, 2010) and spatial access to healthy foods (Black, Moon, & Baird, 2014). However, both of these explanations have been challenged, and it remains unclear how exactly the socioeconomic context may influence consumption.

1.3 Unhealthy physical food environment

The current physical food environment characterized by a wide availability and easy accessibility of inexpensive, energy-dense, palatable foods is widely held responsible for unhealthy dietary patterns. The popular term *obesogenic environment* has been conceived to refer to environmental factors that contribute to the development of obesity (Lake & Townshend, 2006; Swinburn, Egger, & Raza, 1999). Although the concept is complex, dynamic, and multilevel, most research on environmental determinants of diet and obesity have focused on the role of the built environment, including physical residential and work settings, as well as on the home and out-of-home food environment where people purchase and/or consume food (Kirk, Penney, & McHugh, 2010; Townshend & Lake, 2017). To obtain evidence for the notion that the current physical food environment encourages unhealthy consumption, numerous epidemiological studies have attempted to identify links between the presence of certain types of food outlets or the availability of certain foods within stores on the one hand, and diet-related diseases or food consumption on the other hand (Caspi, Sorensen, Subramanian, & Kawachi, 2012; Townshend & Lake, 2017). For example, the presence of convenience stores in a neighbourhood has been associated with lower diet quality (Rummo et al., 2015). A different line of research has examined how specific physical characteristics within a food choice setting influence food selection. For example, in a small-scale laboratory experiment, making foods less accessible by increasing the distance to foods decreased consumption of these foods (Maas, de Ridder, de Vet, & de Wit, 2012). However, evidence for a direct association between the physical food environment and diet or disease remains mixed (Caspi et al., 2012; Townshend & Lake, 2017). Although the availability of energy-dense, palatable foods is obviously an essential permissive factor in unhealthy diets, it does not fundamentally explain overconsumption (Dhurandhar, 2016). Several theoretical models have been proposed that conceptualize how elements of food environments may relate to various individual-level factors in determining eating patterns, e.g. model of nutrition environments (Glanz, Sallis, Saelens, & Frank, 2005); environmental research framework for weight gain prevention (EnRG) (Kremers et al., 2006). However, specific underlying processes between the physical food environment and dietary outcomes have not been sufficiently addressed empirically. Accordingly, there have been calls for research that

aims to reveal such processes (Drewnowski et al., 2020; Giskes, van Lenthe, Avendano-Pabon, & Brug, 2011; Lytle & Sokol, 2017; Townshend & Lake, 2017) in order to unpack the so-called black box of environmental influences on diet and health (Macintyre, Ellaway, & Cummins, 2002).

1.4 Socioeconomic context

Not only has the physical food environment with a wide availability and easy accessibility of unhealthy foods been held responsible for unhealthy dietary patterns, it has also been identified as a driver of socioeconomic disparities in diet. Unhealthy food outlets are more often available and more accessible in disadvantaged areas, suggesting that people with lower socioeconomic status are generally more exposed to unhealthy foods (Black et al., 2014; Moore & Roux, 2006). For example, in the United Kingdom, fast food outlets are more prevalent in low-income neighbourhoods (Maguire, Burgoine, & Monsivais, 2015). Another dominant contextual explanation for the trend of socioeconomic disparities in diet is the cost of foods; unhealthy, energy-dense foods are generally relatively inexpensive and so more affordable for people with low incomes (Darmon & Drewnowski, 2015; Monsivais, Aggarwal, & Drewnowski, 2012). Although both explanations are widely acknowledged, evidence for the differential role of food access and cost among different income groups is inconsistent or small in size (Caldwell & Sayer, 2019; Claassen, Klein, Bratanova, Claes, & Corneille, 2019). For example, in contrast to the USA, in the Netherlands, supermarkets are well represented in lower-income areas, indicating that healthy foods are spatially accessible for people living in these areas (Pinho et al., 2020). Moreover, disparities in spatial access to food stores appear to play only a small role in explaining socioeconomic differences in consumption (Handbury, Rahkovsky, & Schnell, 2015). Also, the extent to which food cost and the perceived affordability of healthy foods are determining factors in the diet quality of low-income groups remains questionable (e.g. Dijkstra et al., 2018; Lee, Kane, Ramsey, Good, & Dick, 2016). A healthy diet does not necessarily cost more than a less healthy diet, especially in European countries (Carlson & Frazão, 2014), and interventions that increase the food budgets of financially disadvantaged individuals show unsubstantial and even unintended, undesirable effects on diet and weight outcomes (Capacci et al., 2012; Leroy, Gadsden, González de Cossío, & Gertler, 2013; McFadden et al., 2014). Moreover, a correlational study revealed that food costs explained only 2 to 7% of the association between educational level and diet quality among an older Dutch population (Hoenink et al., 2020). Overall, there may be additional factors specific to the experience of living in a lower socioeconomic context that can help explain socioeconomic disparities in diet and disease.

1.5 This thesis

1.5.1 Influence of contexts: a psychological account

Our understanding of how an unhealthy food environment determines unhealthy food consumption, and how this is of particular relevance for low socioeconomic groups, is still limited. Scholars have largely treated contextual factors (e.g. unhealthy food access) and individual characteristics (e.g. impulsivity) as if these are two independent influences on diet and eating behaviour (Cummins, Curtis, Diez-Roux, & Macintyre, 2007; Macintyre et al., 2002). There have, however, been recent calls in the food environment, socioeconomic status, obesity, and diet quality literature for research on the intersection between contextual influences and individual perceptions and behaviours (Caldwell & Sayer, 2019; Lytle & Sokol, 2017; Penney, Almiron-Roig, Shearer, McIsaac, & Kirk, 2014). For example, it has been stressed that, to achieve a better understanding of how context influences food consumption and health, *a priori* hypothesized processes between people and their physical and social resources need to be investigated (Claassen, Klein, et al., 2019; Lytle & Sokol, 2017). Following a psychosocial perspective on health behaviours (Ogden, 1995), this thesis focuses on psychological processes that may explain how objective physical and social contexts and conditions may influence food consumption.

In this thesis, various contemporary psychological theories on motivational and decision-making processes are applied specifically to the food environment and eating behaviour. The first part of this thesis (Chapters 2 and 3) focuses on *social norms* that may be conveyed by physical food environments on the in-store/restaurant and neighbourhood level, and thereby influence consumption. In the second part (Chapters 4 and 5), the focus is on *resource scarcity* and *relative deprivation*, which may explain how an individual's deprived socioeconomic context increases unhealthier food consumption in the presence of unhealthy foods. In the next sections, these psychological theories are briefly introduced, including a proposition on how they might apply to the food context and consumption. These sections may have some overlap with subsequent chapters that present these concepts and ideas in each of the studies in more detail. Figure 1.1 presents a conceptual model of this thesis.

1.5.2 Physical food environment: social norms

The first part of the thesis focuses on the widely studied concept of social norms, as a novel, social interpretation of physical food environments. Social norms are implicit rules within a social group for what are considered acceptable behaviours, values, or beliefs of the group's members (Aronson, Wilson, & Akert, 2005). Social norms appear to be powerful drivers of various kinds of health behaviours, including eating behaviour (Higgs, 2015; Robinson, Thomas, Aveyard, & Higgs, 2014; Stok, de Vet, de Ridder, & de Wit, 2016). It is theorized that social norms influence behaviour by providing information to an individual about what

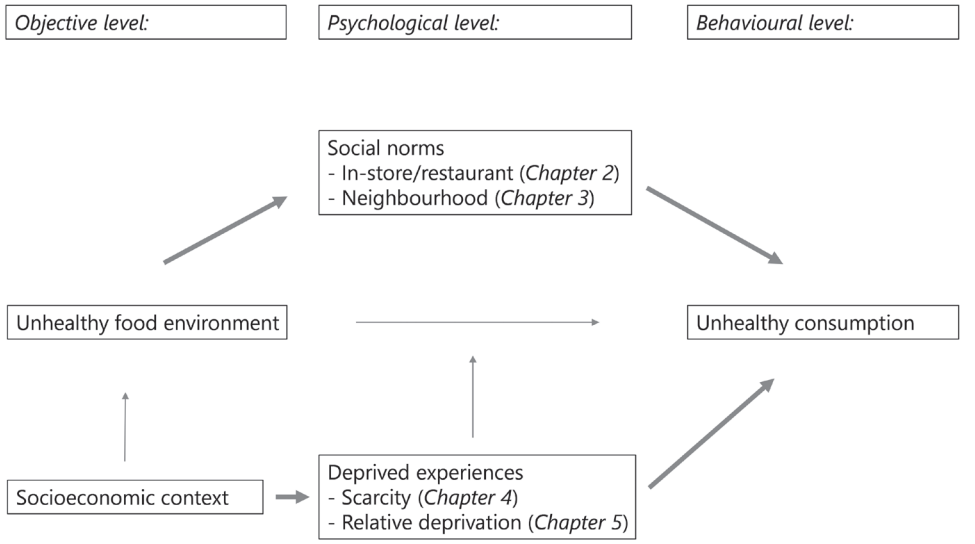

Figure 1.1. Conceptual model of this thesis

is a socially appropriate or adaptive course of action (Cialdini & Goldstein, 2004; Cialdini, Reno, & Kallgren, 1990; Knight Lapinski & Rimal, 2005). A key distinction can be made between actual norms (i.e. the prevailing norm, actual behaviour, or true expectancies of the group) and perceived norms (i.e. beliefs about common or appropriate behaviour) (Cialdini et al., 1990; Reno, Cialdini, & Kallgren, 1993). Of these two types, perceived norms are believed to be of particular importance for explaining behaviour, because people are ultimately influenced by their own interpretation of a social norm (Rimal & Real, 2003; Robinson et al., 2014). It is commonly assumed that social norm perceptions are derived from observations of, and interactions with, others, but initial research has indicated that social norms may also be inferred from physical cues in the environment, even without explicit referral to social norm information. For example, the presence of physical traces indicating how others have eaten (e.g. empty snack wrappers) may lead individuals to consume these foods as well (Burger et al., 2010; Prinsen, de Ridder, & de Vet, 2013). However, it remains to be explored how the actual, real-world food environment may convey social norms regarding common and appropriate eating behaviour and thereby encourage consumption. This social interpretation of physical food environments is investigated in two studies that differ in level of observation of the food environment (and hence in methodological approach). In **Chapter 2**, the in-store/restaurant food context is explored, to investigate how a range of small physical cues in food environments may be perceived as subtle guidelines for socially acceptable and appropriate food selection and consumption. In **Chapter 3**, the proposition that perceptions about normal consumption may be derived from the physical food environment is tested on the level of the built, neighbourhood environment.

1.5.3 Socioeconomic context: scarcity and relative deprivation

In the second part of the thesis, the focus is on two distinct evaluative interpretations of socioeconomic conditions, namely, the feeling of having less than one needs (scarcity) or the feeling of having less than others (relative deprivation). Although the concepts of scarcity and relative deprivation have in principal been treated separately in the scientific literature, they both address people's subjective, negative experience as a result of the evaluative interpretation of their socioeconomic context in terms of economic resources and opportunities. Both concepts have been used to explain how these experiences may influence motivational and decision-making processes, but have hardly been applied to actual eating behaviour. However, these theories also differ considerably in how they approach the exact mental processes in relation to behaviour, as well as the evaluative nature of deprivation (absolute versus relative), as further explained below.

Scarcity theory (Mullainathan & Shafir, 2013) proposes that perceptions of absolute scarcity of resources (i.e. having too little, e.g. in terms of money, time, or food) lead to more short-sighted decisions than situations of abundance, because scarcity narrows a person's attention to the immediate problem and urgent needs, and leaves less mental space to think about the decision in line with a long-term goal. This theory is based on common scientific insights from cognitive psychology and, although the mechanism essentially applies to everyone struggling with having less than they need, it has particularly been developed to provide a contextual (rather than individual) explanation of various deficiencies in the lives of people living in poverty. Evidence for the detrimental effects of scarcity on cognitive processes stems from a small number of studies showing that certain experimental manipulations of scarcity resulted in poorer performance of tasks assessing cognitive control (Mani, Mullainathan, Shafir, & Zhao, 2013; Shah, Mullainathan, & Shafir, 2012) and self-control (Spears, 2011). A different line of research has shown, in various ways, that self-regulation is essential for healthy eating. Particularly, a lower cognitive capacity to persist with long-term healthy eating goals and so to inhibit the impulse to eat tasty, high-caloric foods, has been associated with unhealthy eating behaviour such as overeating (Dohle, Diel, & Hofmann, 2018). Although scarcity theory has also been used to explain higher rates of obesity in people with low incomes, research that directly tests an effect of scarcity on eating behaviour remains scarce. In **Chapter 4**, it is examined whether experiences of scarcity indeed result in unhealthier consumption in terms of calorie intake from directly available snacks.

Subjective relative deprivation refers broadly to the belief that one is deprived of a desired outcome as a result of negative, upward social comparisons (i.e. being worse-off than others) (Crosby, 1976; Smith, Pettigrew, Pippin, & Bialosiewicz, 2012). This concept has been used to study the relation between objective income inequality and various health-related outcomes on an individual, subjective level (e.g. Beshai, Mishra, Meadows,

Parmar, & Huang, 2017; Callan, Kim, & Matthews, 2015; Mishra & Carleton, 2015). In this thesis, the focus is on personal relative deprivation (PRD), a concept that specifically refers to the perceptions of an individual rather than those of a social group (Smith & Ortiz, 2002; Smith et al., 2012). In addition to a cognitive component that involves the perception of being worse off, PRD has an affective component that includes feelings of frustration and resentment. PRD has been associated with a range of behaviours, including materialistic (Zhang, Tian, Lei, Yu, & Liu, 2015) and risk behaviours (Callan, Shead, & Olson, 2011; Elgar, Canale, Wohl, Lenzi, & Vieno, 2018; Mishra & Novakowski, 2016). An underlying psychological explanation for how PRD may result in risk behaviours is the preference for immediate, small rewards over long-term, greater benefits (Callan et al., 2011; Mishra & Novakowski, 2016). However, PRD has not been specifically linked to food choice behaviours, and unhealthy food choices often also reflect a preference for snack-type foods that are immediately rewarding rather than beneficial for health. In **Chapter 5**, it is tested whether experiencing PRD results in a higher preference for palatable, high-caloric, snack-type foods.

1.6 Aim and overview of thesis

The overall aim of this thesis is to investigate potential psychological processes that may explain how aspects of the physical food environment and socioeconomic context may steer unhealthy food consumption. Table 1.1 provides a short overview of the thesis chapters and the main study details.

Table 1.1. Overview of thesis including research questions and methodological approach

Research question		**Methodological approach**	**Chapter**
1	How are social norms physically embedded in in-store/restaurant food environments and how may these guide food consumption?	A mixed-method photo study Study 1: Qualitative Study 2: Mixed-methods, *N* = 173	**2**
2	Do neighbourhood social norms mediate the relationship between residential fast food outlet exposure and consumption?	A correlational study combining panel data and geospatial food outlet data *N* = 1038	**3**
3	Do experiences of scarcity result in higher calorie intake from snacks?	Experimental lab studies Study 1: *N* = 81 Study 2: *N* = 95 Study 3: *N* = 115 Study 4: *N* = 122	**4**
4	Does personal relative deprivation lead to more snack-type (palatable and high-caloric) food choices?	Experimental studies online and lab-in-the-field Study 1: *N* = 102 Study 2: *N* = 287 Study 3: *N* = 260	**5**

In **Chapter 6**, the results are summarized, the implications of the findings and methodological issues are discussed, and perspectives for future research are provided.

CHAPTER 2

IDENTIFYING SOCIAL NORMS IN PHYSICAL ASPECTS OF FOOD ENVIRONMENTS: A PHOTO STUDY

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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 analysed 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 behaviour 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 behaviour. Further research should study the effects of these cues on behaviour 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 et al., 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 neighbourhoods, 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, Gallegos, Comans, Cameron, & Thornton, 2017; Story, Kaphingst, Robinson-O'Brien, & Glanz, 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 neighbourhood) and dietary behaviour have predominantly been investigated in correlational studies (e.g. Morland, Wing, and Roux (2002). However, it remains poorly understood how specific physical aspects (i.e. physical cues) affect eating behaviour. 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 behaviour (Higgs, 2015). Social norms can be descriptive, i.e. *de*scribing the behaviour of others in identical situations and thereby showing what is considered 'normal'. Social norms can also *pre*scribe the behaviour one ought to exhibit and signal what behaviour others approve/disapprove of, so-called injunctive norms (Cialdini et al., 1990). Ample research demonstrates that social norms are important in guiding eating behaviour, as demonstrated in recent systematic reviews (Higgs, 2015; Robinson 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 behaviours that are considered acceptable or approved of (De Ridder, De Vet, Stok, Adriaanse, & De Wit, 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, Polivy, Pliner, & Vartanian, 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 behaviour 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 and 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 analysing 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 analysed in Study 1.

2.2 Study 1: Analysing photographs taken in self-service food environments

To systematically take and analyse 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 analysing 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 analysed 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.
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.	*Social norm interpretation* The means of the connotative meaning ratings were analysed in order to investigate the connotations that participants attach to the physical cues.

2.2.1 Methods

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 behaviour by informing people of what is seen as effective or adaptive behaviour, whereas injunctive norms indicate what is approved/disapproved of in a culture and motivate behaviour by promising social sanctions (Cialdini et al., 1990; Jacobson, Mortensen, & Cialdini, 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 one meter 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.

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

Photo A

Photo B

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 analysed 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 analysed 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 analysed 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.

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'.

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 Figures 2.1 and 2.2 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 2.1 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.

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.

The 18 higher level physical cue categories that were identified as bearing descriptive and/or injunctive social norms are presented below. Supplementary Table 2.1 lists the subcategories that belong to the higher level physical cue categories.

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). 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).

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).

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

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).

2.2.3 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,

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.

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: Normative interpretations among laypeople

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 signalling 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

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 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 programmes 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).

3 A third photograph was included in the questionnaire; however, in hindsight we decided against analysing 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.

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 behaviour themselves (Nolan, Schultz, Cialdini, Goldstein, & Griskevicius, 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.

Measurements

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.

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 (strongly disagree) to 5 (strongly 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').

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.

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').

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 2.1. 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 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 analysed for each item.

2.3.2 Results

Physical cue identification

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 2.2. 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.

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 2.2. 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'*).

Social norm interpretation

Photo A

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.

Photo B

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)

Note: Categories of this Likert scale were (translated from Dutch) 1: strongly disagree, 2: disagree, 3: neither agree nor disagree, 4: agree, 5: strongly 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 behaviour 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 analysed 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 behaviour of previous consumers, and these traces of others' behaviour 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 behavioural rules about appropriate behaviour, which is *not* clearly visible in environments. Physically embedded descriptive norms that show the behaviour 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 behaviour.

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 behaviour 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' behaviour 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 behaviour, 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 signalling 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 behaviour 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 behaviour. 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 behaviour 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 behaviour (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 signalling 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 signalling 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, Evenson, Rodriguez, & Ammerman, 2011; Giskes et al., 2011). In line with the current study, it might be reasoned that neighbourhoods in which unhealthy foods are readily available and accessible convey social norms (descriptive and injunctive) favouring unhealthy eating. Hence, it would be interesting to test whether neighbourhood 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 neighbourhoods in shaping norm perceptions about drug injection behaviours. The results of that study showed that both social and physical aspects (e.g. litter) were associated with perceived norms about risk behaviours (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 behaviour and obesity, the current study built on evidence that social norms are important drivers of eating behaviour 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 behavioural 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 behaviour and to verify the extent to which social norm interpretations can be attributed to this.

Acknowledgement
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CHAPTER 3

NEIGHBOURHOOD FAST FOOD EXPOSURE AND CONSUMPTION: THE MEDIATING ROLE OF NEIGHBOURHOOD SOCIAL NORMS

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Abstract

Background: The association between the residential fast food environment and diet has gained growing attention. However, why the food environment affects food consumption is under-examined. This study aimed to investigate neighbourhood social norms with respect to fast food consumption as a potential mediating pathway between residential fast food outlet exposure and residents' fast food consumption.

Methods: A correlational study was conducted in which a nationwide sample of 1038 respondents living across The Netherlands completed a survey. Respondents reported their fast food consumption (amount/week) as well as perceived descriptive and injunctive norms regarding fast food consumption in their neighbourhood. Fast food outlet exposure was measured by the average count of fast food outlets within a 400 meter walking distance buffer around the zip-codes of the respondents, using a retail outlet database. Regression models were used to assess associations between residential fast food outlet exposure, fast food consumption, and social norm perceptions, and a bootstrapping procedure was used to test the indirect -mediation- effect. Separate analyses were performed for descriptive norms and injunctive norms.

Results: There was no overall or direct association between residential fast food outlet exposure and residents' fast food consumption. However, fast food outlet exposure was positively associated with neighbourhood social norms (descriptive and injunctive) regarding fast food consumption, which in turn were positively associated with the odds of consuming fast food. Moreover, results of the bootstrapped analysis provided evidence of indirect effects of fast food outlet exposure on fast food consumption, via descriptive norms and injunctive norms.

Conclusions: In neighbourhoods with more fast food outlets, residents were more likely to perceive fast food consumption in the neighbourhood as more common and appropriate. In turn, stronger neighbourhood social norms were associated with higher fast food consumption. Acknowledging the correlational design, this study is the first that implies that neighbourhood social norms may be a mediating pathway in the relation between the residential fast food environment and fast food consumption. Future research may examine the role of neighbourhood social norms in other contexts and explore how the changing food environment may shift our consumption norms.

3.1 Introduction

Following the rapid increase in the number of fast food outlets in the past decades (Maguire et al., 2015; Statista, 2019; Statistics Netherlands, 2018a), the relationship between the fast food environment and diet and health outcomes has gained societal attention (e.g. Halberstadt & Seidell, 2018; Homer, 2018; Slawson, 2017). Evidence of an association between neighbourhood exposure to fast food outlets and both diet and health outcomes is however mixed (Caspi et al., 2012; Fraser, Edwards, Cade, & Clarke, 2010; Townshend & Lake, 2017). Despite increasing calls and plans to ban fast food outlets in certain areas in a bid to curb obesity, it remains poorly understood *how* the food environment relates to food consumption and there has been a call for research to examine pathways that may explain potential relationships (Charreire et al., 2010; Clary, Matthews, & Kestens, 2017; Fleischhacker et al., 2011; Fraser et al., 2010; Giskes et al., 2011; Hobbs, Green, Roberts, Griffiths, & McKenna, 2019; Lytle & Sokol, 2017). Although various mediating factors have been proposed (e.g. taste preferences, food preparation skills, perceptions of the food environment (Clary et al., 2017; Lytle & Sokol, 2017), studies investigating specific pathways are scarce.

It is well established that the social environment exerts a powerful influence on people's perceptions and behaviours (Fiske, 2010). People are influenced by others' behaviours and values to establish what is a correct (informational or descriptive social norm influence) or appropriate (normative or injunctive social norm influence) behaviour (Cialdini et al., 1990; Deutsch & Gerard, 1955). There is a growing body of evidence of social norm influences on dietary behaviour (see for reviews Higgs, 2015; Robinson et al., 2014; Stok et al., 2016), including fast food consumption. More specifically, a cross-sectional study showed that descriptive social norm perceptions regarding others eating fast food was associated with fast food consumption (Ball, Jeffery, Abbott, McNaughton, & Crawford, 2010). Yet, the social aspects of the neighbourhood food environment (e.g. eating appropriateness standards, situational norms including social facilitation and modelling of food intake) are understudied (De Ridder et al., 2013; Herman & Polivy, 2005; Suglia et al., 2016). Moreover, scholars have treated the physical and social food environment as if these are two independent environmental influences on food consumption (Carroll-Scott et al., 2013; Kirk et al., 2010; Nieuwendyk et al., 2016). However, there are indications that these influences are linked; specifically, that the physical food environment may contribute to social norms regarding appropriate eating (De Ridder et al., 2013; Thompson, Ponsford, Lewis, & Cummins, 2018), thereby affecting food choices (Burger et al., 2010; Higgs, 2015; Prinsen et al., 2013; Robinson et al., 2014). For example, building on social practice theory (Reckwitz, 2002; Shove, Pantzar, & Watson, 2012), a qualitative study of fast food neighbourhood perceptions revealed that fast food outlets became normalized for those living near them (Thompson et al., 2018). Yet, it has not quantitatively been

studied whether the neighbourhood-level food environment is associated with social norms, that may in turn be associated with food consumption. We refer to these social norms as 'neighbourhood social norms', i.e. perceptions about what other people in the neighbourhood consume and what is normal or appropriate consumption in the neighbourhood.

Various visual aspects within the neighbourhood may form neighbourhood norms about appropriate fast food consumption. For example, people are exposed to fast food outlets, delivery vehicles, individuals purchasing and/or eating fast food at these outlets or on-street, and traces/rubbish of fast food consumption. Hence, both others' fast food consumption-related behaviours and physical aspects of the neighbourhood may form input for residents' fast food norm perceptions. Yet, it remains unknown if these elements contribute to fast food norm perceptions, and if so, whether these norm perceptions influence fast food consumption. The present study aimed to investigate to what extent perceived neighbourhood social norms towards fast food mediated the association between exposure to fast food outlets in the residential environment and fast food consumption among a nationwide adult sample in the Netherlands. We hypothesized that a higher residential exposure to fast food outlets is associated with more positive neighbourhood social norms regarding common and appropriate fast food consumption (i.e. descriptive and injunctive norms, respectively). In turn, it was hypothesized that the relation between fast food outlet exposure and fast food consumption is mediated through these neighbourhood social norms.

3.2 Methods

3.2.1 Participants, design and procedure

A nationwide sample living across the Netherlands was recruited by a panel bureau (Flycatcher). The aim was to reach a sample size of 1000 respondents, based on the maximum budget available. Taken into account an expected response rate of 50%, an initial sample of 1988 respondents were emailed an invitation to participate in the survey. Respondents were given 7 days to complete each survey. A reminder email was sent to non-responders one day before the call closed. Inclusion criteria were age 25-60 years and not currently enrolled in education. Eligible respondents from the panel were selected on household income to have an equal proportion of low- middle- and high-incomes. A total number of 387, 338, and 330 respondents in these respective income groups completed our survey, which resulted in a total sample of 1055 (response rate = 53%). In comparison with records from Statistics Netherlands (2019), this sample was representative for the Dutch population aged 25-60 years with respect to sex, age, education level and province. Seventeen respondents were excluded because they provided a non-existing postcode or

because fast food outlet data or area-level income data was missing, resulting in an analytic sample of 1038 respondents (mean age = 45.5, *SD* = 10.3, 58% female, 95% Dutch ethnicity). Twenty-two (2.1%) respondents had the same postcode. This study has a correlational survey design, where the first survey assessed demographics and neighbourhood norms, and a second survey four weeks later assessed fast food consumption (response rate = 59% and 79%, respectively). Data were collected in January and February 2019. Ethical approval was granted by the ethics committee of the faculty of Bèta-Geo Sciences of Utrecht University, the Netherlands (GEO FETC18-014).

3.2.2 Fast food outlet data

Addresses of fast food outlets were obtained from the Locatus database (2017), which contains independently and objectively recorded retail information of all outlets in the Netherlands through annual on-site surveys. Data were extracted from three retail categories typically selling fast food: 1) fast-food outlets (e.g. McDonald's, local "snackbar"), 2) delivery/take-away outlets (e.g. Chinese, pizza); 3) grillroom/kebab outlets. These three retail categories included chain and non-chain outlets selling quickly prepared and served, mainly energy-dense foods for in-store consumption and/or takeaway and/or delivery.

3.2.3 Measures

Outcome measure: Fast food consumption

Frequency consumption of fast foods was estimated by two questions asking how frequently during the last four weeks respondents (1) consumed fast foods within a fast food restaurant or through take away (i.e., not delivery) and (2) had fast food delivered from a fast food restaurant. Examples of fast food outlets were given ("Mc Donalds/Burger King/KFC, Febo, snack bar, grillroom (kebab, Turkish pizza, shawarma), New York Pizza, and other fast food outlets (pizza, Chinese, tacos)". The delivery item also mentioned examples of delivery services ("Takeaway, Ubereats, Foodora, Deliveroo, or the delivery service of the restaurant itself"). There were nine response categories: 'never or less than once a month', '1-3 times a month', 'one day/week', '2 days /week', '3 days /week', '4 days /week', '5 days /week', 6 'days /week', '7 days /week (every day)'. Answers for both items were recoded into weekly equivalent measures of 0 days/week and .5 days/week, 1 day/week, etc. These weekly equivalent scores were summed to generate a weekly equivalent total fast food consumption frequency score. Because 73% of the respondents consumed fast foods 1-3 times a month or less, the weekly scores were subsequently converted into three ordinal categories of 'never or less than once/month', '1-3 times/month', and 'at least once per week'.

Exposure measure: Residential fast food outlet exposure

The cohort was enriched with residential fast food outlet exposure by aggregating all the fast food outlets within a 400 meter walking distance buffer from each address in the

Netherlands. Figure 3.1 illustrates how the residential fast food outlet exposure is calculated. The walking distance was calculated based on the Top10L street network (Kadaster, 2019) with highways removed. The preprocessing (rasterize, resample, mosaic) of the street network was done in ArcGIS (Esri, Redlands, CA, US) and buffer calculations were done in Python (Python Core Team, 2019) and PCRaster (Karssenberg, Schmitz, Salamon, de Jong, & Bierkens, 2010) environments. For privacy reasons we could not ask respondents to self-report their exact home address in the survey and so we asked participants to report their postcode. This postcode, a combination of 4 digits and 2 letters, contains on average 25 houses and represents the scale of (part of) a street (Postcodebijadres, 2019; PostNL, 2019). The average count of fast food outlets within 400m distance buffers per postcode was calculated and rounded. A continuous measure of the count data was used, which ranged from 0 to 29 fast food outlets.

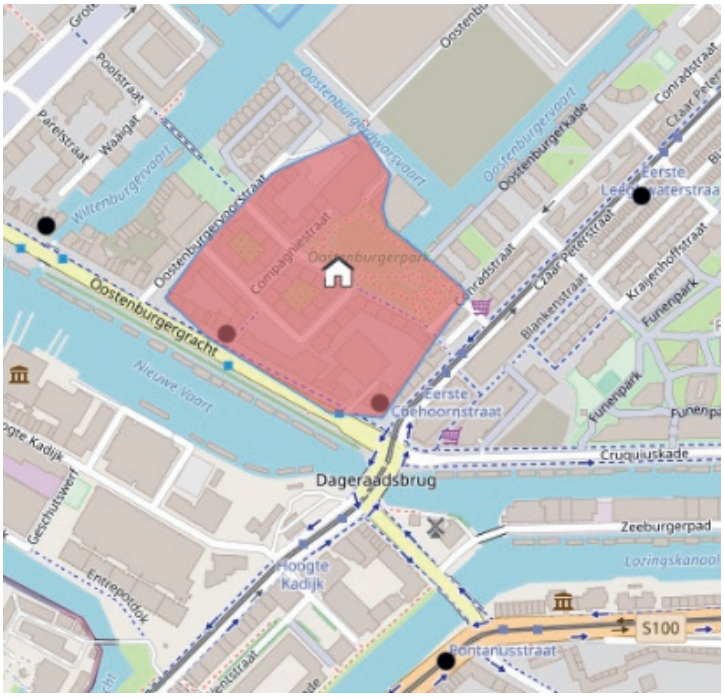

Figure 3.1. A 400m walking distance buffer around an address. The black dots represent fast food outlets. Created in Openstreetmap (Mordechai Haklay, 2008).

Mediator: Perceived neighbourhood social norms

Because of the conceptual distinction between descriptive and injunctive social norms (e.g. Cialdini et al., 1990; Jacobson et al., 2011), these concepts were measured separately. Descriptive social norms were defined as what the respondent perceived other people in their neighbourhood do in relation to eating fast food, which includes in-store

consumption, street consumption, takeaway, and delivery. Descriptive social norms were assessed with the following statements: "I often see other people in my neighbourhood eating or taking away fast food", and "In my neighbourhood people eat fast food frequently". Responses were reported on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree), midpoint 3 (neutral (neither disagree or agree)). A mean score was calculated (Cronbach's alpha = .89). Injunctive social norms were defined as the respondent's beliefs regarding approval/appropriateness of eating fast food in their neighbourhood. These were assessed with the statements: "In my neighbourhood it is normal to eat fast food", "In my neighbourhood it is acceptable to eat fast food", and "In my neighbourhood it is appropriate to eat fast food". Response options were the same as those used for the descriptive norms measure. A mean score of these three items was calculated (Cronbach's alpha = .85). To clarify the (English) term 'fast food' to respondents, a definition of fast food was given in Dutch ("Fast food is an unhealthy quick bite") as well as examples of outlets (identical examples as given with the fast food consumption items). It was also stated that eating fast food entails eating in-store and on-street, as well as takeaway and delivery.

Confounders

We used Directed Acyclic Graphs (DAGs, see Supplementary Figure 3.1) to visually represent the assumed causal relationships among the exposure, the outcome, the mediating variables and the confounders (Chaix, Leal, & Evans, 2010; Fleischer & Roux, 2008; Glymour, 2006; Merchant & Pitiphat, 2002). This enabled us to carefully select confounders, which are only those factors that may independently affect both the exposure (i.e. fast food outlet exposure) *and* the outcome (i.e. fast food consumption) or an ancestor of these (i.e. neighbourhood norms). This process led us to identify age and area-level income as confounders. Individual level socio-demographic (i.e. ethnicity, household composition) and socio-economic factors (i.e. income level, education level, employment) were assumed to influence fast food outlet exposure only through area-level income, as it is likely that choice of fast food outlet location is more heavily influenced by the collective characteristics of an area, rather than by an individual's characteristics (Kwate, 2008; Melaniphy, 1992). Sex was assumed to affect fast food consumption but not exposure or neighbourhood norms. Area-level income was obtained from Statistics Netherlands (2018b) and was measured as postcode-4 level household equivalent income in 2015, on a continuous scale. A postcode-4 level contains on average 2216 addresses, although there is large variation (Statistics Netherlands, 2020).

3.2.4 Statistical analyses

To test potential indirect effects of fast food outlet exposure on fast food consumption via neighbourhood social norm perceptions, mediation analyses were performed using Stata 13 IC (StataCorp, 2013). Separate mediation analyses were conducted for the two potential

mediators (i.e., descriptive norms and injunctive norms). The hypothesized mediation model is shown in Figure 3.2. First, an ordinal logistic regression model was used to test the total effect of fast food outlet exposure on the outcome variable fast food consumption (c path). Second, a linear regression model was fitted to test the association between fast food outlet exposure and the potential mediator variable neighbourhood social norms (a path). Third, an ordinal logistic regression model with fast food consumption as the outcome variable and fast food outlet exposure and neighbourhood social norms as covariates was fitted to test the independent effects of the mediator (b path) and the exposure (c' path; direct effect) on the outcome. An attenuation of the direct effect compared to the total effect indicates evidence of mediation. The indirect, or mediated, effect of the exposure on the outcome was calculated as the difference between the total and direct effects (c – c') (Imai, Keele, & Tingley, 2010). Bootstrapping (1000 replications) was used to calculate percentile-based confidence intervals of the indirect effects (Fritz, Taylor, & MacKinnon, 2012; Hayes & Scharkow, 2013). A 95% CI of the indirect effect that does not cross zero indicates evidence of mediation (i.e., a non-zero indirect effect) at a $p<.05$ level. All regression models were adjusted for the confounders age and area-level income.

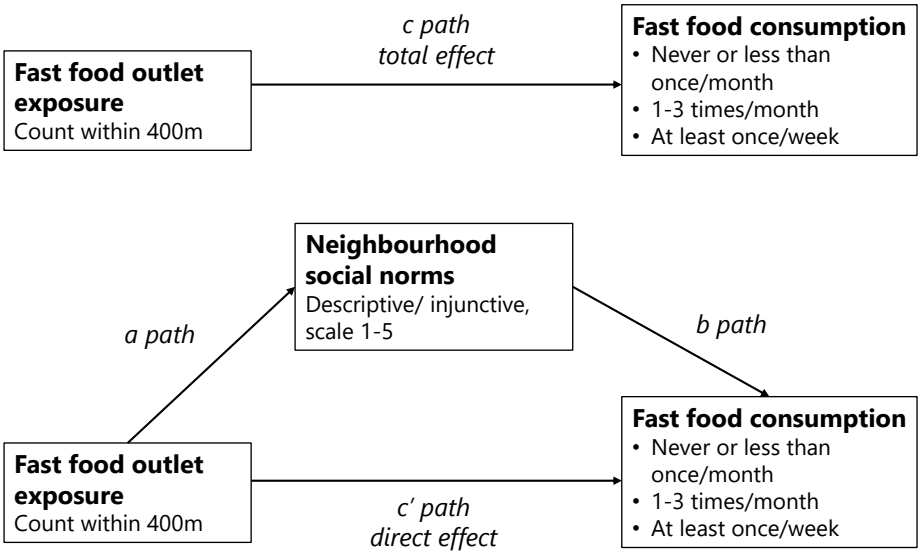

Figure 3.2. Overview of the mediation model including all pathways. Separate mediation analyses were performed for the two potential mediators (i.e., descriptive norms and injunctive norms). All analyses were controlled for age and area-level income.

3.3 Results

3.3.1 Descriptives

Table 3.1 shows the descriptive statistics of the sample. The median number of residential fast food outlets was 1.0 (IQR (25^{th}-75^{th} percentile) = 0.0-2.0) and the maximum value was 29.0. On a scale from 1 to 5, respondents had an average score of 2.7 (*SD* = 0.9) and 3.0 (*SD* = 0.7) on descriptive and injunctive norms, respectively. In total, 33% of the respondents consumed fast food 1-3 times a month, and 28% consumed fast food at least once a week.

Table 3.1. Descriptive statistics (*N* = 1038)

Age, mean (*SD*)	45.5 (10.3)
Area level household equivalent income x 1000 euro, mean (*SD*)	37.3 (7.5)
Fast food outlet exposure (count within 400m)	
Median (25^{th}-75^{th} percentile)	1.0 (0.0-2.0)
Min-max	0-29
Norm perceptions (scale 1-5), mean (*SD*)	
Descriptive	2.7 (0.9)
Injunctive	3.0 (0.7)
Fast food consumption, *N* (%)	
Never or less than once/month	413 (39.8)
1-3 time/month	340 (32.8)
At least once a week	285 (27.5)

3.3.2 Total effect

There was no evidence ($p = .22$) of an overall association between fast food outlet exposure and the odds of fast food consumption (c path, Table 3.2).

3.3.3 Mediation model with descriptive norms as mediator

There was a significant positive association between fast food outlet exposure and descriptive norm perceptions ($p < .001$, a path) (Table 3.2). Controlling for fast food outlet exposure, perceived descriptive norms were significantly positively associated with the odds of fast food consumption ($p = .03$, b path). Controlling for the mediator descriptive norms, fast food outlet exposure remained non-associated with fast food consumption ($p = .36$, c' path). There was evidence (at the $p < .05$ level) of an indirect effect of fast food outlet exposure on fast food consumption, via descriptive norms (c-c').

3.3.4 Mediation model with injunctive norms as mediator

There was a significant positive association between fast food outlet exposure and injunctive norm perceptions ($p < .001$, a path) (Table 3.2). Controlling for fast food outlet exposure, perceived injunctive norms were significantly positively associated with the odds of consuming fast food ($p < .001$, b path). Controlling for the mediator injunctive

norms, fast food outlet exposure remained non-associated with fast food consumption ($p = .46$, c' path). There was evidence (at the $p < .05$ level) of an indirect effect of fast food outlet exposure on fast food consumption, via injunctive norms (c-c').

In sum, the results indicate that both neighbourhood descriptive and injunctive norms may be a mediating pathway in the relation between fast food outlet exposure and consumption.

Table 3.2. Mediation analyses results

	Paths								
	a		b		Direct effect c′		Total effect c		Indirect effect c-c′
Mediator	B (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*	OR (95% CI)	*P*	B (95% CI)
Descriptive norm	0.05 (0.03, 0.07)	< .001	1.16 (1.01, 1.33)	.03	1.02 (0.98, 1.06)	.36	1.02 (0.99, 1.07)	.22	0.006 (0.0003, 0.013)
Injunctive norm	0.03 (0.02, 0.04)	< .001	1.44 (1.22, 1.70)	< .001	1.02 (0.98, 1.06)	.46	1.02 (0.99, 1.07)	.22	0.01 (0.004, 0.017)

Note: See Figure 3.2 for an overview of the pathways in the mediation model. All analyses were adjusted for age and area-level income. Associations for pathways b, c′, and c are presented on the odds scale (i.e., as odds-ratios), while the indirect effect (c-c′) is presented on the log-odds scale.

3.4 Discussion

The present study shows that exposure to fast food outlets in the neighbourhood is positively associated with social norm perceptions regarding fast food consumption in the neighbourhood. Moreover, there was evidence that neighbourhood social norms (both descriptive and injunctive) mediated the relationship between fast food outlet exposure and fast food consumption. However, a higher exposure to fast food outlets was not directly associated with higher consumption of fast food. Our findings, although correlational, may suggest that an increased exposure to fast food outlets in the residential neighbourhood may thus shape 'unhealthier' norms towards fast food consumption, and these norms may steer actual fast food intake.

This is one of the first studies to demonstrate the pathway by which spatial planning of food outlets may ultimately influence perceptions about food-related code of conduct in a neighbourhood. This association between fast food outlet exposure and neighbourhood norm perceptions (the a path) is intriguing, as it suggests that individuals who have a higher residential availability of fast food outlets, perceive fast food consumption in the neighbourhood as more common and appropriate. It remains unclear however, what specific aspects of fast food outlet exposure may influence norm perceptions. In principal, the exposure measure is purely physical in nature, yet these outlets create opportunities to observe and model others' consumption behaviours. The general presumption regarding the formation of norms is that social norms are developed through observations of and interactions with others (Bandura, 1977; Clary et al., 2017), which may be particularly relevant in the context of neighbourhoods, where people live in close proximity with each other (Suglia et al., 2016). Yet, small-scale experimental studies on diet-related norms showed also that small, physical aspects of the food environment (e.g. empty food wrappers) directly communicate consumption norms (Burger et al., 2010; Prinsen et al., 2013), and such factors of the residential fast food environment (e.g. empty fast food packaging, meal delivery vehicles) may also steer social norms, yet remains unknown from the current study To our knowledge, the present study is the first to link the structural, neighbourhood-level physical food environment to norm perceptions. Future research may unpack what and how specific neighbourhood-level physical and social aspects influence norm cognitions regarding appropriate consumption.

The positive association found between neighbourhood norms and fast food consumption (the b path) suggests that these perceptions of what is 'normal' fast food consumption in the neighbourhood is associated with individual consumption. Humans are part of many different social groups (e.g., (e.g. family, friends, colleagues) and eating norms may differ between the social groups one belongs to. Although norms of more close relatives may be equally or even more important for one's eating behaviour (Roux, 2001), our results

imply that one's neighbours are also important for fast food consumption. Effect sizes were small, though on population level these may still be meaningful for eating behaviour. A study on the link between neighbourhood norms about drunkenness and drinking behaviour found that this relationship was significant independent of friend, family, and personal norms (Ahern, Galea, Hubbard, Midanik, & Syme, 2008). Further research may compare social norms of different reference groups and how they interact in their relation to fast food consumption.

Importantly, it should also be noted that no direct relationship between fast food outlet exposure and consumption was observed. This might be explained from methodological issues. The test of the total effect has relatively low power and therefore it is not uncommon to find an indirect effect even when there is no total or direct effect (for a discussion, see Kenny & Judd, 2014). Moreover, there may be unmeasured other mediating pathways, and when varying in sign, they may nullify the overall effect (Fairchild & McDaniel, 2017). The lack of evidence for a direct link between fast food outlet exposure and diet/health might also be due to the fact that people may purchase fast food from outside their neighbourhood (e.g. near the workplace, or on the go) (Caspi et al., 2012; Clary et al., 2017; Feng, Glass, Curriero, Stewart, & Schwartz, 2010), thereby undermining the direct influence of fast food outlet that are physically located in the residential neighbourhood on consumption behaviour. However, results of the present study imply that people may eat according to their residential social norms, irrespective of where they purchase their fast food. Accordingly, findings provide preliminary evidence for the proposal of Clary et al. (2017), who suggested that local food outlet exposure may shape preferences and norms that, when progressively internalized, may influence overall food purchasing behaviours.

This study has made unique contributions to the literature on the link between fast food environment and diet in two main ways. First, it tested a new conceptual model including perceptions of neighbourhood norms as a mediating pathway between neighbourhood fast food outlet exposure and fast food consumption. Acknowledging that there may be many other mediating pathways, our positive findings contribute to opening the often cited "black box of places" in health and place research (Macintyre et al., 2002). Further research is needed to examine additional pathways (e.g. food preferences) through which the neighbourhood fast food environment may influence consumption. Second, we measured a rather small street-network buffer of 400m around the home, to study the immediate and visible residential fast food environment. This can be considered a strength for the study purpose. Previous fast food access studies that employed buffer metrics commonly used larger buffers ranging from 800m to 3km around the home address, whereas smaller buffers of 400m have predominantly been used around schools (Caspi et al., 2012; Cobb et al., 2015; Fleischhacker et al., 2011; Fraser et al., 2010; Wilkins et al., 2019). Yet, a small buffer of 400m around the residential address was considered relevant for

the formation of an individual's immediate neighbourhood norm perceptions, because a direct and daily/frequent exposure to the residential food environment may enhance internalization of norms in the neighbourhood (see also Clary et al., 2017). It remains to be tested if results are generalizable to other countries, as street networks and types of fast food outlets differ over countries.

This study has several other noteworthy methodological strengths. First, we included a national representative sample with respect to sex, age, education level, and province. Second, by distributing the survey in two waves with a four weeks interval we aimed to prevent that responses to the first set of items (including psychological measures, e.g. neighbourhood social norms) would influence responses to the second set (including fast food consumption). Third, the use of DAGs allowed us to carefully identify necessary adjustment for confounders while avoiding overadjustment, which may in itself introduce bias (Fleischer & Roux, 2008).

This study also has some limitations. First, as this study has a correlational design, no causal conclusions can be drawn. The assumed direction of the relationship between fast food outlet exposure, neighbourhood norms and fast food consumption may also be reversed. For example, the act of making inferences about the frequency of others' fast food consumption may be biased by own fast food consumption (confirm the false consensus effect). Moreover, fast food outlet exposure might be biased by neighbourhood self-selection. Therefore, natural experiments examining changes in the residential fast food environment (e.g. Thornton et al., 2016) are needed to further explore the mediating role of changes in neighbourhood norms in the impact on fast food consumption. Nevertheless, it was deemed implausible that people determine their home location based on residential fast food availability. Second, the dates of data collection of the fast food outlet exposure measure (end of 2017) and the norms and consumption measures (early 2019) did not align exactly. However, it is unlikely that the minor changes in the availability of fast food outlets influenced the results drastically. Third, due to privacy reasons we could not obtain the exact address of the respondents. However, a postcode area in the Netherlands represents on average 25 houses and would closely represent exposure at the precise address point. Fourth, the social norm items were only framed in a positive direction. Disagreement about items measuring the appropriateness of fast food consumption could imply that respondents perceived an 'opposing' norm or that no norm was perceived whatsoever. Using a negative framing would be interesting to verify our findings: when *less* exposed to fast food outlets, do people find fast food consumption more *un*common and *in*appropriate? Fifth, the fast food consumption measure relied on self-report and recall which must be taken into account in the interpretation of the findings. Yet, a FFQ has been shown to be a valid and practical tool to provide a reasonable

accurate ranking of low to high food intake (Block, Gillespie, Rosenbaum, & Jenson, 2000; Willett, 2013).

3.5 Conclusions

The present study provided the first evidence for the mediating role of neighbourhood fast food norms in the much studied association between neighbourhood fast food outlet exposure and fast food consumption. Acknowledging the correlational design, results imply that a higher exposure to fast food outlets in the residential neighbourhood may form 'unhealthier' norms regarding fast food consumption, and these norms may guide fast food consumption. The food environment is rapidly changing: apart from fast food outlets, the number of full-service restaurants, coffee shops, and convenience stores increased over time in residential as well as workplace and commuting environments (James, Seward, James O'Malley, Subramanian, & Block, 2017; Pinho et al., 2020). Hence, we invite future research to test the mediating role of social norms in different food contexts and to disentangle how these may shift our norms regarding common and appropriate consumption. Such insights would support policymakers in urban planning to develop healthier neighbourhoods and ultimately stimulate healthier consumption.

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CHAPTER 4

DEALING WITH TOO LITTLE: THE DIRECT EXPERIENCE OF SCARCITY DOES NOT AFFECT SNACK INTAKE

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Abstract

Background: The experience of scarcity provides an explanation for the relatively unhealthy diets of people with low income. Causal evidence for an effect of direct experiences of scarcity on eating behaviour is lacking.

Methods: Two studies ($N = 81$, $N = 115$) tested and refined a self-developed trade-off task, in which participants' resources where restricted (scarcity condition) or unrestricted (no-scarcity condition), for manipulating experiences of scarcity. Two further studies ($N = 95$, $N = 122$) were performed to test whether scarcity results in greater calorie consumption from snacks and lower self-reported self-regulation of eating.

Results: The scarcity manipulation appeared successful. A significant main effect of scarcity on eating was not found; however, an interaction effect between hunger and scarcity bordered significance, such that the scarcity condition consumed more calories under low hunger. In the second experiment, participants were instructed to eat prior to participation to lower their hunger level. No difference between conditions was found in calorie consumption and self-regulation of eating.

Conclusion: Although the trade-off task appeared to evoke scarcity experiences, the present research could not support the notion that these result in unhealthier eating. A more nuanced view of the influence of scarcity on eating is needed.

4.1 Introduction

Diet-related diseases such as obesity, diabetes and heart disease are approaching epidemic levels in many parts of the world (Deitel, 2003; Fardet & Boirie, 2014; Wagner & Brath, 2012). It has been well established that diet quality differs over income groups: people with low income have more unhealthy diets (Drewnowski & Specter, 2004; Ricciuto & Tarasuk, 2007). Moreover, lower incomes are associated with higher obesity rates (Schoenborn, Adams, & Barnes, 2002) in both developed and developing countries (James, Leach, Kalamara, & Shayeghi, 2001). A dominant explanation is that a low income induces a selection of less expensive unhealthy, high energy-dense foods. However, research focused on the role of food prices and perceived affordability of healthy foods in diet quality of different income groups has shown inconsistent findings (Dijkstra et al., 2018; Lee et al., 2016). Hence, there may be other explanations for why having a low income contributes to unhealthy eating. This research focuses on a more fundamental reason for this relationship: psychological consequences of the experience of scarcity resulting from a low income.

Relatively recently, a psychological perspective of financial scarcity has been put forward that provides an underlying explanation for anomalies in a wide variety of behaviours, including healthy eating. This approach, also labelled as "scarcity theory" (Mullainathan & Shafir, 2013; Shah et al., 2012), primarily advocates that the experience of scarcity (i.e. "a subjective sense of having more needs than resources"; (Mullainathan & Shafir, 2014, p. 86), negatively affects cognitive capacity, which subsequently results in behaviours that are in contrast to one's long-term interest. Although the adverse impact of scarcity on eating behaviour as an explanation for unhealthy diets among people with low income has been suggested before (Mullainathan & Shafir, 2013; Spears, 2011), empirical evidence remains scarce. A recent cross-sectional study showed that financial scarcity (financial strain) indeed related negatively to self-reported health behaviours including fruit and vegetable intake (Beenackers, Oude Groeniger, van Lenthe, & Kamphuis, 2017), whereas a longitudinal study found that financial strain had limited to no effect on diet-related health outcomes including being overweight (Prentice, McKillop, & French, 2017). To our knowledge, Bratanova, Loughnan, Klein, Claassen, and Wood (2016) showed first experimental evidence for a causal effect of perceptions of poverty on unhealthy eating. They found that students writing about their own experiences with poverty (versus wealth) consumed more calories from snacks. The present study is more in line with scarcity theory and aims to expand on these first results by experimentally testing the impact of direct experiences of scarcity on snack consumption rather than by reliving or imagining situations of poverty.

4.1.1 Scarcity theory and its relation to unhealthy eating

Essentially, the *perception* of scarcity of resources is the feeling that one has more needs than resources, or in other words, that one's resources are *too* little for the available options that would satisfy one's needs or desires. Having insufficient resources then forces daily difficult decision making in involving trade-offs and sacrifices, thereby enhancing the sense of having too little (Mullainathan & Shafir, 2013). As illustrated by Mullainathan and Shafir (2013) one could compare a situation of scarcity and trade-off making with holiday packing with a small suitcase (representing a small budget); one has to think hard what to include and what could be left out. Fundamental to scarcity theory is that this experience of scarcity captures our attention: people tend to automatically focus on immediate problems and urgent unmet needs. Since people are limited in their attention and cognitive processing capacity (e.g. Kahneman, 1973), a preoccupation with immediate unmet needs and difficult trade-offs reduces the cognitive capacity available for other (future) responsibilities (Mullainathan & Shafir, 2013). Cognitive capacity may deteriorate even further by the stress and negative affect associated with scarcity, which can further increase impulsiveness (Haushofer & Fehr, 2014). Notably, direct evidence for the negative effect of scarcity on cognitive capacity and control is scarce. Two revealing experimental studies showed that participants who were preoccupied with difficult (versus easy) hypothetical financial decisions (Mani et al., 2013) or who received few (versus many) guesses in a word puzzle (Shah et al., 2012) performed worse on a computerized cognitive control task (spatial incompatibility task, see also (Davidson, Amso, Anderson, & Diamond, 2006). Furthermore, Spears (2011) revealed that participants who received a smaller (versus larger) choice 'budget' to choose from free gifts, executed less self-control as indicated by the duration of squeezing a handgrip and performance on a numerical Stroop task.

Notably, the scarcity theory harmonizes with self-regulation theory, which is concerned with immediate urges on one hand and long-term goals (e.g. health) on the other (Baumeister & Vohs, 2007). Also the ability to self-regulate is assumed to be limited and subject to situational circumstances including cognitive load, stress, and affect (Hofmann, Friese, & Wiers, 2008), all of which have been related to the experience of scarcity (Haushofer & Fehr, 2014; Shah et al., 2012). Applied to eating behaviour this means that when cognitive capacity to act in line with health goals is (temporarily) diminished, the influence of tempting food stimuli on behaviour is enhanced (Hofmann, Rauch, & Gawronski, 2007). Indeed, experimental studies have shown that unhealthy eating behaviours can result from situationally decreased cognitive capacity. For example, applying a commonly used manipulation for cognitive load, namely asking participants to remember a 7-digit (versus 3-digit) number, experimental studies have shown that this cognitive load increased unhealthy food choices (Shiv & Fedorikhin, 1999) and calorie consumption (Ward & Mann, 2000). Based on these insights, it has been reasoned that

experiencing scarcity, resembling a cognitive load, increases susceptibility to consume tempting foods (Mullainathan & Shafir, 2013; Spears, 2011). Apart from the idea that scarcity experiences lead to less cognitive capacity and self-regulation, it is plausible that unhealthy eating may be a more direct result from a more present-time focus stemming from the threatening nature of scarcity perceptions. Obtaining caloric resources in times of scarcity may reflect an adaptive motivation to compensate for (future) scarcity of resources (see also Laran & Salerno, 2013; Swaffield & Roberts, 2015). Overall, the present research may provide additional support for the notion that food consumption in response to scarcity is not domain restricted but may also be evoked by non-food resources (Briers & Laporte, 2013; Koles, Wells, & Tadajewski, 2018). Especially when people with low income live in neighbourhoods in which they are more frequently exposed to unhealthy (often tempting) foods (Cummins, 2003; Darmon & Drewnowski, 2008), adopting a healthy diet may be a difficult endeavour when also experiencing scarcity.

4.1.2 The present research

Our aim was to experimentally investigate whether direct experiences of scarcity indeed result in unhealthier eating in terms of calorie intake from snacks. Specifically, by restricting the amount of choice resources in a trade-off task (based on Spears, 2011), we aimed to evoke real time experiences of scarcity including a sense of having too little and trade-off making, as to mimic daily difficult decision making with limited resources. Four experimental studies with independent student samples were performed. We designed the task such that the selection of options (goods and services) served to achieve a salient, concrete goal which was to organize a successful student party. In accordance with scarcity theory, we argued that experiences of scarcity can be induced as long as available resources to select options are insufficient to satisfy goal-related needs and desires. In Study 1 and 3, we tested the feasibility and the refinement (respectively) of the trade-off task directed at organizing a successful party for manipulating experiences of scarcity. Notably, in the limited number of studies on the cognitive effects of scarcity of resources it was not checked whether objectively receiving few versus many resources indeed resulted in different experiences of scarcity. Checking the validity of the manipulation was considered particularly important because although the experience of scarcity is socially contextualized it also depends on the subjective evaluation (own tastes) to what extent needs and desires are met (Mullainathan & Shafir, 2013). In Study 2 and 4, we tested the effect of scarcity on calorie consumption and self-reported indicators of self-regulation of eating in an experimental lab setting. Participants were requested to taste high-caloric snacks while performing the trade-off task. Eating large amounts of snacks, which are usually considered tasty (provide immediate pleasure) but unhealthy (have a long-term consideration), is generally seen as a self-defeating behaviour, especially if people have the goal to act otherwise (see also Brownell, 1991; Heatherton, Polivy, & Herman, 1991).

4.2 Study 1: Testing a manipulation of scarcity

In Study 1, we tested the feasibility of a trade-off task for manipulating experiences of scarcity. The trade-off task was inspired by a study of Spears (2011) in which participants could either choose two gifts ("rich" condition) or one gift ("poor" condition) out of three gifts. Likewise, our manipulation aimed to involve difficult decision-making processes imposed by a scarcity of choice resources on one hand and an availability of desirable options on the other hand.

4.2.1 Method

Participants, design and procedure

A total of 81 undergraduate students (22 men) with a mean age of 21.27 (*SD* = 1.73, range 19-28) voluntarily completed a trade-off task during a course lecture. Participants received a hypothetical scenario on paper that described that the participant was given the unique responsibility to organize, on behalf of the university, a successful party for fellow students. All participants were presented a list of 9 categories of goods and services desirable for a party (e.g. "drinks", "promotion"). Each category consisted of 3 equally attractive alternative choice options[5]. For instance, in the category "drinks", the 3 options listed were beer, wine, and soda and in the category "promotion" were the options email, social media, and posters/flyers (see Supplementary information 4.1.1 for the entire trade-off task). Participants in one half of the lecture room were assigned to a scarcity (experimental) condition where participants were only allowed to choose 1 option per category. The other half of participants were assigned to the no-scarcity condition (control) where multiple (up to 3) options per category could be selected. After the trade-off task, participants completed a questionnaire (self-report instrument, see below) to assess direct scarcity perceptions and potential experiences of decision-making under scarcity. For explorative purpose, psychological states suggested to result from scarcity were measured on 7-point scales, including mental engagement, cognitive load, and affect (see Supplementary information 4.2 for more details).

Measures

Self-report instrument: Scarcity and decision-making experiences

Items were based on specific definitions of scarcity perceptions as described by Mullainathan and Shafir (2013). Specifically, five items pertained to the experience of having more needs than resources and four items pertained to having to making trade-offs and sacrifices. Additionally, four items pertained to experiences potentially

5 The construction of the list of categories with desirable, competing options was based on a discussion with 3 fellow researchers and a pre-test among 30 students, respectively. From a list of 13 categories, students were asked to choose one option per category, and to mark 5 categories they perceived as the most difficult trade-offs. The 9 most marked categories were included in Study 1.

involved in decision making under scarcity, including freedom of choice, choice overload, indecisiveness, and uncertainty. The answer scale ranged from 1 (strongly disagree) to 7 (strongly agree). To validate the different dimensions in the self-report instrument, a principal component analysis was conducted with orthogonal rotation (varimax). Examination of the scree plot and eigenvalues over 1 suggested the presence of three components, in combination accounting for 73.71% of the variance. Based on saliently loading items of the three components (all loadings > .59), three reliable subscales (.71 < Cronbach's α < .94) were constructed, which we labelled respectively 'making-trade-offs', 'need for more', and 'indecisiveness'. Mean scores on these scales were computed. One item, concerning freedom of choice, did not load high on any of the components (loadings < 0.4) and was therefore removed from the total set of items. See Table 4.1 for the twelve included items, their factor loadings for the three components, and the corresponding scales.

4.2.2 Results

Independent t-tests showed that participants in the scarcity condition scored significantly higher than participants in the no-scarcity condition on the three scales. Table 4.1 reports the mean scores and standard deviations (*SD*s) per condition on each scale, and the corresponding test-statistics, Cohen's *d* effect sizes and confidence intervals. See Supplementary Table 4.1 for results of states related to scarcity, which shows that the scarcity manipulation had an effect on engagement ($p = .02$) and cognitive load ($p = .02$), but not on affect ($p = .35$).

4.2.3 Discussion

The manipulation was considered successful as participants in the scarcity condition indicated more scarcity experiences (in terms of a need for more and trade-off making) compared to participants in the no-scarcity condition.

Table 4.1. Items and their factor loadings for the three scales and results of t-tests comparing the two conditions on experienced scarcity ('Need for more' and 'Making trade-offs') and experiences related to decision making under scarcity ('Indecisiveness') in Study 1

Scales and items[1,2]	Factor loadings	Scarcity condition (*N* = 41) Mean (*SD*)	No-scarcity condition (*N* = 40) Mean (*SD*)	*t*-test (*df* = 79)	Cohen's *d*	95% CI Lower Bound	95% CI Upper Bound
Making trade-offs		5.42 (0.90)	2.53 (1.35)	11.29***	2.51	2.38	3.40
... I needed to give up other choices	.856						
... I had to make a trade-off to come to a choice	.876						
... I had difficulty choosing	.823						
... making a choice meant not having another attractive option	.859						
Need for more		5.36 (0.89)	3.86 (1.74)	4.81***	1.09	0.89	2.10
... I wanted to choose more than I could	.827						
... I could choose too little	.842						
... I had enough choice[3]	.837						
... I wanted to be able to choose more	.831						
... I was restricted in my choice	.762						
Indecisiveness		3.36 (0.93)	2.37 (1.24)	4.05***	0.90	0.50	1.48
... I was overwhelmed with choices	.799						
... I was indecisive	.730						
... I was uncertain	.590						

Note: *** $p < .001$. [1]Questionnaire started with the phrase "During choosing I had the feeling that…". [2] Answered on scale ranging from 1 to 7. [3]Responses recoded.

4.3 Study 2: Testing the effect of scarcity on unhealthy food intake

In Study 2 we examined the impact of scarcity on unhealthy food intake. While completing the trade-off task as developed in Study 1, participants were requested to taste high-caloric snacks. The trade-off task and the 'tasting task' were performed simultaneously to be consistent with scarcity theory. Mullainathan and Shafir (2013) suggest that scarcity and the preoccupation it causes has an immediate effect, resembling cognitive load. It was hypothesized that participants in the scarcity condition consumed more calories from snacks than participants in the no-scarcity condition. Furthermore, following the reasoning that scarcity reduces cognitive capacity and thereby undermines self-regulation of eating in the presence of tempting snacks (immediately pleasurable and high-calorie foods), we additionally examined whether the scarcity condition reported a higher wanting of food and lower inhibition of eating (Hofmann et al., 2008; Strack & Deutsch, 2004).

4.3.1 Method

Participants and design

Students were recruited via email, social media, flyers, posters, direct person-to-person, and during course lectures. G*power was used to calculate the sample size needed to detect an effect size of f = 0.30, which was sourced from two previous studies that experimentally tested the effect of poverty/scarcity on calorie intake from snacks (Bratanova et al., 2016; Laran & Salerno, 2013). To reach at least a power of 80% (alpha of 0.05), a total sample size of N = 90 was required for data analysis. We did not use a pre-defined stopping rule. Instead, experiments were continued for the full three weeks during which the laboratory rooms were available, eventually resulting in a laboratory visit of 104 students. After pre-testing the procedure among three students, the experimental protocol was finalized. A total of 101 students participated in a two-group between-subjects experiment in exchange for a small monetary reward of 5 euros. We excluded six participants from analysis: three participants had a food allergy related to the presented snacks, and three participants did not adhere to instructions (two participants did not eat any snacks and one participant grabbed a hand of snacks after the experiment had finished). As a result, the sample for analysis consisted of 95 participants (12 men) with an average age of 20.83 (*SD* = 2.20, range 18-28).

Manipulation

The scarcity manipulation involved the trade-off task as explained in Study 1. Based on the frequency distribution of chosen options in Study 1, small adaptations to the trade-off task were made. One category with two infrequently options chosen was removed from the task, and two other infrequently chosen options were replaced by other, intuitively

more attractive options (see Supplementary information 4.1.2 for the adapted trade-off task).

Procedure and measures

Participants who signed up for the study, were scheduled for an individual test session during daytimes (between 9.30-17.00h). Participants were randomly assigned to either the scarcity (experimental) or no-scarcity (control) condition using a computer-generated numbers list. Upon entering the lab, participants read and signed the informed consent. Thereafter, the first questionnaire was administered which included demographic measures (i.e. age, gender, year and field of study), an item measuring hunger ("How hungry are you at this moment?", embedded among four filler state items i.e. thirst, stress, mood, and fatigue), and items measuring healthy eating goal and restraint eating goal ("In daily life I try to eat healthily" and "In daily life I try to eat not too much, embedded among eight filler daily life goal items (e.g. physical activity, relaxation). All items of this first questionnaire were answered on a 7-point scale ranging from 1 (not at all) to 7 (very much). In the adjacent room (decorated with party items), participants were seated at the table with the trade-off task sheets, a cup of water and 4 bowls with different snacks (M&Ms, popcorn, crispy coated peanuts, and crisps). The four types of food were used to balance for a preference for sweet or savoury snacks. These snacks were deemed as tasty and unhealthy foods (all contained a minimum energy value of 400 Kcal per 100 gram) and consumption thereof is likely susceptible to self-regulation resources. All bowls (12 cm diameter and 8 cm deep) were fully filled so that an individual could eat substantial amounts without creating any obvious indication of consumption (target weights were crisps 80 grams, crispy coated peanuts 230 grams, popcorn 70 grams, and M&Ms 400 grams). As a cover story, participants were told that we investigated students' views on the ideal student party, and that the party decoration served to appeal to one's imagination in the task, as well as to explore the influence of party atmosphere on taste perception. Participants were told to consume whatever and as much of the snack as they desired during the task. After 8 minutes, which was considered sufficient time to complete the task and taste the snacks, the experimenter returned, replaced the snacks at the far end of the room, and presented the participants with the last questionnaire that included the scarcity and decision making experiences questionnaire, scarcity-related states during the task (stress was measured in addition), boredom after the task ("How bored were you after filling in the task?"), wanting of snacks ("How much did you want [snack]?"), liking of consumed snacks (e.g. "The crisps were tasty"), and inhibition of eating ("Did you inhibit yourself from consuming snacks?"), (in that order). The 7-point answer scale of the items of the last questionnaire ranged from strongly disagree to strongly agree for items formulated as statements and from not at all to very much for items formulated as questions. A final question asked to state what they thought the purpose of this study was. None of the participants mentioned the true purpose of the study (i.e. the relation

between scarcity and snack intake)[6]. Finally, participants were thanked, reimbursed and debriefed upon request by email. Each of the bowls of snacks was unobtrusively weighed with a kitchen scale (0.1 grams precision) before and after participation, these eight weight values were all collected in a predesigned table on a sheet of paper coded with the participant number. Consumed calories per snack were calculated based on the consumed weight and the energy content indicated on the product label. A composite score was formed, summing together the consumed calories of the four snacks.

4.3.2 Results

Descriptives and comparability between conditions

As calorie consumption was highly positively skewed, a logarithmic transformation was used to normalize the distribution of residuals. Participants on average indicated having a goal to eat healthily (M = 5.49, SD = 1.01), and a somewhat restraint eating goal (M = 4.40, SD = 1.28*)*. Participants liked the snacks they consumed, with the M&Ms gaining the highest rating, which indicates that the snacks were indeed tasty and pleasurable to consume ($M_{\text{M\&M's}}$ = 5.99, SD = 1.02; M_{popcorn} = 4.89, SD = 1.76; M_{crisps} = 5.25, SD = 1.49; $M_{\text{crispy coated peanuts}}$ = 4.46, SD = 1.83). Conditions did not differ on pre-test variables age, hunger, healthy eating goal, restraint goal, t's (93) < .25, p's > .18, and gender, χ^2 (1, N = 95) = 1.25, p = .26, suggesting our randomization was successful. Conditions neither differed on the post-test variable boredom, t(93) = .19, p = .85, indicating that we can rule out this potential alternative explanation for consumption. An analysis of significant correlations between the control variables and dependent variables resulted in the identification of gender and hunger as relevant covariates. Means, *SD*s and correlations of the variables under study are reported in Supplementary Table 4.2.

Manipulation check and exploration of states

Independent t-tests revealed that participants in the scarcity condition scored significantly higher than participants in the no-scarcity condition on experienced scarcity scales 'need for more' and 'making trade-offs', as well as on 'indecisiveness'. Hence, the manipulation appears successful. Table 4.2 reports the mean scores and *SD*s per condition on each of these scales, and the corresponding test-statistics, Cohen's d effect sizes and confidence intervals.

See Supplementary Table 4.3 for results of scarcity-relates states. No significant differences between conditions were found in engagement, cognitive load, stress, and affect (p's > 0.20).

6 Excluding 11 participants who mentioned snack intake as a possible purpose did not change the pattern of results.

Table 4.2. Results of t-tests (Study 2 and 4) and post hoc Dunnett's test (Study 3) comparing the conditions on experienced scarcity ('Need for more' and 'Making trade-offs') and 'Indecisiveness'

	Conditions				95% CI	
	Scarcity	No-scarcity *No-scarcity extra*				
Scale (Cronbach's α)	**Mean *(SD)***	**Mean *(SD)***	***t*-test**	**Cohen's *d***	**Lower bound**	**Upper bound**
Study 2	*N* = 49	*N* = 46	*df* = 93			
Need for more (.87)	5.41 (0.86)	4.05 (1.50)	5.39***	1.11	0.87	1.86
Making trade-offs (.91)	5.62 (0.90)	2.73 (1.16)	13.57***	2.78	2.46	3.31
Indecisiveness (.68)	2.80 (1.09)	2.17 (0.89)	3.01**	0.63	0.22	1.04
	N = 39	*N* = 38				
Study 3		*N = 38*				
Need for more (.88)	5.53 (0.84)[a]	3.36 (1.51)[b]	N/A	1.78	-2.79	-1.55
		2.98 (1.18)[b]	N/A	2.50	-3.17	-1.94
Making trade-offs (.91)	5.60 (1.00)[a]	2.53 (1.28)[b]	N/A	2.67	-3.66	-2.50
		2.38 (1.11)[b]	N/A	3.05	-3.80	-2.64
Indecisiveness (.71)	2.74 (1.08)[a]	2.06 (1.02)[b]	N/A	0.65	-1.20	-0.14
		2.36 (1.00)[a]	N/A	0.37	-0.91	0.16
Study 4	*N* = 59	*N = 63*	*df* = 120			
Need for more (.89)	5.34 (0.89)	*2.99 (1.24)*	11.98***	2.18	1.96	2.74
Making trade-offs (.91)	5.76 (0.94)	*2.82 (1.08)*	16.01***	2.90	2.58	3.30
Indecisiveness (.76)	2.77 (1.20)	*2.59 (1.09)*	*ns*	0.16	-0.23	0.59

Note: ** $p < .01$, *** $p < .001$. Study 3: Means with different superscripts differ significantly ($p < .05$). Study 3 and 4: The means and SDs of the 'No-scarcity extra' condition are presented in italics. N/A = not applicable.

Test of hypotheses: Calories consumed

Checking the analysis of covariance (ANCOVA) assumption of homogeneity of regression slopes for the full sample (N = 95) revealed a significant interaction between the mean centered covariate hunger and condition, $F(1, 91) = 5.85$, $p = .018$, $\eta_p^2 = .06$. Hence, this assumption was violated and hunger cannot be used as covariate in an ANCOVA model. To test the hypothesized main effect of condition on calorie consumption after checking all assumptions, a full model ANCOVA with gender as covariate and condition, hunger and their interaction on log-transformed calories consumed was performed. There was no significant main effect of condition on calorie consumption, $F(1, 90) = 1.08$, $p = .30$, 95% CI [-0.09, 0.28], $\eta_p^2 = .12$. Participants in the scarcity condition ($M_{\text{untransformed}} = 126.88$, $SD = 125.44$; $M_{\text{adj, log-transformed}} = 1.93$, $SE = 0.06$) did not differ in the amount of calories consumed from participants in the no-scarcity condition ($M_{\text{untransformed}} = 132.68$, $SD = 148.02$; $M_{\text{adj, log-transformed}} = 1.84$, $SE = 0.07$).

We additionally tested whether the extent of experienced scarcity influenced calories consumption, irrespective of condition. A multiple regression analysis on 'need for more', 'making trade-offs', gender and hunger accounted for 16.5 % of the variance in log-transformed calories consumed, $F(4, 90) = 4.43$, $p = .0003$, $R^2 = 16.5$. Although the bivariate correlation between 'need for more' and log-transformed calories consumed was marginally significant ($r = .19$, $p = .071$), 'need for more' and 'making trade-offs' did not relate to log-transformed calorie consumption in the full regression model, $\beta = 0.18$, $t(90) = 1.47$, $p = .14$, and $\beta = -0.02$, $t(90) = -0.51$, $p = .61$, respectively.

Test of hypotheses: Wanting of snacks and inhibition of eating

Average wanting of snacks presented correlated positively to calories consumed, $r = .42$, $p < .001$, but inhibition of eating was not correlated with calories consumed, $r = -.02$, $p = .84$. Controlling for gender and hunger, no differences between the scarcity condition ($M_{\text{adj}} = 3.62$, $SE = 0.13$) and the no-scarcity condition ($M_{\text{adj}} = 3.59$, $SE = 0.01$) were found in wanting of snacks, $F(1, 91) = 0.03$, $p = 0.86$, 95% CI [-0.33, 0.39], $\eta_p^2 = 0.00$. The scarcity condition ($M = 3.58$, $SD = 1.68$) and no-scarcity condition ($M = 3.89$, $SD = 1.40$) neither differed in reported inhibition of eating, $F(1, 91) = 0.91$, $p = .34$, 95% CI [-0.94, 0.33], $\eta_p^2 = 0.01$.

Exploratory analyses

For exploratory reasons, we further disentangled the non-hypothesized interaction between hunger and condition that was found upon checking the ANCOVA assumption of homogeneity of regression slopes. Simple slope analyses (see Aiken & West, 1991) demonstrated that for participated with a low level of hunger (-1SD), conditions differed on the calories consumed, such that the scarcity condition consumed significantly more calories than the no-scarcity condition ($\beta = -0.35$, $t(91) = -2.64$, $p = .01$). However, for participants with a high level of hunger (+1SD), no significant difference between

conditions was observed (β = 0.10, $t(91) = 0.78$, $p = .44$). Checking the assumption of homogeneity of regression slopes without two outliers (two participants consumed a disproportional amount of calories, z-scores > 4), revealed a non-significant (or 'marginally' significant) interaction between hunger and condition on square root transformed calories, $F(1, 89) = 3.42$, $p = .068$, $\eta_p^2 = .04$. Exclusion of the two outliers did not change the results of tests of hypotheses.

Since consuming a large amount of calories may be especially defeating for individuals who have the goal to act otherwise (see also Brownell, 1991; Heatherton et al., 1991), it was additionally tested whether restraint eating goal interacted with scarcity condition on calorie consumption. This interaction was not significant, $F(5, 82) = 1.04$, $p = 0.40$, indicating that the effect of scarcity on the amount of calories consumed did not depend on participants' restraint eating goal.

4.3.3 Discussion

In Study 2, no support was found for the hypothesized main effect of scarcity on unhealthy food intake, wanting of snacks or inhibition of eating. Although not hypothesized, a (marginally significant) interaction between condition and hunger was found. Scarcity appeared to affect calorie consumption under low hunger levels. Hunger is a strong primary motive that overrules alternative motives (Loewenstein, 1996), and it is plausible that people would be more sensitive to scarcity under situations where such strong biological motives are not active. Hence, our findings concerning the effect of scarcity on eating behaviour remain inconclusive. Furthermore, we noted that also control group participants reported a rather high level of scarcity. Even when all options could be chosen, the task may have evoked feelings of wanting to have more. This highlights the theoretical notion that experienced scarcity depends not only on objective resources but also on personal tastes and subjective perception of how much is needed to accomplish (Mullainathan & Shafir, 2014). To test the scarcity hypothesis under more stringent conditions, the experiment was replicated with an improved scarcity manipulation in a sample with low hunger level.

4.4 Study 3: Refining the scarcity manipulation

In Study 3 we aimed to improve the scarcity manipulation used in Study 2. More specifically, by making small changes to the design of the manipulation we aimed to limit experiences of scarcity in participants in the no-scarcity condition.

4.4.1. Method

Participants, design, and procedure

The design and procedure of this study were similar to Study 1 (N = 115, 30 men, mean age 20.27 (SD = 1.62, range 17-25). Two changes were made to the trade-off task compared to Study 2: Two new categories were added, and one option was added to each category[7]. Hence, the trade-off task consisted of 10 categories of 4 options. One extra no-scarcity condition was created in which participants could freely add options to each category (i.e., the "no-scarcity extra condition"). To limit the induction of extra effort of this no-scarcity extra condition compared to the no-scarcity condition, we added a sentence to the instruction that additional options were only to be filled in when there was a desire to add something extra. Another sentence was added to the instruction of all conditions stating that for each category a 'restricted budget' (scarcity condition) versus a 'certain budget' (no-scarcity conditions) has been provisioned by the university. Adding this phrase was done to provide a logical reason – related to financial resources - why participants could choose only one option (scarcity condition) versus multiple (no-scarcity) per category. See Supplementary information 4.1.3 for the 'no-scarcity extra' version of the trade-off task. Participants in one-third of the lecture room were assigned to the scarcity condition, one-third of students in the lecture room were assigned to the no-scarcity condition where all (up to 4) options per category could be selected, and the final one-third was assigned to the no-scarcity extra condition where all options could be selected plus one idea could be added (5 options in total).

4.4.2 Results

Experiences of scarcity and indecisiveness

One-way ANOVAs showed there was a significant difference between the three conditions on 'need for more', $F(2, 112) = 50.54$, $p < .001$, 'making trade-offs', $F(2, 112) = 99.16$, $p < .001$, and 'indecisiveness', $F(2, 110) = 4.04$, $p = .020$. Table 4.2 reports the means, SDs per condition on each of these scales, and the post hoc results, Cohen's d effect sizes and confidence intervals. Post hoc tests (Dunnett's) revealed that a higher need for more and trade-off making was reported by the scarcity condition compared to both the no-scarcity conditions, p's $< .001$. Significantly more indecisiveness was reported by the scarcity condition compared to the no-scarcity condition, $p = .010$, but not compared to the no-scarcity extra condition $p = .20$. See Supplementary Table 4.4 for results of scarcity-related states (only engagement and cognitive load were assessed). The scarcity condition scored higher on engagement than the no-scarcity extra condition ($p < .01$) but not compared

7 The added options were based on frequently reported answers on a filler question in the post-test questionnaire in Study 2, asking what items participants would add for an ideal party.

to the no-scarcity condition (p = .46). There was no difference on cognitive load between scarcity condition and the no-scarcity conditions (p's > .09).

4.4.3 Discussion

Small adjustments in the design of the trade-off task resulted in an improved scarcity manipulation as the no-scarcity conditions generally reported lower means (and standard deviations) for need for more and making trade-offs in this study than in Study 1 and Study 2. As the no-scarcity extra condition reported the lowest means for need for more and making trade-offs, this no-scarcity condition was used in Study 4.

4.5 Study 4: Testing the effect of scarcity on unhealthy food intake under low level of hunger

Study 4 was a replication of Study 2 under more stringent conditions. Specifically, in this experiment we explicitly instructed participants to have eaten within one hour prior to participation, and used the improved scarcity manipulation of Study 3. We hypothesized that with the improved scarcity manipulation and with a sample with low hunger, scarcity results in more calorie consumption, and a higher wanting of snacks and lower inhibition of eating.

4.5.1 Method

Participants and design

In addition to the participant recruitment strategies used in Study 2, students seated in the university canteen were approached and requested to participate within one hour after finishing their meal. A greater sample size than Study 2 was desirable to allow exclusion of participants not adhering to the instruction to eat prior to participation (see procedure). As no exact estimation of this exclusion could be made, and no preliminary analyses or calculations were performed during the data collection, recruitment efforts were increased over a three-week period during which the laboratory rooms were available. The procedure was pre-tested among three students who were not included in the analysis. One hundred forty-one students participated in a two-group between-subjects experiment in exchange for a monetary reward of 5 euros. Sixteen participants were excluded from analyses because they did not adhere to the inclusion criterion to eat within an hour prior to the experiment (see procedure). Three participants who had an allergy related to the presented snacks were excluded. Hence, the sample for analysis consisted of 122 participants (20 men), with an average age of 20.26 (SD = 2.10, range 18-31).

Procedure and measures

The procedure was identical to Study 2, except for the following adaptations related to the aim to form a sample with low level of hunger. Participants were scheduled for an individual lab session between 8.30-11.00h and between 12.00-15.00h as these times plausibly were closely preceded by breakfast and lunch. Furthermore, participants were instructed verbally (in the university canteen) or by email to have eaten within one hour before participation. Upon arrival to the laboratory room, participants were verbally asked whether they had eaten in the last hour. If the answer was no, they were asked to make a new appointment for participation (this occurred four times). One item was added to the pre-test questionnaire, to check more objectively when was the last time participants had eaten (i.e. "When did you eat *last*?"). As in Study 2, none of the participants identified the true purpose of the study[8].

4.5.2 Results

Descriptives and comparability between conditions

A square root transformation on calories consumed was used as this transformation resulted in normally distributed residuals. Participants reported having a goal to eat healthily ($M = 5.61$, $SD = .90$), and a somewhat restraint eating goal ($M = 4.41$, $SD = 1.34$). Participants indicated to like the snacks they consumed ($M_{\text{M\&M's}} = 5.96$, $SD = 1.17$; $M_{\text{popcorn}} = 4.65$, $SD = 1.61$; $M_{\text{crisps}} = 5.38$, $SD = 1.52$; $M_{\text{crispy coated peanuts}} = 4.64$, $SD = 1.48$). This sample reported an average hunger level of 2.16 ($SD = 1.11$) on a 7-point rating scale. Conditions did not differ on pre-test variables age, hunger, healthy eating goal, restraint eating goal, *t*'s (120) < .24, *p*'s > .14, and gender, χ^2 (1, N = 122) = 0.11, $p = .74$, indicating successful randomization. As the scarcity condition reported to experience significantly more boredom after the task ($M = 3.86$, $SD = 1.59$) compared to the no-scarcity condition ($M = 3.13$, $SD = 1.61$), $t(120) = 2.54$, $p = .012$, boredom was included as a covariate in the analyses of calories consumed. Analysis of correlations between the control variables and dependent variables resulted in the identification of gender and hunger as additional covariates in the analyses of calories consumed, age and hunger as covariates in the analyses of wanting of snacks, and age in the analyses of inhibitions of eating. Means, *SD*s and correlations of all variables under study are reported in Supplementary Table 4.5.

Manipulation check and exploration of states

T-tests showed that participants in the scarcity condition scored significantly higher than those in the no-scarcity condition on experienced scarcity scales 'need for more' and 'making trade-offs', but not on 'indecisiveness'. See Table 4.2 for the results of this manipulation check. See Supplementary Table 4.6 for results of scarcity-related states. Scarcity condition scored higher on engagement than the no-scarcity condition ($p < .01$).

8 Excluding 17 participants who mentioned snack intake did not change the pattern of results.

No differences between conditions were found on cognitive load ($p = .44$), affect ($p = .42$), and stress ($p = .90$).

Tests of hypotheses: Calories consumed[9]

To assess the effect of scarcity condition on calories consumed, an ANCOVA was conducted with gender, hunger, and boredom as covariates. All of the identified covariates (i.e. gender, hunger, boredom) did not interact with condition, meaning that the assumption of homogeneity of regression slopes was met. There was no significant main effect of condition on calorie consumption $F(1, 117) = 0.02$, $p = .88$, 95% CI [-1.63, 1.89], $\eta_p^2 = .00$. Participants in the scarcity condition ($M_{\text{untransformed}} = 130.49$, $SD = 107.10$; $M_{\text{adj, square root-transformed}} = 10.46$, $SE = 0.63$) did not differ in calories consumed from those in the no-scarcity condition ($M_{\text{untransformed}} = 132.98$, $SD = 123.98$; $M_{\text{adj, square root-transformed}} = 10.33$, $SE = 0.61$). Also the extent of experienced scarcity was not related to calories consumed, as 'need for more', $\beta = -0.07$, $t(116) = -0.53$, $p = .60$, and 'making-trade-offs', $\beta = 0.10$, $t(116) = 0.75$, $p = .46$ were no significant predictors in a multiple regression model including the covariates gender, hunger, and boredom, $F(5, 116) = 2.20$, $p = .06$, $R^2 = .09$.

Tests of hypotheses: Wanting of snacks and inhibition of eating

Wanting of snacks and inhibition of eating both significantly correlated with calories consumed in the expected direction, respectively $r = .28$, $p = .001$, and $r = -.27$, $p = .003$. An ANCOVA controlling for age and hunger showed no differences between the scarcity condition ($M_{\text{adj,}} = 3.31$, $SE = 0.13$) and the no-scarcity condition ($M_{\text{adj}} = 3.48$, $SE = 0.13$) on wanting of snacks, $F(1, 118) = 0.99$, $p = .32$, 95% CI [-0.53, 0.18], $\eta_p^2 = .01$. An ANCOVA controlling for age revealed that the scarcity condition ($M_{\text{adj,}} = 3.56$, $SE = 0.21$) and no-scarcity condition ($M_{\text{adj,}} = 3.51$, $SE = 0.20$) neither differed in reported inhibition of eating, $F(1, 119) = 0.03$, $p = .86$, 95% CI [-0.53, 0.63], $\eta_p^2 = .00$.

Exploratory analysis

Conform Study 2, it was tested whether restraint eating goal interacted with scarcity condition on calorie consumption. This interaction was again not significant, $F(5, 109) = 1.18$, $p = 0.33$.

4.5.3 Discussion

In contrast to our expectations, the results of Study 4 indicated that scarcity did not result in more calorie consumption, a higher wanting of snacks or a lower inhibition of eating, in a sample with relatively low self-reported hunger. The effect sizes of experienced scarcity

9 The tests of hypotheses were also performed on a subsample of participants reporting little hunger. Excluding sixteen participants from the current sample who rated their hunger level as more than 3 on a 7-point rating scale (i.e. 4, 5, 6, or 7) did not affect the results of the tests of hypotheses as reported.

were greater than those in Study 2, indicating that the manipulation used in Study 4 resulted more successfully in the induction of scarcity versus no scarcity experiences.

4.6 General discussion

The present research indicates that although the trade-off task seemed to evoke scarcity experiences, these do not affect eating behaviour (calorie consumption and self-regulation of eating). Hence, whereas previous studies showed that scarcity and trade-off making negatively affect cognitive and attentional outcomes (Mani et al., 2013; Shah et al., 2012); the current research could not support the notion that directly experiencing scarcity also resulted in unhealthy eating. Our results are in line with a longitudinal study of Prentice et al. (2017) that found that at-the-moment financial strain was not associated with health behaviours and a diet-related outcome of overweight. However, there are also studies that show a relation between scarcity and eating behaviour, albeit not experimentally. We discuss three dominant explanations for the inconsistency in the literature regarding this relationship. These explanations may shed light on a more precise conceptualization and operationalization of scarcity-induced eating.

First, it may be that scarcity needs to be experienced as urgent and personally threatening to observe an effect on eating behaviour. This is in line with the suggestion that the enhanced focus on scarcity results particularly from its threat to well-being: inability to fulfil one's basic needs can have negative and immediate, personal consequences (Koster, Crombez, Van Damme, Verschuere, & De Houwer, 2004; Mullainathan & Shafir, 2013). An experimental study on perceived poverty found that manipulating perceived financial scarcity by reading and writing a text about personal experiences with poor versus rich circumstances did affect subsequent calorie intake (Bratanova et al., 2016). Likewise, a cross-sectional study found that financial strain, as measured by questions asking to what extent participants could make ends meet and experienced financial difficulties in paying bills for basic needs (e.g. food, electricity) in the preceding year was associated with decreased fruit and vegetable intake (Beenackers et al., 2017). Also, a longitudinal study showed that evaluations of the family as very poor to just getting by given needs and financial responsibilities increased calorie but decreased fruit and vegetable consumption (Venn & Strazdins, 2017). In contrast to these studies, the present study did not involve personal money resources for meeting basic living needs (poverty concerns), but hypothetical others' resources (i.e. of the university) for meeting needs related to a luxurious event. We reasoned that, following the basic definition of experiencing scarcity (i.e. "a subjective sense of having more needs than resources") (Mullainathan & Shafir, 2014, p. 86), scarcity could be experienced as long as resources are insufficient to fulfil needs and desires. Thereby it was assumed that a certain student culture would shape

these needs and desires, allowing to compose a uniform trade-off task. Indeed, scarcity was experienced according to these definitions, yet this did not translate to unhealthier eating.

Second, scarcity may have a more pronounced effect on behaviour when it is relative rather than absolute. It has been suggested that subjective experience of scarcity may not be best shaped by absolute availability of resources, but instead by social comparisons with the wealth of others (Festinger, 1954; Sim, Lim, Forde, & Cheon, 2018). Growing evidence shows that subjective perception of own worth compared to others may be more predictive of health than objective, absolute socioeconomic status (SES) indicators including income (Adler, Epel, Castellazzo, & Ickovics, 2000; Boyce, Brown, & Moore, 2010). Based on the proposition that upward social comparisons are a particular powerful drive for compensation with resources (e.g. food), a recent experimental study showed that personal relative deprivation increases calorie selection and intake (Sim et al., 2018). Plausibly, in the current research scarcity would be experienced to a higher extent when the manipulation involved an upward (versus downward) comparison with others who received more (versus less) resources and this provides an interesting direction for future studies.

Third, chronic experiences of scarcity may be more relevant in explaining unhealthy eating than acute or temporal experiences. Longitudinal studies have concluded that especially persistent, chronic financial scarcity or stress results in less healthy eating behaviours (Siahpush et al., 2014; Venn & Strazdins, 2017). The present study aimed to test whether temporarily induced scarcity affects eating behaviour, which is in line with both scarcity theory and self-regulation theory. For example, a correlational study found that shopping, an economic decision-making activity) is associated with more simultaneous eating among poorer and not among richer people (Spears, 2011). However, the influence of income scarcity on eating behaviour may particularly come forward when chronic threats to well-being occur (e.g. savings are drawn). Prolonged experiences of income scarcity may stimulate the development of eating habits that undermine a healthy diet.

Altogether, it can be argued that scarcity needs to be experienced in a sufficiently intrusive way for observing an effect on eating behaviour. Notably, the manipulation in the present study was inspired by previous successful studies showing cognitive effects of dealing with scarce resources, using manipulations involving game playing (Shah et al., 2012) and choosing gifts (Spears, 2011). Although it appeared that we succeeded in manipulating experiences of scarcity, this experience may have been insufficiently intrusive to affect a multifactorially determined behaviour such as food intake. This was also reflected by the inconsistent results of the scarcity-related processes that were assessed in each of the four studies and that could act as mechanisms in the effect of scarcity on snack intake (an

effect on mental engagement was observed in three studies, on cognitive load only in the first study). However, this conclusion can only be drawn carefully given the psychometric quality of the measures (i.e. with the exception of engagement, the process variables were measured with one-item). Null findings may also be due to a lack of power, however, since our sample size is larger than was predetermined in a power calculation and exceeds those in previous similar experiments including food consumption (Bratanova et al., 2016; Sim et al., 2018), a lack of power does not seem a satisfactory explanation.

Although not a priori hypothesized, in the first lab experiment (Study 2), an interaction between the scarcity condition and hunger bordered significance, such that scarcity may only affect calorie consumption under low levels of hunger. This finding was intriguing as a similar pattern was observed in a correlational study by Hill, Prokosch, DelPriore, Griskevicius, and Kramer (2016): participants raised in low SES neighbourhoods, characterized by scarcity of resources, consumed a high amount of calories independent of their energy need, whereas those raised in high SES neighbourhoods regulated their caloric consumption according to their energy need. Based on Life History theory, the authors suggested that growing up in resource-scarce environments stimulates eating in the absence of hunger as this would promote survival. Bratanova et al. (2016) also suggested that the effect of poverty perceptions on food intake would occur in the absence of hunger, although this was not tested in their studies. However, in our second lab experiment (Study 4) in which participants were explicitly instructed to eat prior to participation, an effect of scarcity under low hunger level could not be replicated. Altogether, we conclude that no effect of scarcity on eating was found. We advise future research on the relationship between scarcity and eating behaviour to assess or manipulate hunger level.

4.6.1 Limitations and strengths

The present study also has limitations that need to be acknowledged in these interpretations. First, scarcity-related processes (e.g. cognitive load, stress) and indications of self-regulation of eating were mainly measured by single item retrospective measures, which may not have been reliable. Although calorie consumption was the main focus of the study, it would be an interesting direction for future research studying the effect of scarcity on eating to check a scarcity manipulation not only by measuring perceived scarcity but also to assess these processes more thoroughly. For instance, state cognitive control can be more directly assessed with a computer task measuring impulse inhibition and stress more objectively by blood pressure and heart rate measures. Second, we did not measure participants' own income level and financial strain in personal life, and hence we cannot rule out that personal scarcity was not equal between conditions. However, we did not expect influence of income for two reasons. Firstly, the lab experiments were based on random assignment. Therefore one would not expect differences in income between

conditions. Secondly, in our manipulation participants were (hypothetically) *put in a new situation* of trying to fulfil needs under scarcity (versus no-scarcity); this would induce a direct experience of scarcity. It is implausible that participants would think of their personal financial situation when conducting this task. Third, as we did not assess time to complete the trade-off task in the lab studies, it remains unclear whether differences in duration of completion between conditions may have differentially affected cognitive capacity and eating. Fourth, we only assessed immediate calorie intake of snacks as eating such tasty but unhealthy foods was considered particularly susceptible to impulsive tendencies, but it would also be of interest to test whether scarcity affects other eating behaviours that contribute to unhealthy eating patterns, including food choice, consumption of main meals, and overall daily calorie intake. Nevertheless, this is one of the first studies to experimentally investigate the direct causal effect of scarcity experiences on (one type of) eating behaviour. Future studies may investigate more lasting effects of scarcity on eating behaviours that contribute to unhealthy eating patterns. Nevertheless, this is one of the first studies to experimentally investigate the direct causal effect of scarcity experiences on (one type of) eating behaviour. Our study was distinct from previous studies in that it focused on acute dealing with scarcity, involving trade-offs and sacrifices that reinforce the feeling of having less than needed (Mullainathan & Shafir, 2013). This study succeeded in developing a successful trade-off task including various needed and desirable options, resulting in experiences of having too little and wanting more. To our knowledge, this study was the first to comprehensively check whether objective forms of scarcity (in this study receiving few resources to choose options) translate to subjective experiences of scarcity while these are in essence shaped by personal evaluations.

4.7 Conclusion

In conclusion, our studies did not show an acute effect of experienced scarcity on caloric intake. We argue that not all forms of experienced scarcity are sufficiently threatening to affect eating behaviours. Rather, based on previous successful studies, we suggest that scarcity posing a threat to personal well-being, a relative form of scarcity, or a more persistent experience of scarcity may be more likely to have negative consequences for healthy eating. Our findings call for a more nuanced view of scarcity and how and under what circumstances scarcity affects eating behaviour. Future research should sharpen the conceptualization of scarcity and evaluate specific elements of scarcity in their relevance to eating behaviour. These insights could inform new psychological interventions for decreasing diet quality disparities between income groups.

CHAPTER 5

THE EFFECT OF PERSONAL RELATIVE DEPRIVATION ON FOOD CHOICE: AN EXPERIMENTAL APPROACH

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Abstract

Growing evidence suggests that relative disadvantage is more relevant than absolute socioeconomic factors in explaining disparities in healthfulness of diet. In a series of pre-registered experiments, we tested whether personal relative deprivation (PRD), i.e. the sense that one is unfairly deprived of a deserved outcome relative to others, results in choosing more palatable, rewarding foods. Study 1 (N = 102) demonstrated the feasibility and effectiveness of a game for inducing real-time experiences of PRD. Study 2 (N = 287) showed no main effect of PRD condition on hypothetical food choices, but an interaction between chronic PRD and condition revealed that those in the PRD condition chose more rewarding foods when feeling chronically deprived. In Study 3 (N = 260) the hypothesized main effect was found on real, non-hypothetical food choices: those in the PRD condition chose more rewarding foods, controlling for sensitivity to palatable food. Our results provide preliminary indications that the experience of being relatively deprived, rather than the objective amount or resources, may result in a higher preference for high-caloric and palatable foods. It may be suggested that efforts to reduce societal disparities in healthfulness of diet may need to focus on perceptions of injustice beyond objective inequalities.

5.1 Introduction

The association between socioeconomic status (SES) and diet quality is globally well established (Appelhans et al., 2012; Darmon & Drewnowski, 2008). People living on a low income have unhealthier diets (Hough & Sosa, 2015) and higher rates of diet-related diseases such as obesity (Thirlaway & Upton, 2009; Vlismas, Stavrinos, & Panagiotakos, 2009) than people who are better off. Dominant explanations for socioeconomic disparities in diet and obesity have focused on physical and economic food access. Unhealthy food outlets are more prevalent in low SES neighbourhoods (Hilmers, Hilmers, & Dave, 2012), and it has been claimed that unhealthy foods are cheaper than healthy alternatives (Rao, Afshin, Singh, & Mozaffarian, 2013). Importantly, having a low income or a low educational status in an absolute sense does not fully explain socioeconomic inequalities in diet. Inequality also comprises a relative aspect, i.e. earning less than others or being less educated than others. Relative disadvantage may even be more relevant than absolute factors like income. This is illustrated with epidemiological evidence showing a positive correlation between societal income inequality and obesity prevalence (Pickett, Kelly, Brunner, Lobstein, & Wilkinson, 2005; Su, Esqueda, Li, & Martinez-Pagan, 2012), even after controlling for absolute socioeconomic measures (Pickett & Wilkinson, 2015; Subramanian & Kawachi, 2004). Additionally, growing evidence shows that subjective, relative wealth is indeed more predictive of health than objective, absolute socioeconomic indicators (Daly, Boyce, & Wood, 2015). The relative deprivation hypothesis proposes that making upward comparisons has negative psychological consequences, leading to health compromising behaviour (Eibner & Evans, 2005). Focusing on dietary behaviour specifically, a correlational study showed that the Yitzhaki index, a demographic measure of relative deprivation (income), was associated with self-reported behaviours such as less healthful food choices (Elgar, Xie, Pförtner, White, & Pickett, 2016). However, evidence for a causal relation between relative deprivation and diet quality at the proximate, individual level is lacking. In a series of experimental studies, we aimed to address this gap by experimentally inducing relative deprivation and investigating how it affects food choice behaviour.

A common conceptualization of subjective, individual-level relative deprivation is personal relative deprivation (PRD), which relates to feelings of frustration and resentment in response to the idea of being deprived of a deserved and desired outcome, stemming from upward comparisons with similar others (Callan, Ellard, Will Shead, & Hodgins, 2008; Runciman & Runciman, 1966; Smith & Ortiz, 2002; Smith et al., 2012). Human concern for justice is a key prerequisite for the experience of relative deprivation (e.g. Olson, 2014), which in turn produces perceptions of injustice and unfairness (Callan, Ellard, & Nicol, 2006; Callan et al., 2008; Smith et al., 2012). PRD has been associated with various adverse outcomes, including depression (Beshai et al., 2017), physical and mental health

issues (Mishra & Carleton, 2015), but also gambling and other risk behaviours (Callan et al., 2011; Mishra & Novakowski, 2016). As a psychological mechanism, feelings of PRD have been theorized to result in a greater desire for immediate small rewards (Callan et al., 2011; Mishra & Novakowski, 2016). The reasoning for this, drawing on theories of justice motivation (Lerner, 1977) and delay discounting (Ainslie, 1975), is that people who experience feelings of not being treated in the same way as others prefer immediate small rewards because of the need to feel that their deservingness concerns are being addressed (Lerner, 1977, 2002). If people lose their trust in a just world, then they might be more attracted to immediate gratification at the expense of longer-term, larger gains (Callan et al., 2011).

We posit that, in the current food context of easy food access and abundant choice, people experiencing PRD may similarly have a preference for foods that are immediately rewarding rather than beneficial for health, as a way to combat these negative experiences and restore the sense of personal deservingness. Although food may not be as rewarding as monetary rewards in response to deprivation of resources, recent research on resource scarcity-induced eating indicates that the human motivational system for food and money overlap (Bratanova et al., 2016; Briers, Pandelaere, Dewitte, & Warlop, 2006; Mellis et al., 2018). Furthermore, the experience of PRD may be a precursor to a general sensitivity to reward, and it has previously been found that individual sensitivity to reward predicts a preference for high-calorie food (Davis, Levitan, Smith, Tweed, & Curtis, 2006; Davis et al., 2007). Moreover, the motivational component of food reward is essentially driven by the brain's appetitive system (largely the dopamine pathway), which also mediates the motivation for risk behaviours like gambling (Alcaro, Huber, & Panksepp, 2007; Kelley, Schiltz, & Landry, 2005). Hence, PRD may evoke a pleasure-oriented preference for selecting high-fat or high-sugar, palatable foods, as these are immediately rewarding.

The present research links to a growing number of experimental studies that have demonstrated an effect of a subjective relative socioeconomic manipulation on high-caloric food preference and intake (see for reviews Caldwell & Sayer, 2019; Claassen, Corneille, & Klein, 2019). For example, Briers and Laporte (2013) showed that a manipulation of relative income resulted in a higher selection of high versus low caloric dishes. Cheon and Hong (2017) demonstrated that low subjective socioeconomic status (SSS) resulted in a greater preference for high-caloric foods (over fruits and vegetables). SSS was induced with a popular, much-used manipulation, i.e. an adapted version of the MacArthur Ladder of SSS (Cheon, Lim, McCrickerd, Zaihan, & Forde, 2018; Dubois, Rucker, & Galinsky, 2015; Kraus, Côté, & Keltner, 2010; Piff, Stancato, Côté, Mendoza-Denton, & Keltner, 2012). Participants were asked to compare themselves with those who were at either the very top (low SSS condition) or the bottom (high SSS condition) of the ladder by indicating where they stood relative to these people, and to write about a hypothetical

interaction with one these individuals. Although relative income and SSS income involve a subjective evaluation of relative standing, they lack an important emotional component of relative deprivation. PRD is a more specific and emotionally laden concept of relative status that comprises both cognitive and affective responses to unfair outcomes, and has been shown to be a better predictor of health than relative SSS (Callan et al., 2015). Whether PRD affects food preference as a proxy for diet quality remains to be tested, and with this research we aimed to answer this question.

One previous study provided first evidence for a causal effect of PRD on food selection, showing that induced feelings of PRD resulted in the selection of larger meal portions in a computerized portion selection task (Sim et al., 2018). However, in that experiment, the PRD manipulation involved reading a hypothetical scenario unrelated to the food (receiving a smaller versus equal work bonus relative to colleagues) and the portion size selection was hypothetical in nature. The present study expanded on these first results in two main ways. First, it aimed to test the impact of real-time experience of PRD in resources on actual rather than hypothetical food choices. Second, the resources earned were linked to food choices, as earnings served as resources to be spent on foods. This contributes to external validity because in actual life/natural environments eating is almost always a choice and foods are usually obtained with one's resources (e.g. while grocery shopping), rather than by self-serving from free buffets, as commonly applied in experimental studies focusing on SES (although self-serving is a valuable measure in other regards, i.e. actual assessment of quantity consumed and portion control). In Study 1, we tested the feasibility of a self-developed card game for manipulating real-time experiences of PRD. In Study 2, we tested the effect of PRD on food preference in a hypothetical online food shopping setting. Following a pre-test, the available foods were categorized into rewarding and neutral foods. Study 3 was a conceptual replication of Study 2 in a lab-in-the-field setting, where a diverse community sample made real (non-hypothetical) food choices using the points earned. It was hypothesized that PRD would result in a higher selection of high-caloric and palatable (immediately rewarding) foods.

5.2 Study 1: Testing the PRD manipulation task

The aim of Study 1 was to examine whether experiences of PRD can be effectively induced using a self-developed card game. In conformity with a pilot study in which participants were relatively disadvantaged in a Monopoly game (Cardel et al., 2016), our PRD manipulation involved playing a computer card game in which participants actively experienced earning fewer (PRD condition) versus equal (control condition) resources relative to a fictitious player.

5.2.1 Methods

Participants and procedure

On the basis of a power calculation (power of .90, medium effect size (Cohen's *d*) of .5), 172 participants aged between 18 and 70 years with fluency in English were recruited online via Prolific, an online participant recruitment platform (www.prolific.co). Four participants were excluded and substituted with new participants because they completed the study in a substantially short amount of time (i.e. below 6 minutes). Another exclusion criterion was incorrect answers on both the attention check items (none excluded). The analytic sample consisted of 102 (59%) females, 15 different nationalities (51% British), an average age of 34.83 (*SD* = 11.39), and a range of educational backgrounds (24% no education/high school degree, 27% college/associate degree, 47% academic degree). All participants provided written informed consent at the start of the study. After the game, participants completed demographic measures and a bogus task in which they allocated their earnings (points) to a list of food products. The social science ethics committee of Wageningen University approved the study.

PRD manipulation: card game

The card game was designed to induce subjective experiences of relative deprivation, which specifically entail upward social comparisons leading to perceptions of being worse off and unfairly treated as well as feelings of resentment, dissatisfaction, and anger (Callan et al., 2011; Smith et al., 2012). The card game was developed in Qualtrics, an online survey tool (Qualtrics, 2005). It was explained that the card game served as a way to earn points that were necessary for completing a subsequent task. The participants were led to believe that they were playing the game against a previous participant (a fictitious opponent) of the same gender and age, so as to induce an idea of a 'similar other'. In each of 10 rounds, two different playing cards were presented (e.g. four of diamonds and nine of clubs). All participants were shown the exact same cards. Participants had to guess whether the number of a third card, supposedly drawn at random by the computer, would be between or not between the numbers on these cards.

After a practice round, participants were randomly assigned to either the PRD or the control condition by Qualtrics. Before the actual game started, participants read an additional instruction page about the point earnings, which differed for the two conditions. Participants in the PRD condition learned that they would receive fewer points than their (fictitious) opponent for each correct answer (i.e. 5 versus 10 points) and fewer bonus points than their (fictitious) opponent if they, rather than their opponent, had most points at the end of the 10 rounds (i.e. 25 versus 50 bonus points). The participants in the control condition learned that would earn the same as their opponent for each correct answer (i.e. 5 points) and an additional 25 bonus points for having most points after 10 rounds. After each round, participants were shown a bar chart depicting the interim score of points

earned by themselves and their opponent. Unbeknownst to the participant, the 'game' was completely pre-programmed, such that all participants (and the fictitious opponent) had a total of six correct answers, and so *each* participant ended with total score of (6x5 =) 30 points. As the earning of bonus points was based on having the most points at the end of the game, the distribution of bonus points also differed between conditions (i.e. 50 points for the opponent of participants in the PRD condition and no bonus points for participants and their opponent in the control condition). Figure 5.1 presents the final score screens of the PRD and the control condition.

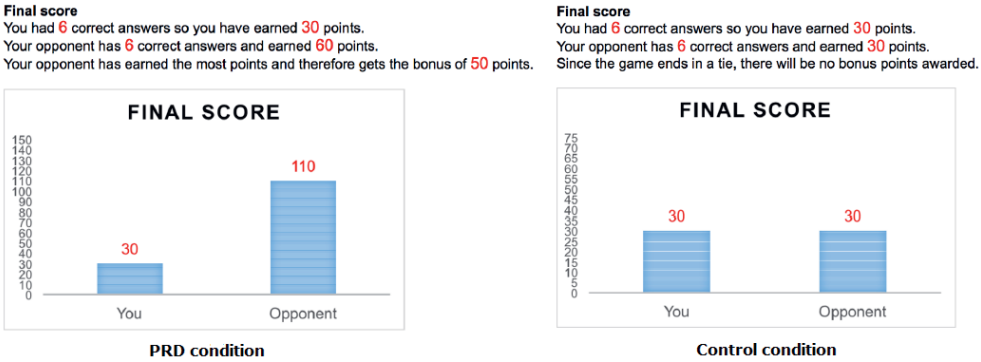

Figure 5.1. Screens of the final scores of the PRD condition and the control condition, as part of the PRD manipulation. The points earned did not objectively differ between conditions, conditions differed in the idea that the opponent earned much more (PRD condition) or just the same (control condition) for the same number of correct answers.

5

Assessment of experienced PRD

A 7-item scale was developed based on Callan et al.'s (2011) revised PRD scale that asked about the perception of being deprived and unfairly treated (e.g. "I felt worse off when I compared myself with my opponent"), as well as feelings of resentment, dissatisfaction, and frustration (e.g. "I was frustrated when I saw how many points I earned compared to my opponent"). The answer scale ranged from 1 (strongly disagree) to 7 (strongly agree). To detect the number of components of the self-report instrument, a principal component analysis was conducted with orthogonal rotation (varimax). Examination of the scree plot and eigenvalues over 1 suggested the presence of one component that accounted for 71.24% of the variance. The scale was reliable, Cronbach's alpha = .93. A mean score was calculated, with higher scores representing higher experiences of PRD. See Table 5.1 for the items.

Assessment of game experience

It was additionally explored whether participants' liking of the game (i.e. how much fun the card game was; if they would like to play this game again) and their involvement (i.e.

if they cared about the points earned; if they did their best; if they cared about the points their opponent earned). The answer scale ranged from 1 (strongly disagree) to 7 (strongly agree). An average score of the liking items was calculated (Cronbach's alpha = .89), and the involvement items were analysed separately, as this scale was not reliable (Cronbach's alpha = .56)

Table 5.1 Items of the Experienced PRD scale that functioned as manipulation check of the card game

1. I felt worse-off when I compared myself with my opponent
2. I think the amount of points I earned compared to my opponent was unfair
3. I felt that the amount of points I earned compared to my opponent was just[a]
4. I felt I was deprived when I compared my points with my opponent
5. I felt resentment when I saw how many points I earned compared to my opponent
6. I felt satisfied with the amount of points I earned compared to my opponent[a]
7. I was frustrated when I saw how many points I earned compared to my opponent

Note: [a]reverse coded

Table 5.2. Means and *SD*s of items of game liking and involvement per condition

	Mean (*SD*)	
	PRD condition	**Control condition**
The card game was fun to play	5.28 (1.43)	5.64 (1.25)
I would like to play this card game again	5.05 (1.56)	5.35 (1.48)
I cared about the points I earned	5.45 (1.58)	5.72 (1.32)
I did my best during the card game	6.44 (.85)	6.49 (.81)
I cared about the points my opponent earned	4.71 (1.93)	5.05 (1.65)

Note: Scored on 7-point scale

5.2.2 Results

A t-test showed that the PRD condition (M = 5.33, SD = 1.33) scored significantly higher than the control condition on the experienced PRD scale (M = 2.37, SD = 1.03), t (170) = 16.29, $p < .001$, 95% CI [2.61-3.33], d = 2.49. Conditions did not differ significantly in game liking, $t(170) = 1.60$, $p = .11$. Conditions did not differ either in caring about their points, $t(170) = 1.21$, $p = .23$, or their opponent's points, $t(170) = 1.22$, $p = .23$, or doing their best, $t(170) = 0.45$, $p = .65$. On average, participants rated a positive liking experience (M = 5.33, SD = 1.37) and reported that they cared about their points (M = 5.58, SD = 1.46) and their opponent's points (M = 4.88, SD = 1.80) and that they did their best (M = 5.33, SD = 1.37). See Table 5.2 for means and *SD*s of items per condition.

5.2.3 Discussion

This manipulation was considered successful, as conditions differed significantly in their PRD experience during the card game. Furthermore, both conditions reported liking the game and caring about earning points (i.e. the main goal of the game). This is relevant,

because it ensures that potential differences in food choice are not the result of plausible side-effect game experiences. Moreover, these observations indicate that the outcome was indeed desired, an important precondition of experiencing relative deprivation (Beshai et al., 2017; Runciman & Runciman, 1966).

5.3 Study 2: Effect of PRD on hypothetical food choice

The aim of Study 2 was to test the effect of PRD on (hypothetical) food choice. The points earned in the card game served as resources to select (purchase) food products in an online food shopping task. It was hypothesized that the PRD condition would select more palatable, snack-type (i.e. rewarding) food products than the control condition. Hypotheses and methods were preregistered on Open Science Framework prior to data collection (https://osf.io/vk6mq).

5.3.1 Methods

Participants

Participants aged 18–70 years who were fluent in English were recruited via Prolific and were compensated with £1.30 (average completion time was 13 minutes). Other inclusion criteria were no prior participation in Study 1 and no allergy for gluten, dairy/lactose, eggs, nuts, and wheat/grain. Based on a power calculation using G*Power (alpha of .05, power of .90, effect size (Cohen's *f*) of .2) and an additional 10% of oversampling allowing for exclusion, the sample size for recruitment was 292. A small to medium effect size was expected, given that food choice is a multifactorially determined behaviour and plausibly also/most affected by individual differences in liking of the specific products (de Graaf et al., 2005; Mustonen, Hissa, Huotilainen, Miettinen, & Tuorila, 2007). Six participants were excluded from analysis based on *a priori* exclusion criteria (i.e. incorrect answers on both attention check items (N = 2) and an exceptional completion time of below 6 minutes (N = 1) or higher than 35 minutes (N = 3), based on Study 1, suggesting inadequate performance). As a result, the sample for analysis consisted of 287 participants (58.2% male, 41.1% female, 0.01% other) with a mean age of 30.57 years (SD = 10.52, range 18–68). Of the 44 participating nationalities, the most frequent were British (19.2%), American (11.5%), and Polish (11.1%).

Procedure

After providing written informed consent, participants completed the Revised PRD Scale (Callan et al., 2011) and the Power of Food Scale (Lowe et al., 2009) (see description of these control measures below). Next, they were randomly assigned to either the PRD or the control condition and played the card game described in Study 1 (PRD manipulation)

in which they earned points that served as resources to be spent in the succeeding online food shopping task. Participants were then asked about their level of hunger, weight in kg, and height in cm (conversion information was provided, i.e. 1 inch = 2.54 cm and 1 pound = 0.4536 kg), dietary concerns, and demographic information including gender, age, nationality, and last completed education. Lastly, participants were thanked and debriefed. The study was approved by the social science ethics committee of Wageningen University.

Online food shopping task

Participants were asked to choose from eight products presented on screen, using their total earnings of 30 points (see Figure 5.2). Four typical high-sugar/fat snack-type food products (i.e. chocolate cookie, chocolate bar, two types of crisps) were deemed as 'rewarding' foods and the other four products (i.e. unsalted peanuts, muesli bar, rice waffles, pear) were deemed as 'neutral and healthy'. This classification was determined based on a pilot study in which participants rated the palatability and healthiness of food products (see Supplementary information 5.1 and Supplementary Table 5.1 for details). As each product 'cost' 10 points, participants had to select three products (different products or more of the same product). Each product picture portrayed one serving for immediate consumption. Participants were instructed to imagine that the foods were immediately available to them and to base their food choice on what they desired the most at that moment (this choice was obviously hypothetical, i.e. participants did not receive chosen products). The dependent variable was the number of rewarding food choices, ranging from 0 to 3.

Control variables

Chronic PRD. Chronic tendencies for PRD were measured, because it was reasoned that these may in themselves influence food choices (Sim et al., 2018) and interfere with the state of experiences of PRD. The 5-item revised Personal Relative Deprivation Scale (Callan et al., 2011) was used, which assesses the extent to which participants feel subjectively worse off compared with others (e.g. "I feel deprived when I think about what I have compared to what other people like me have") on a 6-point Likert scale ranging from 1 (strongly disagree) to 6 (strongly agree). A mean score was calculated for the 5 items. The scale had a Cronbach's alpha of .76.

Sensitivity to palatable food. The Power of Food Scale (Cronbach's alpha = .93) measures appetite for palatable foods and the psychological influence that the food environment has on the individual (Lowe et al., 2009). The scale has 15 items (e.g. "I find myself thinking about food even when I'm not physically hungry") answered on a 5-point scale ranging from 1 (I don't agree at all) to 5 (I strongly agree). A mean score was calculated. Sensitivity to palatable food was included because this trait-level factor may obviously have

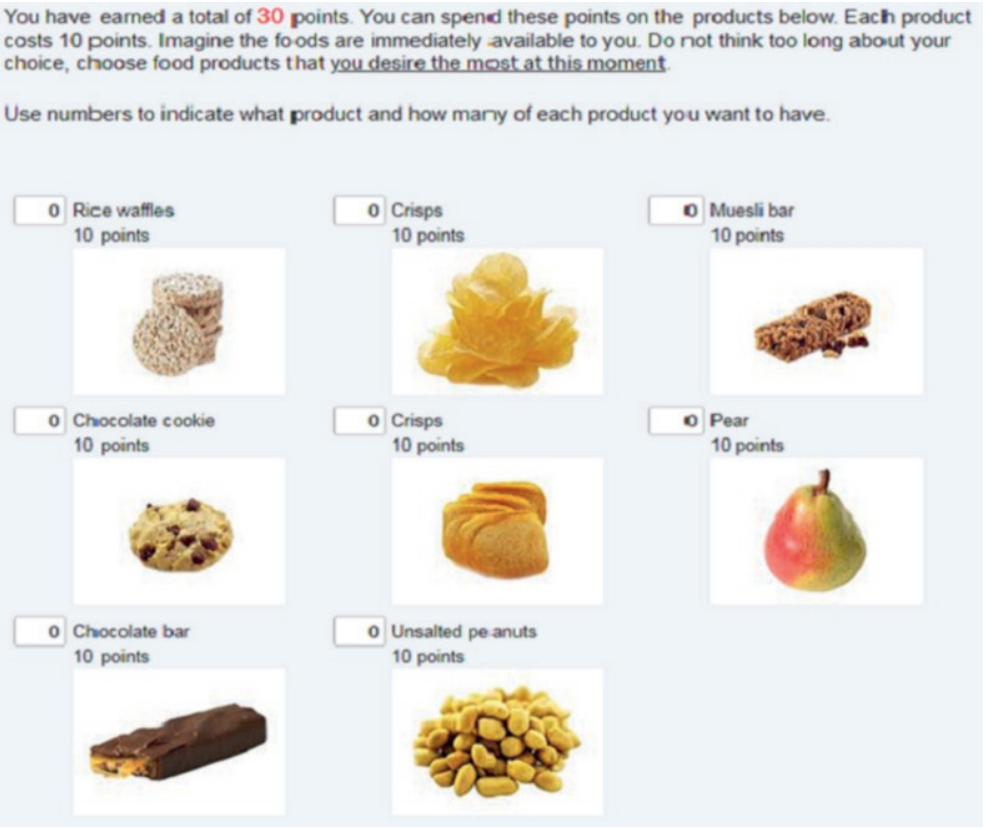

Figure 5.2. Online food shopping task in Study 2. Food images were obtained from a food image database (Blechert, Meule, Busch, & Ohla, 2014).

considerable influence on rewarding food choices in this experiment (Appelhans et al., 2011; Rollins, Dearing, & Epstein, 2010).

Hunger. Participants were asked how hungry they were on a 7-point scale ranging from 1 (not at all) to 7 (very much), as this has been shown to be a primary motive for eating (Loewenstein, 1996) and may also influence food choices.

BMI. Body mass index was calculated by dividing self-reported weight (kg) by the square of the person's height (m^2). Seven participants had an unrealistic BMI value (> 271) because of a low value for height (< 1 metre); these were coded as missing values. BMI was included because it has been reported that people with overweight or obesity tend to choose smaller immediate rewards (Kulendran et al., 2014; Kulendran et al., 2013), which may translate into more rewarding food choices.

Dietary concern. Dietary restraint was measured with the 6-item Concern for Dieting subscale of the Revised Restraint Scale, which assesses attitude towards dieting (Herman & Polivy, 1980). Items were answered on a 4 to 5-point scale. The scale had a Cronbach's alpha

of .72. Dietary concern was included because dieters' food choice may be predominantly based on weight-control strategies such as eating fewer calories (Kruger, Galuska, Serdula, & Jones, 2004).

5.3.2 Results

Descriptives, correlations, and comparability between conditions

Following the preregistration, an analysis of significant correlations between the control variables and the dependent variable – rewarding food choice – resulted in the identification of sensitivity to palatable food and hunger as covariates. T-tests revealed that conditions did not differ on chronic PRD, sensitivity to palatable food, hunger, age, BMI, and dietary concern, $t < 1.11$, $p > .269$. Conditions did not differ either on gender, χ^2 (2, N = 287) = 2.16, $p = 0.34$, nationality, χ^2 (43, N = 287) = 45.02, $p = 0.39$, or education level χ^2 (8, N = 287) = 8.79, $p = 0.36$, suggesting that randomization was successful. See Supplementary Table 5.2 for the correlations between variables and the means and standard deviations (*SD*s) per experimental condition.

Test of hypothesis

Neither of the identified covariates (i.e. hunger and sensitivity to palatable food) interacted with condition for rewarding food choice, meaning that the assumption of homogeneity of regression slopes was met. As the residuals of the mean number of rewarding food choices were non-normally distributed, bootstrapping (10,000 samples) was applied (Parra-Frutos, 2014). There was no significant main effect of experimental condition on the mean number of rewarding food choices, $F(1, 283) = 1.08$, $p = .60$, 95% CI[-0.29, 0.17], $\eta_p^2 = 0.001$. Participants in the PRD condition ($M_{adj,} = 1.73$, $SE = 0.08$) did not differ from those in the control condition on the number of rewarding foods chosen ($M_{adj,} = 1.67$, $SE = 0.08$). The covariates hunger and sensitivity to palatable food were significantly related to rewarding food choice, *p*'s < .05. Tests of hypotheses and exploratory analyses were also performed without serious outliers in BMI (outliers were identified according to a Z-score criterion of ± 3, i.e. BMI > 56). Exclusion of these seven outliers did not change the results.

Exploratory analyses, preregistered

Exploratory analyses of two-way interactions between experimental condition and control variables on rewarding food choice were conducted, using the PROCESS macro for a bootstrapped test (Hayes, 2017). A significant disordinal interaction between condition (centered) and chronic PRD (centered PRD scale) on rewarding food choice was found, $F(1, 283) = 7.08$, $p = .008$, R^2-change = 0.02, also when the identified covariates were controlled for, $F(1, 281) = 4.48$, $p = .04$, R^2-change = 0.01. Simple effects including identified covariates demonstrated that conditions did not differ significantly on rewarding food choice for participants with a high level of chronic PRD (+1*SD*; 4.02), B = .30, $t(281) = 1.71$, $p = .087$,

95% CI [-0.64, 0.04], average level of chronic PRD (3.09), B = .06, $t(281) = .53$, $p = .59$, 95% CI [-.29, .18], or a low level of chronic PRD (-1*SD*; 2.16), B = -.17, $t(281) = -1.19$, $p = .23$, 95% CI [-0.11, 0.47]. Simple effects without covariates showed the same pattern of results as those with covariates, except that the simple effect of high level of chronic PRD was significant ($p = .03$). A difference was in the hypothesized direction, indicating that the PRD condition chose more rewarding foods than the control condition under high levels of chronic PRD. No interaction effects were found between condition and any other control variables, $p > .21$.

5.3.3 Discussion

No main effect of the PRD manipulation on food choice was found. However, the manipulation seemed to have a differential effect for different levels of chronic PRD. Simple effects bordered on significance, showing a pattern that those that were relatively deprived in the card game and also experienced higher chronic relative deprivation appeared to select a higher number of rewarding foods. It may be reasoned that individuals already feeling deprived were more sensitive to the manipulation with respect to its influence on food choice, and that those who did not experience PRD in daily life did not translate incidental feelings of PRD into hypothetical food selection. A limitation of this study was that food choices were hypothetical; therefore, the experiment was next conducted in a lab-in-the-field setting.

5.4 Study 3: Effect of PRD on non-hypothetical (real) food choices

The aim of Study 3 was to conceptually replicate the online study (Study 2) in a lab-in-the-field setting in which participants from a community sample made real, non-hypothetical food choices. It was hypothesized that participants in the PRD condition would choose more palatable (rewarding) snack-type food products than participants in the control condition (i.e. a main effect). Moreover, given the results of the online study, this effect could be expected to be observed only, or at least to a greater extent, in participants scoring high on chronic PRD. The aim, hypothesis, and methods were preregistered on Open Science Framework prior to data collection (https://osf.io/fwy8r).

5.4.1 Methods

Participants

A total of 308 women were recruited at a one-week summer fair (*Libelle Zomerweek*), where they could participate in our workshop "grocery shopping game". Twenty-one rounds of the workshop were held across the fair (at 10.30, 11.30, 12.30, 14.30, 15.30, and 16.30 h)

in maximum groups of 15 participants. Given these constraints, the maximum sample size that could be reached was 315 participants. G*Power indicated that, with this sample size, a power of .87 can be reached for a small to medium effect size of the hypothesized main effect (Cohen's *f*) = 0.175. Participants could enrol for the workshop at the central registration desk and, to fill the open spots, some were actively recruited by research assistants. Twenty-five participants were excluded from analyses because they had an allergy or intolerance for gluten, dairy/lactose, eggs, nuts, soja, or wheat/grain, or followed a vegan diet. Additionally, 19 participants were excluded because they did not adhere to instructions in one or multiple ways (i.e. taking more or fewer than three products, stopping before the food choice task, performing the task together with a friend). Four participants that correctly guessed the purpose of the study were also excluded. Hence, the analytic sample consisted of 260 participants, with an average age of 48.75 (*SD* = 14.05 range 16-76) and various educational backgrounds (categorized into 18.8% low, 42.2% middle, 37.3% high, according to a classification of Statistics Netherlands (www.cbs.nl), and 0.8% indicated 'other').

Participation in this annual summer fair was considered a good opportunity for efficient recruitment of a large and diverse community sample. As this female sample differed from the mixed gender sample in Study 2, we checked whether the results of Study 2 differed for men and women: no two-way interaction between gender and condition was found, and no three-way interaction between gender, chronic PRD, and condition was found.

Procedure and measures

Participants were seated at a long table and were separated by shields so that they would conduct the study individually. Each participant was provided with a participant number, a handout with the steps, and a tablet computer. At the start of the workshop, participants were collectively introduced to the study "about grocery shopping" and were instructed not to talk with one another. The same methodology (i.e. informed consent, manipulation, and measures) as in the online study was applied, with the following adaptations. First, for feasibility reasons, the procedure was shortened by excluding the nationality measure and by using the 4-item Present Food subscale of the Power of Food Scale (Lowe et al., 2009) and one item from the Dietary Concern scale, i.e. "How conscious are you of what you are eating?" (Herman & Polivy, 1980). The 4-item Present Food subscale of the Power of Food Scale involves "reactions to palatable foods when they are physically present but have not yet been tasted". This subscale (Cronbach's alpha = .84 in the current study) was conceptually closest to food choice and correlated most strongly with food preference in the online study. The 1-item dietary concern was based on a principal component analysis with varimax rotation of the online study data, which suggested two components; one of the components containing this item (loading .92) was conceptually closest to food choice. Also, weight and height items were deleted to avoid participants feeling

uncomfortable answering these items. Second, the food choice measure was realized by letting each participant collect products from a wooden crate positioned at her table (see *Food choice task*). Third, in the instructions for the card game, it was already explained that each product cost 10 points, as it was arguably better to know beforehand the value of the points that could be earned. Fourth, a final question asked what participants thought the purpose of the study was. Participants were collectively debriefed via a quiz. The study was approved by the social science ethics committee of Wageningen University. Prior to this study, a non-preregistered pilot study was conducted to test the feasibility of the PRD manipulation and a different form of the food shopping task among a community sample (N = 101, see Supplementary information 5.2).

Food choice task

Participants were instructed to spend their points earned in the card game on groceries. Each product cost 10 points, as indicated on Qualtrics and on the 'price tag' near each product. Participants chose products from a cloth-covered crate containing two shelves that presented the eight different products (four products per shelf, three pieces of each product). The placement of the products was identical for all participants (see also Figure 5.3). Participants were instructed to remove the cloth from the crate and to put their choice of products in a paper bag. On the Qualtrics instruction screen, it was stated that participants should not think for too long and choose something that they would want to eat now. In conformity with the online study, the rewarding foods were chocolate waffle, chocolate bar, and two types of crisps. The neutral, healthy foods were muesli bar, pear, rice waffles, and unsalted peanuts. All foods were served as single-portion packages (except the pear). After participants left, food choices were recorded by the researchers (who were blind to the condition assignment) by counting the products taken.

5.4.2 Results

Descriptives, correlations, and comparability between conditions

An analysis of significant correlations between the control variables and the dependent variable – rewarding food choice – resulted in the identification of age, education level, dietary concern, and sensitivity to palatable food (Present Food subscale) as covariates. T-tests showed that conditions did not differ on the control variables sensitivity to palatable food (Present Food subscale), hunger, age, and dietary concern, $t(258) < 1.72$, $p > .09$ and education, χ^2 (7, N = 258) = 11.58, $p = .12$. Supplementary Table 5.3 presents the correlations between the variables under study and the means and standard deviations (*SD*s) per condition.

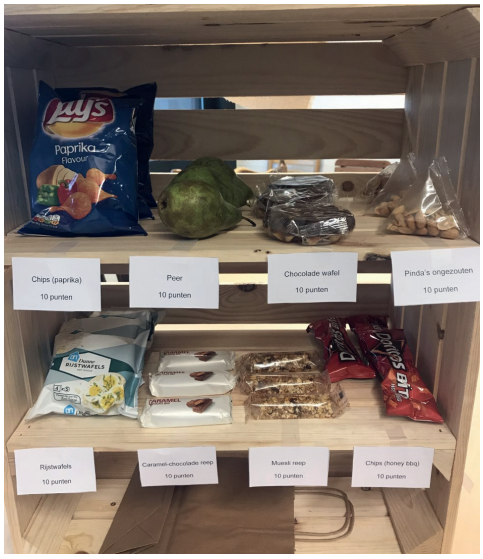

Figure 5.3 Picture of the food choice crate in Study 3

Test of hypotheses

None of the identified covariates (i.e. age, education level, dietary concern, and sensitivity to palatable food) interacted with condition for rewarding food choice, meaning that the assumption of homogeneity of regression slopes was met. A bootstrapped (10,000 samples) ANCOVA showed that there was a significant main effect of experimental condition on the mean number of rewarding food choices, $F(1, 250) = 4.61$, $p = .031$, 95% CI[0.03, 0.45], $\eta_p^2 = 0.02$. Participants in the PRD condition ($M_{adj,} = 1.56$, $SE = 0.16$) chose more rewarding foods than those in the control condition ($M_{adj,} = 1.33$, $SE = 0.17$). The covariates education level, dietary concern, and sensitivity to palatable food were significantly related to rewarding food choice, *p*'s < .01. Age was not significantly related to food choice, $p = .14$. This main effect was not significant without any covariates, F(1, 258) = 2.49, p = .11, 95% CI[-.0.04, 0.40], ηp2 = 0.01. Controlling only for sensitivity to palatable food resulted in a significant main effect, F(1, 257) = 3.97, p = .043 , 95% CI[0.01, 0.44], ηp2 = 0.02, indicating that this was an important covariate in the testing of hypotheses.

To analyse whether condition affects food choice differently for scores on chronic PRD (in conformity with Study 2), it was tested whether chronic PRD (centred PRD scale) interacted with experimental condition (centred), using bootstrapping in PROCESS (Hayes, 2017). This interaction was not significant, $F(1, 256) = 1.86$, $p = .17$, R^2-change = 0.01; nor was it significant when the identified covariates were controlled for $F(1, 248) = 0.53$, $p = .47$, R^2-change = 0.00. Removing two participants with the highest chronic PRD scores (> 4.20) from the sample did not change these non-significant results of this two-way interaction, ANOVA model $p = .07$, ANCOVA model, $p = .37$.

Exploratory analyses, preregistered

Three-way interactions between experimental condition, chronic PRD, and each of the control variables were explored with PROCESS (Hayes, 2017). A significant interaction was found between centred condition, centred chronic PRD, and centred age, $F(1, 252) = 4.32$, $p = .039$, 95% CI[0.001, 0.048], R^2-change = .02, also when the identified covariates were controlled for, $F(1, 245) = 5.03$, $p = .026$, R^2-change = 0.02. This adjusted three-way interaction was further disentangled by bootstrapped conditional effects. No significant conditional effects of the two-way interaction between chronic PRD and condition on rewarding food choice were found for participants with higher age (+ 1*SD*; 62.8 years), $B = .45$, $t(245) = 1.97$, $p = .050$, 95% CI [0.001, 0.89], lower age (- 1 *SD*; 34.7 years), $B = -.22$, $t(245) = -1.91$, $p = .23$, 95% CI [-0.58, 0.15], or medium age (48.8 years) $B = .11$, $t(245) = 0.79$, $p = .43$, 95% CI [-0.001, 0.41]. As the answer items of the PRD scale ranged from 1 to 6, it appears that PRD scores were overall rather low; these low, medium, and high ranges need to be interpreted in relative terms. Other three-way interactions between condition, chronic PRD, and any control variable other than age were not significant, all *p*'s > .15.

5.4.3 Discussion

On average, participants in the PRD condition chose more rewarding foods than those in the control condition, when particularly sensitivity to palatable food was controlled for. An interaction between condition and chronic PRD, as observed in Study 2, bordered on significance for participants in the higher age group.

5.5 General discussion

Drawing on the relative deprivation hypothesis and the theory of justice motivation (Lerner, 1977), the aim of this research was to demonstrate the effect of experiences of PRD on food choice behaviour. In two preregistered experimental studies, some preliminary evidence was found for an effect of induced PRD on hypothetical and real food choices in a grocery shopping setting. Across the studies, a difference in food choice between conditions bordered on significance and hence the findings need to be interpreted with caution. The effect of PRD on real, non-hypothetical food choice appeared significant, when sensitivity to palatable foods was controlled for. A numerical difference was repeatedly in the hypothesized direction: those who were unfairly relatively deprived of resources earned in a card game spent these resources on more palatable, energy-rich food products (rather than neutral tasting, healthier foods), although this effect may be truer for those with higher chronic PRD.

This is one of the first studies to demonstrate some causal effect of feelings of PRD on actual food choice behaviour. Building on previous studies showing that chronic-level PRD

is associated with health outcomes (Beshai et al., 2017; Mishra & Carleton, 2015) and state-level PRD with an inclination towards immediate rewards (Callan et al., 2011), our results show that PRD may result in more palatable and unhealthy food choices. These findings are relevant in light of the current obesogenic environment characterized by its abundance of unhealthy foods, where it appears that part of society is disproportionally affected by these temptations. A large body of evidence indicates that inequality and obesity and health are linked at the societal level. The (preliminary) results of this study suggest that this association may be partly due to the effect of relative deprivation (a downstream psychological consequence of inequality) and food choices at the individual level. Specifically, as all participants in this study received the same number of resources, this research indicates the relevance of targeting the perception of inequality and unfairness beyond a person's absolute, economic situation. Indeed, Inglis, Ball, and Crawford (2009) showed that socioeconomic inequalities in the healthfulness of food choices were not reduced through varying food budgets available to women with low and high incomes. Decreasing economic inequality has been declared as the approach to improve a nation's health (Wilkinson & Pickett, 2009), but, with respect to dietary behaviours, this may be insufficient when not accompanied by a reduction in experiences of injustice stemming from social comparisons.

Our findings have important implications for theorizing about food choice behaviour under states of deprivation in two main ways. First, the finding that those who were relatively deprived chose more snack-type foods that were assessed as relatively unhealthy and highly palatable may imply that the hedonic – and so immediately rewarding – properties of foods become more important under deprivation. Hence, an implicit assumption for this reasoning is that the act of making food choices under deprivation theoretically entails a subconscious motivational trade-off between immediate pleasure and long-term health goals; this accords with empirical evidence for the relation between PRD and a preference for immediate rewards (Callan et al., 2011; Mishra & Novakowski, 2016) and with research on self-regulation of eating (Herman & Polivy, 2004). However, in previous studies on SSS and caloric preference/intake, such a categorization has not been made and findings have generally been explained with an evolutionary approach that assumes that people have a functional, adaptive motivation to compensate for resource scarcity directly with calorie-rich foods, as this promotes survival (e.g. see Briers & Laporte, 2013; Cheon & Hong, 2017; Laran & Salerno, 2013). This functional explanation could apply to the present study as well, especially given a sub-analysis showing that PRD also affected actual food choice when calorie-rich peanuts, which were not perceived as particularly tasty, were additionally categorized as rewarding foods rather than as neutral, healthy foods. Hence, it remains questionable whether PRD leads to a particular preference for energy versus hedonic properties of foods, although these specific processes may be hard to disentangle as the reward system has evolved such that humans prefer energy-dense

sweet and fat foods (Birch, 1999; Drewnowski & Almiron-Roig, 2009). Moreover, as liking of foods evolves over the life course as a result of socio-cultural influences, future research on socioeconomic disparities in diet quality should investigate the extent to which the food liking of people with various SES or PRD levels is shaped by differential exposure to food availability (Clary et al., 2017).

Second, the finding that the effect of state-level PRD on rewarding food choice was moderated by higher chronic feelings of PRD may elucidate the challenge of recapitulating an intrusive level of PRD as experienced by individuals actually living under deprived conditions (Caldwell & Sayer, 2019). Particularly, a plausible explanation for this finding is that only those with chronic PRD actively engaged in the self-comparison that is needed for a true PRD effect on eating behaviour. Moreover, these findings may contribute to insights into how food choice behaviour is formed by previous experiences of deprivation. In light of studies focused on emotions as a stimulus for the conditioning of food craving and selection (e.g. Bongers & Jansen, 2016; Jansen, Schyns, Bongers, & van den Akker, 2016), our findings may imply that state-related deprivation may lead to palatable food selection because of a learned response to feelings of PRD, reflecting a form of habitual reinforcement (Mercer & Holder, 1997). Notably, a previous experimental study that focused on childhood SES environments and eating showed that, independent of energy needs, food intake increased for those who were raised in a low (versus high) socioeconomic environment (Hill et al., 2016). Further research is needed to further disentangle whether and how states of PRD and childhood or chronic experiences of PRD may interact in the influence on food preferences/cravings and dietary patterns.

This study has some particular strengths. First, the experiment with real, non-hypothetical food choices was conducted in a community sample with various educational backgrounds, rather than in a homogenous highly educated student sample as commonly used in previous studies on social status and eating (Bratanova et al., 2016; Cheon & Hong, 2017; Cheon et al., 2018; Pavela, Lewis, Dawson, Cardel, & Allison, 2017; Sim et al., 2018). Second, we employed a real-time induction of PRD experiences where participants were actually unfairly deprived of resources compared to a (fictitious) opponent player, and we believe that this method is more powerful than a person imagining him/herself in a hypothetical scenario. Moreover, the resources that were the source of relative deprivation were directly used in the grocery shopping task, and this enhances ecological validity.

This study has limitations regarding its generalizability to naturalistic situations. First, the food products offered during the grocery shopping task were limited in variety and may not represent the foods chosen by the participants in daily life. Nevertheless, we selected products with which most people are familiar, and in sub-analyses we observed that all products were substantially selected by the samples, allowing some variety in popularity.

Second, we assessed food preference at only one juncture, and more long-term assessments of food purchases are necessary to generalize to dietary patterns. Third, all foods had the same 'price' in the food shopping task, whereas in real life these foods have different prices. Nevertheless, we counterbalanced for actual prices of products in the two categories of foods (i.e. rewarding versus neutral) so that these categories were equally expensive. Future studies on the effect of PRD on food choice may disentangle the relative importance of price and palatability of the presented foods. Fourth, presented foods were categorized into rewarding versus neutral foods based on perceived palatability and healthiness. Other, unmeasured food properties (e.g. convenience of consumption) may also have differed between these categories and may have confounded the outcome. Fifth, in Study 3, the sample consisted of women only and so its findings cannot be generalized to men. Yet, studying a female population may be especially relevant, as the social status and BMI relationship has been more consistently found among women than among men (Caldwell & Sayer, 2019; Claassen, Corneille, et al., 2019; Davillas & Benzeval, 2016). Future research on PRD and dietary outcomes may need to identify any differential effects for gender. A final noteworthy limitation is that the perceived palatability and healthfulness of the foods was not consistently evaluated in each experiment. The lack of these data precludes evaluation of the extent to which null effects were the result of invalid food categorization across our different samples and/or within individuals. This is of particular relevance for Study 3. However, apart from feasibility concerns (i.e. time constraints), the validity of these evaluations pre or post experiment may be questionable, given potential carryover effects.

5.6 Conclusion

Although conclusions can only be drawn with reservation, this research found some initial evidence for a causal effect of experiences of relative deprivation on unhealthy food choices. Effect sizes of this multifactorial behavioural outcome were small, and more research is needed to establish more firmly a causal link between relative deprivation and unhealthy dietary behaviours. We suggest that future studies should focus on a more proxy measure of rewarding food preference, such as rewarding value of food (Epstein & Leddy, 2006; Rollins et al., 2010) or food cue reactivity (Boswell & Kober, 2016). Nevertheless, this research provides initial support for the idea that targeting inequality and injustice, and their psychological consequences, may be part of the solution to reduce societal disparities in the healthfulness of dietary patterns.

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CHAPTER 6

GENERAL DISCUSSION

6.1 Aim and main findings

In addition to well-researched individual-level predictors of food decision making, contextual factors have been increasingly recognized as influencing food consumption (Symmank et al., 2017). Over the past decades, the physical food environment has become much unhealthier, as characterized by a high accessibility and availability of relatively inexpensive ultra-processed foods that are high in sugar and trans fats (Maguire et al., 2015; Reedy, Krebs-Smith, & Bosire, 2010; Schäfer Elinder & Jansson, 2009). The quality of diets of individuals with low socioeconomic status (SES) appears disproportionally affected in comparison with those with high SES. Disparities in diet quality between socioeconomic groups have persistently been demonstrated in various high-income countries (Dijkstra et al., 2018; Grech et al., 2017; Wang et al., 2014; Yau et al., 2019). How the unhealthy food environment steers unhealthy food consumption, and how this is of particular relevance for low socioeconomic groups, is less understood. The overall aim of this thesis was to examine *a priori* hypothesized psychological processes that could explain how the physical food environment and an individual's socioeconomic context may steer unhealthy food consumption. To this end, contemporary psychological theories were applied specifically to the food environment and eating behaviour. Each of these theories was selected based on its in-depth explanation of how a particular context influences motivational and decision-making processes. Given the importance of social influence in shaping food consumption (Fiske, 2010; Herman & Polivy, 2005; Higgs & Ruddock, 2020), in the first part of this thesis (Chapters 2 and 3), it was examined how perceptions of social norms may be derived from the real-world physical food environment and how these may influence food consumption. In light of the global trend of socioeconomic disparities in diet healthfulness, in the second part (Chapters 4 and 5), it was investigated how two distinct evaluative interpretations of socioeconomic conditions, i.e. resource scarcity and relative deprivation, may lead to unhealthier food consumption. Before discussing the implications of the findings, methodological issues, and future research directions, I provide a summary of the findings of each chapter.

In the first part of this thesis, the focus was on social norms that may be inferred from physical food environments and hence influence food consumption. This proposition was explored on two different environmental levels and types of food environments. On the micro level (i.e. the outside-the-home and in-store/restaurant food contexts), we revealed how social norms were physically embedded in self-service food environments. On the neighbourhood level, we demonstrated that perceptions of neighbourhood social norms regarding fast food consumption were associated with exposure to the neighbourhood built fast food environment and with consumption of these foods.

More specifically, the objective of Chapter 2 was to provide a new understanding of how physical aspects in micro food environments may influence consumption, by proposing that social norms are embedded in physical cues in these environments. In study 1, it was demonstrated that a wide variety of physical cues in self-service food environments may implicitly communicate messages about other consumers' behaviour or the popularity of/ demand for a product (i.e. descriptive norms) and/or the appropriateness of consumption (i.e. injunctive norms). In study 2, the majority of cues that laypeople identified as being influential on food selection had been acknowledged in study 1 as bearing a social norm message. Laypeople did not spontaneously provide a normative explanation of how these cues would influence food selection, but, when explicitly assessed, a descriptive normative interpretation concerning other people's behaviour appeared easier to recognize than an injunctive normative interpretation concerning informal behavioural rules about appropriate food consumption. Overall, the findings indicate that social norms may be derived from various physical cues in the in-store/restaurant food environment, and may thereby guide a person's food consumption.

In Chapter 3, we aimed to test empirically whether social norm perceptions regarding fast food consumption in the neighbourhood mediated the relationship between residential fast food outlet exposure and consumption. Fast food outlet exposure was measured as the number of fast food outlets within a 400m walking distance buffer around the postcodes of respondents living across the Netherlands. We could not find a direct association between residential fast food exposure and frequency of fast food consumption; however, we demonstrated that fast food outlet exposure was positively associated with perceived neighbourhood social norms (descriptive and injunctive), which in turn were positively associated with the odds of fast food consumption. Moreover, both types of norms appeared to mediate the relationship between exposure and consumption. These findings, although correlational in nature, suggest that unhealthier social norm perceptions regarding common and appropriate consumption may be derived from a higher exposure to unhealthy food outlets in the neighbourhood and that these norms may guide unhealthier consumption. Hence, this chapter provides the first correlational evidence for the proposition that social norms may be a relevant psychological process that explains how the physical food environment (in terms of residential availability of food outlets) may influence food consumption.

In the second part of this thesis, we aimed to investigate psychological processes that could explain how a person's specific socioeconomic context or condition affects unhealthy food consumption. Subjective evaluative interpretations of the socioeconomic context were approached in both an absolute and a relative sense by applying two distinct psychological theories. Regarding an absolute type of evaluation, we could not demonstrate an acute effect of experienced scarcity (i.e. having too few resources) on

calorie consumption from snacks. Regarding a relative type of evaluation, we provided some first evidence that relative deprivation (i.e. being worse off than others) affected food choice.

Specifically, in Chapter 4, we could not provide conclusive evidence for the notion that resource scarcity results in unhealthier eating. Our self-developed scarcity manipulation involved a trade-off task in which participants' resources for choosing desirable options were either restricted (scarcity condition) or unrestricted (no-scarcity condition). The dependent variable was the number of calories from snacks consumed during the trade-off task. In two lab experiments, no main effect of scarcity on calorie consumption from available snacks was found. In the first lab experiment, an interaction between scarcity and hunger was revealed, although it bordered on significance. Those in the scarcity condition indeed consumed more calories than those in the no-scarcity (control) condition when they had a low level of hunger. No difference between conditions was found for those having a high level of hunger. However, a difference in calorie consumption between the two conditions could not be replicated in the second lab experiment in which participants were instructed to have eaten prior to participation so as to reduce their hunger. Overall, although the trade-off task (i.e. scarcity manipulation) appeared to induce experiences of scarcity consistently across experiments, these did not consistently result in unhealthier food consumption.

In Chapter 5, we aimed to test whether personal relative deprivation (PRD, i.e. the sense of being deprived of a deserved outcome relative to others) resulted in an unhealthier food choice. In our PRD manipulation – a computer card game – the points earned served as resources to be spent on foods in a grocery shopping task. The dependent variable was the number of unhealthy foods chosen from a set of eight different food products, of which half were categorized as palatable and unhealthy, and the other half as neutral tasting and healthy. In an online study, no main effect of PRD on hypothetical food choice was found. However, an interaction effect between the PRD condition and chronic experiences of PRD was observed, and although the simple effect analyses showed inconclusive results, a pattern emerged that indicated that a higher number of unhealthy snack-type food products were selected by those who were both relatively deprived in the game and reported a higher level of PRD in their daily life. The experiment was subsequently conducted in a lab-in-the-field setting, where female participants with various educational backgrounds made real food choices (took actual food products). It was demonstrated that those who were relatively deprived of points chose more snack-type food products compared to those who were not deprived, when self-reported sensitivity to palatable food was controlled for. Hence, although conclusions can only be drawn with some reservation, this study revealed some first causal evidence that relative deprivation results in an unhealthier food choice.

All in all, with the present dissertation, we revealed different psychological processes that may explain how a person's particular context may influence unhealthy food consumption. We demonstrated how social norms may be embedded in a wide variety of physical cues in in-store/restaurant food environments and thereby guide a person's food consumption. Moreover, we revealed that social norms regarding fast food consumption may be inferred from fast food outlets in the residential neighbourhood.
Furthermore, we demonstrated that the experience of scarcity, as gained from having too few resources to satisfy a person's needs and desires, did not consistently result in increased snack consumption. The experience of relative deprivation, resulting from negative upward social comparisons, seemed to affect food choice in terms of the number of unhealthy snack-type foods chosen, although this effect appeared to depend on the inclusion of individual-level control measures that also influence food choice, particularly a person's sensitivity to palatable food.

6.2 Theoretical reflection on the main findings

6.2.1 Social consumption norms inferred from environmental cues

Social norms have been theorized to influence behaviour by providing an individual with information about a socially appropriate or an adaptive code of conduct (Cialdini & Goldstein, 2004; Cialdini et al., 1990). Over the recent past, evidence for perceived social norms influencing eating behaviour has predominantly been demonstrated by experimental lab studies, with the majority of these studies using an informational descriptive social-norm-based message about prior participants' consumption behaviour (Robinson, 2015; Robinson et al., 2014; Stok et al., 2016). The results of these studies appear consistent; specifically, a text or graphic message informing that others have eaten a large or a small quantity of food respectively increased or decreased the amount of food consumed (Robinson et al., 2014; Stok et al., 2016). To study the importance of perceived social norms for everyday real-life food consumption, relations between perceived descriptive social norms regarding significant others' (e.g. peers') food consumption and daily food consumption have also been reliably established (Robinson et al., 2014; Stok et al., 2016).

However, very little research has focused on the source of the information on which perceived social consumption norms are based. The general presumption in psychology is that perceived social norms are derived from observing the behaviour of others, which acts as an adaptive decision-making cue (Higgs, 2015; Knight Lapinski & Rimal, 2005; Reno et al., 1993). Our findings in Chapters 2 and 3 may contribute to new insights into how social consumption norms may be communicated in the natural world, as they indicate that perceived social norms regarding common and socially appropriate consumption are

derived from visual exposure to the physical food environment, but on different levels (i.e. the level of the in-store/restaurant and the level of the neighbourhood's built food environment). Specifically, in Chapter 2, we demonstrated how various physical cues in specific displays of food selection may communicate how previous consumers have acted, what the popular food choice is, and/or what may be considered an appropriate course of action regarding food selection. Thus, this chapter presents a new understanding of how physical cues in food environments may stimulate eating, thereby supplementing the predominant view that it is merely the high availability and easy accessibility of foods that contribute to overconsumption (Pitt et al., 2017; Story et al., 2008; Townshend & Lake, 2017). Furthermore, we offer an in-depth, theory-based overview of physical cues in self-service food environments that may potentially influence food consumption through normative interpretations. Hence, this study may be interpreted as a comprehensive starting point for further research testing whether and how these cues affect actual eating behaviour. Indeed, a growing body of experimental studies have provided causal evidence of the normative influence of several of these cues. For instance, in one specific study that focused on the availability of products in a food selection display, Raghoebar, Van Kleef, and De Vet (2020) showed that a greater availability of plant-based (versus animal-source) food products resulted in a higher endorsement of perceived descriptive norms about what other people typically chose, although an effect on food selection was not found. No effect of food product availability was found on perceived injunctive norms about the appropriate choice according to other people. Overall, that study provided causal evidence for one of our suggestions as described in Chapter 2, i.e. that a high availability of a certain food product (relative to similar, but other products of this type) communicates a descriptive social norm message about the popularity of/demand for a product. In Chapter 3, a physical availability cue was measured on the level of the built food environment, namely, the number of fast food outlets in the residential neighbourhood. It was demonstrated that the existence of a higher number of fast food outlets in the residential neighbourhood was associated with a higher endorsement of perceived descriptive norms about common fast food consumption in the neighbourhood, as well as with perceived injunctive norms about appropriate fast food consumption in the neighbourhood. In contrast to the smaller-sized physical cues under study in Chapter 2 (or in small-scale lab experiments such as Raghoebar et al. (2020), where participants are situated in the moment of food selection), the neighbourhood-level cues are most probably not directly observable for participants at the moment of measurement. Rather, the survey (including the items about perceived neighbourhood social norms) could be completed anywhere (e.g. at home, at work). However, the finding that the existence of the availability of fast food outlets was significantly associated with perceived neighbourhood social norms regarding common and appropriate fast food consumption, indicates that people appear to have inferred these consumption norms from previous encounters with cues in their direct neighbourhood. On this higher food environment level, the exact cues that may

have provided input for perceived social consumption norms remain unclear; it may be the fast food outlets themselves, as their mere existence inherently means that they are being patronized by customers (an idea already suggested by Clary et al. (2017)). Most probably however, social norm perceptions are not formed solely by this physical measure, but also by the observation of other people that use these outlets; part of the survey that we used specifically focused on these observations, that is, perceived descriptive norms. Regardless of the specific source of neighbourhood norm perceptions, the idea that consumption norms were inferred from previous encounters in the neighbourhood, suggests in turn, that these norm perceptions were essentially based on memory, albeit that this information was stored unconsciously. Given that previous correlational research has indicated that social norm perceptions are often not aligned with actual, prevailing social norms (also referred to as misperceptions (Lally, Bartle, & Wardle, 2011; Lewis & Neighbors, 2004; Perkins, Meilman, Leichliter, Cashin, & Presley, 1999)), the accuracy of the perceived neighbourhood norms is questionable. Nevertheless, memory appears to be a relevant mental process for the acquisition of social norm perceptions, as previous research has demonstrated that humans have a recall bias for normative social information that may serve an adaptive function of conforming to, and avoiding the violation of, norms (O'Gorman, Wilson, & Miller, 2008). Moreover, as the number of physical fast food outlets was a rather objective measure of exposure that was independently assessed from our panel survey, our finding that this measure was significantly associated with perceived norms provides a first indication that social consumption norms are reliably formed by the neighbourhood physical food environment.

All in all, the findings from part 1 indicate that the real-world physical food environment may be a relevant source of social norm perceptions about common and appropriate eating behaviour. These findings confirm recent suggestions that the mere physical availability of unhealthy or healthy foods does not directly lead to consumption of those foods (e.g. Clary et al., 2017; Dhurandhar, 2016). Particularly, our findings highlight the relevance of human social cognition when a person is interpreting physical contexts, as they show that perceptions of social norms may be a psychological mechanism in the relation between the physical food environment and consumption. Evidently, there are other psychological processes that may explain how the physical food environment influences consumption. For example, increased exposure to certain foods may increase liking for those foods, in conformity with the mere exposure effect (a normative interpretation may, however, also underlie this phenomenon (Kwan, Yap, & Chiu, 2015)). Given the importance of human social cognition for various behaviours, our findings contribute to building evidence that contextual social norms constitute a relevant psychological process that may explain how various cues in the physical food environment may influence food consumption. To improve our understanding of the role of social norms in physical food environments, I suggest that future research should investigate how and under what circumstances

various types of physical cues in food environments contribute to social norm perceptions. Moreover, a new direction for future research is to examine how these contextual social norms relate to alternative normative processes (e.g. personal norms) in their relation with food consumption, as well as to alternative (non-normative) psychological processes that could explain how the physical food environment stimulates consumption.

6.2.2 Resource scarcity and relative deprivation as food decision-making processes

In recent years, it is increasingly acknowledged that objective factors related to material deprivation, such as limited access to healthy foods, do not fully explain why people with lower SES have relatively unhealthy diets. Although many studies have demonstrated that lower SES neighbourhoods, in comparison to higher SES neighbourhoods, are characterized by a greater access to outlets selling unhealthy foods (e.g. Black et al., 2014; Laxy, Malecki, Givens, Walsh, & Nieto, 2015), data linking the poorer food environments of low SES neighbourhoods to food consumption among low SES individuals remain inconclusive (Caldwell & Sayer, 2019; Claassen, Klein, et al., 2019). Consequently, a growing number of observational studies have focused on various other intra-individual variabilities in environmental (e.g. neighbourhood quality) and/or psychological (e.g. personal control) factors that could explain the relationship between SES and diet or overweight (for an overview, see Claassen, Klein, et al., 2019). For example, one study found that low subjective social status (SSS, i.e. perceptions of one's place in the status hierarchy of society) was inversely associated with BMI and obesity, and that both socioeconomic factors (e.g. neighbourhood quality) and psychological resources (e.g. perceived stress, personal control, and conscientiousness) partially explained the association between SSS and obesity (Bradshaw, Kent, Henderson, & Setar, 2017). However, causal evidence for a psychosocial explanation for the SES gradient in diet remains scarce (Claassen, Klein, et al., 2019). Taking a more fundamental perspective, only recently, a limited but growing number of experimental researchers have attempted to test how manipulations of social status affect food intake or food preference (e.g. Bratanova et al., 2016; Cheon & Hong, 2017; Pavela et al., 2017). In these studies, hypotheses were generally informed by the assumption that humans, like various animals, have an adaptive drive to secure their energy stores in times of uncertainty to buffer for future food scarcity and so secure survival (Dhurandhar, 2016; Nettle, Andrews, & Bateson, 2017). In these manipulations, participants were merely primed with cues signalling scarcity when reading a scenario, or led to believe or relive their (dis)advantaged socioeconomic situation. Our research on resource scarcity and PRD adopts a different approach by focusing on particular psychological states that have been theorized to result directly from objective socioeconomic conditions. To this end, we manipulated deprived socioeconomic conditions (i.e. absolute scarcity of resources, or deprivation of resources relative to others) and measured whether this actual deprivation of resources indeed leads to more negative subjective psychological

states. Specifically, we demonstrated that manipulating the number of resources to be spent in a trade-off task resulted in experiences of having too little and making trade-offs (i.e. scarcity) and that manipulating the number of resources earned relative to another individual resulted in experiences of unfairness and frustration (i.e. PRD). Notably, these states have previously been shown to alter decision-making processes and behaviours in non-food domains (Callan et al., 2008; Callan et al., 2011; Haushofer & Fehr, 2014; Kim, Callan, Gheorghiu, & Matthews, 2017; Mani et al., 2013; Mishra & Meadows, 2018; Smith et al., 2012; Spears, 2011). On the basis of these evidence-based insights, we measured actual food consumption as a novel behavioural consequence of this shift in psychological states.

Generally, we found that absolute resource scarcity did not consistently result in unhealthier food consumption, but we also presented a pattern indicating that relative deprivation led to unhealthier food choices. The fact that the methodology (i.e. type of sample, type of manipulation, food consumption measure) was inherently heterogeneous across these two studies complicates any direct comparison of their outcomes. However, these results do comply with recent suggestions that the relative component of deprivation is more important than absolute or objective measures in the association with overweight and obesity (Daly et al., 2015; Davillas & Benzeval, 2016). People generally do not live in a social vacuum and tend to infer their level of life satisfaction and success from comparison with others. Neither could recent studies demonstrate associations between perceived financial scarcity and diet quality (Yau et al., 2019) and health behaviours (Prentice et al., 2017), although significant associations between financial scarcity and dietary outcomes have also been found (Beenackers et al., 2017; Venn & Strazdins, 2017). To provide any conclusive, causal evidence for potential effects of resource scarcity or relative deprivation on food consumption, more experimental studies are needed. Moreover, these concepts have not been compared directly in studies on diet or health-related outcomes. I suggest that future research should test the relative importance of absolute resource scarcity versus relative deprivation in their association with diet-related outcomes within the same investigation.

Nevertheless, by including two different theories that both aim to explain how absolute and relative socioeconomic conditions result in short-sighted decision making, this thesis also contributes to a better theoretical understanding of how a person's SES may affect unhealthier food consumption. To date, only one literature review has included the theories of resource scarcity and relative deprivation concurrently to explain deprivation effects on eating behaviours or diet (Claassen, Corneille, et al., 2019). Although these theories' explanations of underlying mechanisms of how scarcity affects mental processes may appear distinct, they are not mutually exclusive. Both theories emphasize a focus on the here-and-now, which results from dealing with immediate problems (scarcity)

or from experiences of the unattainability of future goals in a world that is unjust (PRD). However, whereas scarcity theory emphasizes a decrease in cognitive capacity (or mental bandwidth) under conditions of poverty (Mullainathan & Shafir, 2013; Shah et al., 2012), PRD emphasizes an increase in negative emotions as a result of perceived injustice (Crosby, 1976; Smith et al., 2012). Hence, whereas scarcity theory provides an explanation for unhealthier eating under poverty because of more difficulty with resisting temptations (disinhibition of consuming palatable but unhealthy foods), PRD theory assumes that PRD leads to an increased desire for immediate rewards (which could translate into a higher craving of palatable foods). Overall, scarcity and PRD may be two potential antecedents of lower states of self-regulation that people with lower SES often experience, and this may be driven by a limited cognitive capacity or by motivational processes (for a detailed discussion, see Salmon, 2015). Our preliminary finding that PRD influences food choice to some extent may cautiously suggest that perceptions of unfairness and negative emotional states, which are both inherent to the experience of PRD (Callan et al., 2015; Smith et al., 2012), influence acute food consumption most likely through a compensation (motivation) mechanism. This aligns with previous notions that people raised in deprived neighbourhoods tend to compensate their relatively fragile sense of self with consumption of pleasant products, such as comfort foods (Bartley, 2016). More substantial effects of absolute and relative forms of scarcity on eating behaviour and specific underlying mechanisms remain to be explored by future research.

Overall, the studies in part 2 show how negative psychological experiences consequent to deprived socioeconomic conditions may influence food consumption. Although the findings were somewhat inconclusive, they indicate that inferring a state of relative deprivation by evaluating objective resources through upward social comparison may result in unhealthier food consumption. In contrast, we could not provide evidence that inferring a state of having too little from an absolute number of resources leads to unhealthier food consumption. With these findings, we contribute to a more fundamental, psychological view on the role of context in socioeconomic disparities in diet. Obviously, I acknowledge that this is only one piece of the complex puzzle that may explain these disparities. It remains an avenue for further research to determine the extent to which perceived scarcity and relative deprivation, in addition to other objective and psychological factors, influence food consumption.

6.3 Methodological issues

6.3.1 Food consumption outcome measures

As food consumption is such a complex, multifactorially determined behaviour (Symmank et al., 2017), small effect sizes may be expected when one is studying the influence of one

particular psychological process, especially when measuring actual eating behaviour in smaller-scale experimental lab settings. A great number of larger-scale epidemiological studies investigating undesirable influences of a food environment context or a socioeconomic context on diet-related health outcomes have assessed weight as the outcome variable (Claassen, Klein, et al., 2019; Giskes et al., 2011; Stevenson, Brazeau, Dasgupta, & Ross, 2019). For example, studies aiming to reveal the importance of the changing food environment have focused predominantly on relationships between food outlet access and body mass index (Drewnowski et al., 2016; Gordon-Larsen, 2014), and studies aiming to reveal external factors of socioeconomic disparities in diet or health have also measured links between various socioeconomic factors and BMI (Claassen, Corneille, et al., 2019). However, focal measures such as body weight are ultimately the product of a complex relationship between energy intake and energy expenditure (e.g. Ravussin & Bogardus, 2000). As the overarching aim of this thesis was to provide new insights into psychological processes between contextual factors and unhealthy diets, across all four studies, we focused on a more proximal, behavioural measure of unhealthy diet, namely, food consumption (in the form of calorie intake, food selection, or frequency of consumption). To provide even more comprehensive insights into the exact mechanisms of unhealthy food consumption, we suggest that future research should focus on proxy measures of food consumption, such as the reinforcing value of food or neural activation in the brain (Epstein & Leddy, 2006; French, Epstein, Jeffery, Blundell, & Wardle, 2012).

Essentially, the methodology regarding food consumption outcome measures in this thesis was based on the widely held recognition in cognitive psychology that choices are often made without much conscious deliberation (Kahneman, 1973; Simon, 1955). Also, people's awareness of the influence of the environment on their behaviour is often deficient (Bargh, 2002; Wilson & Brekke, 1994). Building experimental evidence has shown that contextual cues affect eating behaviour without much awareness (Cohen & Farley, 2008; Dijksterhuis, Smith, van Baaren, & Wigboldus, 2005; Kremers et al., 2006). Given this reasoning, the central methodological approach in this thesis was to assess contextual influences on overt eating behaviours, rather than directly asking people to reflect on the causes of their own behaviour, as such reflections may be inaccurate. For example, through self-report, people with low SES have indicated price as an important barrier to a healthy diet, yet, studies in which budgets for food were provided to individuals with low incomes did not detect a change in healthier purchases (Caldwell & Sayer, 2019). It remains uncertain, however, whether the influences of the psychological processes assessed in this thesis (i.e. social norms, resource scarcity, and PRD) on food consumption were truly unconscious, because we have not specifically assessed explicit motives for the eating behaviour under study.

6.3.2 Measures of the psychological processes

Because validated assessment tools are lacking for each of the psychological processes included in this thesis, each of the processes was measured with a self-developed self-report instrument. To ensure a valid and comprehensive measurement of the particular process under study, these self-report instruments were carefully developed based on the theoretical description of the process.

On the basis of the conceptual and motivational distinction between descriptive and injunctive social norms, these types of social norms were assessed separately in both studies of Chapters 2 and 3. Descriptive social norms describe what most people do and motivate conformity by showing what is effective or adaptive behaviour, whereas injunctive social norms prescribe what most others consider appropriate behaviour and motivate conformity through social sanctions (Cialdini et al., 1990; Jacobson et al., 2011; Reno et al., 1993). Previous studies that focused on social norms and eating behaviour have predominantly focused on the influence of descriptive social norms (Ball et al., 2010; Robinson, 2015; Stok et al., 2016). The findings of Chapters 2 and 3 demonstrate that both descriptive and injunctive norms may be inferred from the food environment and that both these types of contextual norms may be relevant processes in the guidance of food consumption. As there appears to be great variety in operationalization of perceived social norm measures (Ball et al., 2010), it may be an avenue for future research to develop and validate a more uniform self-report instrument of perceived social norms (descriptive and injunctive) that can be adjusted to different behaviours, reference groups, and contexts.

In Chapters 4 and 5, the psychological processes, i.e. resource scarcity and PRD, were measured as part of the manipulation checks. On the basis of scarcity theory (Mullainathan & Shafir, 2013), resource scarcity was assessed with items pertaining to both experiences of having too little and making-trade-offs. On the basis of theories of relative deprivation (Callan et al., 2015; Crosby, 1976; Runciman & Runciman, 1966; Smith et al., 2012), PRD was assessed with items relating to perceptions of being worse-off, as well as emotional responses including frustration and resentment. Part of these items were adapted from a self-report instrument of chronic feelings of PRD (Callan et al., 2011). The induction and measurement of these real-time, momentary psychological states allowed us to make causal inferences. However, in line with a life course approach, it may be reasoned that experiences of deprivation may be most influential for behaviour when it is experienced more chronically or earlier in life. Notably, there are indications that a person's early socioeconomic life experiences may play an important role in regulating energy intake later in life, i.e. adulthood. Specifically, adults who have grown up under conditions characterized by low SES tend to eat in the absence of hunger, a pattern that is not generally found among those raised in higher SES environments (Hill et al., 2016; Proffitt Leyva & Hill, 2018). Guided by insights from evolutionary models of life history

theory (e.g. Laran & Salerno, 2013; Mittal & Griskevicius, 2014), it has been proposed that experiences of deprivation in developmental periods condition behavioural patterns of energy regulation systems that are adaptive in those contexts. On the basis of these insights and our results from Chapter 5, I suggest that an avenue for future longitudinal and experimental research on socioeconomic effects on eating would be to include measurements of earlier life experiences of scarcity and PRD, to study potential intra-individual, long-term influences of scarcity on food consumption.

6.3.3 Types of studies

In this thesis, we employed a diverse set of methodological approaches for different types of research questions; this can be considered a strength of this thesis because each methodological approach has unique advantages and has the potential to provide different sorts of evidence. Included are a mixed-method photo study, a correlational study including geospatial data, and a series of experiments in different settings within both studies in part 2. Another noteworthy methodological strength of this thesis is that the sample sizes of the experimental studies were quite large, as compared to similar sorts of studies in the field, thereby giving greater statistical power to detect a hypothesized effect. Next, I briefly discuss each of these approaches regarding its advantages and disadvantages with respect to the type of empirical evidence it may provide.

In Chapter 2, a mixed-method photo study was conducted. It was reasoned that the theory-based exploration of social norm messages in food environments was best analysed qualitatively by the researchers because of the careful application of social norm theory to a new domain (i.e. physical cues in food environments). A study among laypeople was additionally employed to cross-validate the findings of the theory-driven qualitative study. We reasoned that this improved the credibility of the identified cues in terms of bearing a social norm message that influenced behaviour. However, although the aim was to create an inventory of potential social norm cues in natural food environments, a true influence of these cues on behaviour could not be inferred. Nonetheless, over recent years, for several of these cues, experimental evidence has been provided of their effect on eating behaviour, and normative interpretations have been demonstrated as an underlying process (Raghoebar, Haynes, Robinson, Van Kleef, & De Vet, 2019; Raghoebar et al., 2020; Versluis & Papies, 2016).

In Chapter 3, a correlational study was conducted, as we aimed to investigate how the actual neighbourhood-level food environment may be associated with social norms and frequency of consumption of people actually living in those neighbourhoods. Hence, in comparison to experimental studies, this panel study has high ecological validity. Obviously, a major limitation of this study is that no causal inferences can be made. However, we carefully selected for confounders using a directed acyclic graph, aiming to

limit the influence of factors that would independently affect both the exposure and the outcome measure. Moreover, it was reasoned that self-selection of people choosing to live in neighbourhoods based on fast food outlet availability is rather implausible, but a reversed direction of the relationship under study cannot be entirely ruled out. A natural experiment in which the availability of fast food outlets changes over time would therefore be a relevant next step in studying effects on norm perceptions and consumption. Another limitation, in comparison to experimental studies, is that food consumption was self-reported rather than observed, and therefore likely biased by, for example, social desirability or flawed memory (Althubaiti, 2016). Given the focus on the real-world food environment however, and because observation of consumption at people's homes is unfeasible and unethical, measuring food consumption through self-report was rather inevitable.

In Chapters 4 and 5, we employed experimental studies in different types of settings (i.e. the lab, online, and lab-in-the-field) to investigate the direct influence of scarcity and PRD on actual food consumption. Carefully designed experimental studies provide most causal evidence for an isolated effect of a particular independent variable on actual behaviour, at the expense of external validity. However, it has been deemed implausible that attempts to manipulate socioeconomic conditions among participants can recapitulate the experiences of individuals actually living under conditions of lower SES (Caldwell & Sayer, 2019). To study effects of socioeconomic conditions on eating, it would be even better to randomly assign participants to actual different socioeconomic conditions as part of a natural experiment, for example by varying financial resources, but this is obviously unethical. It may also be questioned whether snap-shot measures of consumption, assessed in an experiment, are sufficient to understand dietary patterns in society. However, laboratory experiments allow for precise and accurate measurements of actual, observable eating behaviour, as opposed to self-report measures.

6.4 Remaining perspectives for future research

Apart from suggestions for future research based on specific theoretical reflections on the main findings of this thesis and on methodological issues, we next provide suggestions for shaping future research based on the wider scope of this thesis. So far, part 1 and part 2 of this thesis have addressed two (seemingly) distinct research lines, but there may be interesting links between these lines based on their underlying theoretical frameworks. These links may contribute to the overarching aim of better understanding how and when individuals' specific living contexts shape dietary patterns.

Many epidemiological studies have revealed an inverse association between neighbourhood availability of unhealthy food outlets and neighbourhood SES (Black et al., 2014; Moore & Roux, 2006). By investigating the influence of psychological states of resource scarcity and PRD on unhealthy food consumption, this thesis provides new ways to examine a potential double jeopardy that affects the diets of people with lower SES (Black, Macinko, Dixon, & Fryer, 2010). Not only may people with low SES be more exposed to unhealthy foods in the neighbourhood, but also they may be more susceptible to an unhealthy food environment. First, as explained in Chapters 5 and 6, resource scarcity and PRD are psychological states that may result from lower socioeconomic conditions and may increase susceptibility to tempting (palatable but unhealthy) foods that are available in the direct environment. Previous studies have tested the moderating role of other SES-related psychological states in the relationship between food availability and diet-related outcomes. For example, based on the idea that self-control and financial stress lower the capacity to resist tempting foods, a Dutch observational study demonstrated that these factors moderated the relation between neighbourhood fast food exposure and weight status (Mackenbach et al., 2019). However, the results were in the opposite direction; for example, a higher fast food outlet exposure was associated with a lower BMI in those with great financial stress, but not significantly associated with BMI in those with no financial stress. The fact, however, that this study did not measure dietary intake complicates the understanding of psychological influences on upstream eating behaviour (see also section 6.3.1*)*. Based on the insight that unhealthy foods are more heavily marketed in low-income neighbourhoods (e.g. Lesser, Zimmerman, & Cohen, 2013), an experimental study measuring actual calorie intake revealed preliminary evidence for a double jeopardy of cognitive load and food advertisement, especially in low SES individuals (Zimmerman & Shimoga, 2014). Given that resource scarcity and PRD may be important yet largely overlooked influences on food consumption in research on socioeconomic diet disparities, I suggest that future observational and experimental research could reveal the extent to which unhealthier consumption of those with lower SES can be explained by an independent or potentially joint influence of a higher exposure to unhealthy foods and a higher (chronic) experience of resource scarcity or PRD.

Second, not only may resource scarcity and PRD increase susceptibility to the physical availability of unhealthy foods, but also these psychological states may increase a person's vulnerability to (contextual) normative influences that guide food consumption. An important motivational force behind conformity to group norms is subjective uncertainty (Cialdini & Goldstein, 2004; Deutsch & Gerard, 1955). To reduce feelings of uncertainty, norms can be used as internalized guides for behaviour, even when this behaviour is rather unrelated to the source of a person's uncertainty (Smith, Hogg, Martin, & Terry, 2007). Ample research has shown that uncertainty about the eating situation itself enhances the likelihood of norm conformity (Higgs, 2015), but it remains to be investigated

whether resource scarcity and PRD, when viewed as sources of feelings of insecurity and uncertainty (Cannon, Goldsmith, & Roux, 2019; Zhang et al., 2015), may moderate the influence of consumption norms on eating behaviour. Moreover, perceptions about how other people behave could work as the external influence heuristic of social proof (Cialdini, 2007); e.g. if others consume a lot of fast food, it is the right thing to do. Heuristics appear especially influential for behaviour when people have less cognitive capacity to make a deliberate decision (Jacobson et al., 2011). Robinson, Otten, and Hermans (2016) indeed found that the association between perceived peer consumption norms and self-reported snack consumption was stronger for individuals with low levels of self-control. Given the role of social norms in explaining how a physical food environment influences consumption, future research aimed at better understanding socioeconomic disparities in diet may examine whether the food consumption of people who experience high levels of resource scarcity or PRD, or general uncertainty resulting from socioeconomic conditions (Yang, Yang, Yu, Cottrell, & Jiang, 2017), may be more susceptible to unhealthy (neighbourhood) consumption norms.

A final noteworthy research direction that follows from this thesis is to achieve an increased understanding of different types of social processes that influence food consumption. Traditionally, social influence research in the domain of eating behaviour has focused on social processes including modelling of eating, impression management, and social facilitation (Higgs & Ruddock, 2020). For example, people tend to adapt their behaviour to be similar to that of others, as this proves a guide as to appropriate behaviour (i.e. the social norm). As mentioned previously, part 1 of this thesis has provided new insights into a source of the norm information that may influence food consumption: i.e. physical aspects of the food environment. Part 2, however, also focuses on a social process (PRD) that is overall relatively new in its application to the domain of food consumption. Although social norms and PRD are both driven by positive reinforcement processes (Higgs & Ruddock, 2020), they differ substantially in their theorized mechanism of influencing food consumption. Whereas social norms influence behaviour through confirmation via imitation or observational learning of that particular behaviour (Higgs, 2015; Knight Lapinski & Rimal, 2005), PRD may stimulate immediately rewarding behaviour that is essentially unrelated to the social comparison process itself. Rather, the central social process of PRD is upward social comparisons that are centred around desirable resources and conditions (unrelated to eating) (Crosby, 1976; Festinger, 1954; Smith et al., 2012). Social norms and PRD are similar in that they are both social processes pertaining to oneself relating to other individuals. Particularly, both social processes are inherently shaped by social reference groups: a reference group might be defined at different levels, e.g. nationality, peer group, or geographic region (Eibner & Evans, 2005; Higgs, 2015; Knight Lapinski & Rimal, 2005; Smith et al., 2012). Hence, it remains to be examined how different reference groups within an individual's social environment may influence eating

with respect to normative or comparative processes. Overall, I suggest that studying a potential joint influence of social norms and PRD on eating may be of interest in shaping a more comprehensive view of how an individual's social context (or different social contexts) may shape his/her food consumption.

6.5 Practical implications

Although beyond the scope of this thesis, insights into the psychological processes explaining contextual influences on food consumption may ultimately contribute to designing policies and improving existing interventions aimed at complex behaviour change to stimulate healthier consumption. In the Netherlands, the *Landelijke nota gezondheidsbeleid* (Ministerie van Volksgezondheid, Welzijn en Sport, 2020) describes national priorities in the domain of public health and guides governments' local health policies. Current public health policies are focused mainly on improving the physical and social living environment to improve national health and to decrease health disparities. For example, discouraging the establishment of outlets selling unhealthy foods and encouraging the offer of healthy foods is one the aspirations of a policy strategy to stimulate a healthy lifestyle in deprived neighbourhoods. Adopting a multidisciplinary approach, existing interventions appear particularly effective in improving lifestyle and health when special attention is given to underlying factors including poverty and the direct living environment. Our findings join in this direction and provide insights into specific psychological processes that may need to be addressed additionally in these policies and interventions. Specifically, our findings indicate that an increasing availability of unhealthy food outlets may shift our norms and thereby facilitate unhealthier dietary patterns. As both perceptions of social norms and the physical food environment are amenable to change (Mattern & Neighbors, 2004; Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007), policies and interventions may need to attempt to change perceived consumption norms, potentially through re-designing our physical food environment, to ultimately improve the healthfulness of diets. To test the potential effectiveness of this notion, I suggest that future longitudinal research should investigate whether banning unhealthy food outlets from, and/or the establishment of healthy food outlets in, certain neighbourhoods indeed improves the healthiness of social consumption norms, and hence food consumption. Furthermore, even though this thesis provides only preliminary evidence with regard to the influence of PRD on food consumption, it may be an important psychological process to take into account when aiming to reduce health inequalities through improved diets. For lower socioeconomic groups, changes in the physical food environment may be insufficient, and our research supports calls for social protection policies to address societal inequality – or at least people's subjective experiences of

their relative deprivation – to address various problems in the lives of people with lower socioeconomic conditions, including unhealthier diets and so diet-related diseases.
Moreover, the psychological approach adopted in this thesis may help to shift societal perspectives on reasons why people make unhealthy food choices. Recognizing contextual influences on psychological processes and food consumption may aid viewing unhealthy eating as a collective phenomenon rather than an individual character flaw or deficiency of knowledge about healthy diets; this may help to reduce the widespread negative stigma against obesity and unhealthy food choices, particularly in low socioeconomic groups. Particularly, the approach contributes to our increasing understanding that the tendency to consume unhealthy foods under negative experiences of uncertainty (such as scarcity, PRD) may have evolved because it has a psychologically adaptive function in these uncertain contexts, yet may be sabotaging our health in our current environment with its overabundance of unhealthy foods.

6.6 Concluding thoughts

The present thesis highlights specific psychological processes that could explain how the physical food environment and an individual's socioeconomic context may steer unhealthy food consumption. Although no causal conclusions can be drawn from the first part of the thesis, the findings indicate that social norms regarding common and appropriate consumption are derived from the real-world physical food environment and thereby influence food consumption. We have, therefore, provided new insights into how social consumption norms may be communicated by the existing food environment, on the level of various in-store/restaurant settings and of fast food outlets in the residential neighbourhood. The findings from the second part of the thesis provide causal yet somewhat inconclusive, preliminary evidence suggesting that experiences of resource scarcity do not lead directly to increased snack intake, but that experiences of relative deprivation appear to increase patterns of unhealthier food choice. These findings contribute to more fundamental, psychological perspectives on the role of context in socioeconomic disparities in diet. Overall, this thesis underlines the importance of including the human social cognition element when the aim is to better understand how objective contexts and conditions influence food consumption. As the presented research was based on multiple psychological theories and different methodological approaches, various avenues for further research were provided. Ultimately, growing insights into psychological processes between contextual factors and unhealthy food consumption can be used to design more effective interventions that address psychological processes in addition to objective factors in the direct living environment.

SUPPLEMENTARY MATERIAL

Supplementary material Chapter 2

Supplementary Table 2.1. 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
Colour	Green colour	Green coloured containers
	Red colour	Red coloured arrow
		Red coloured 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

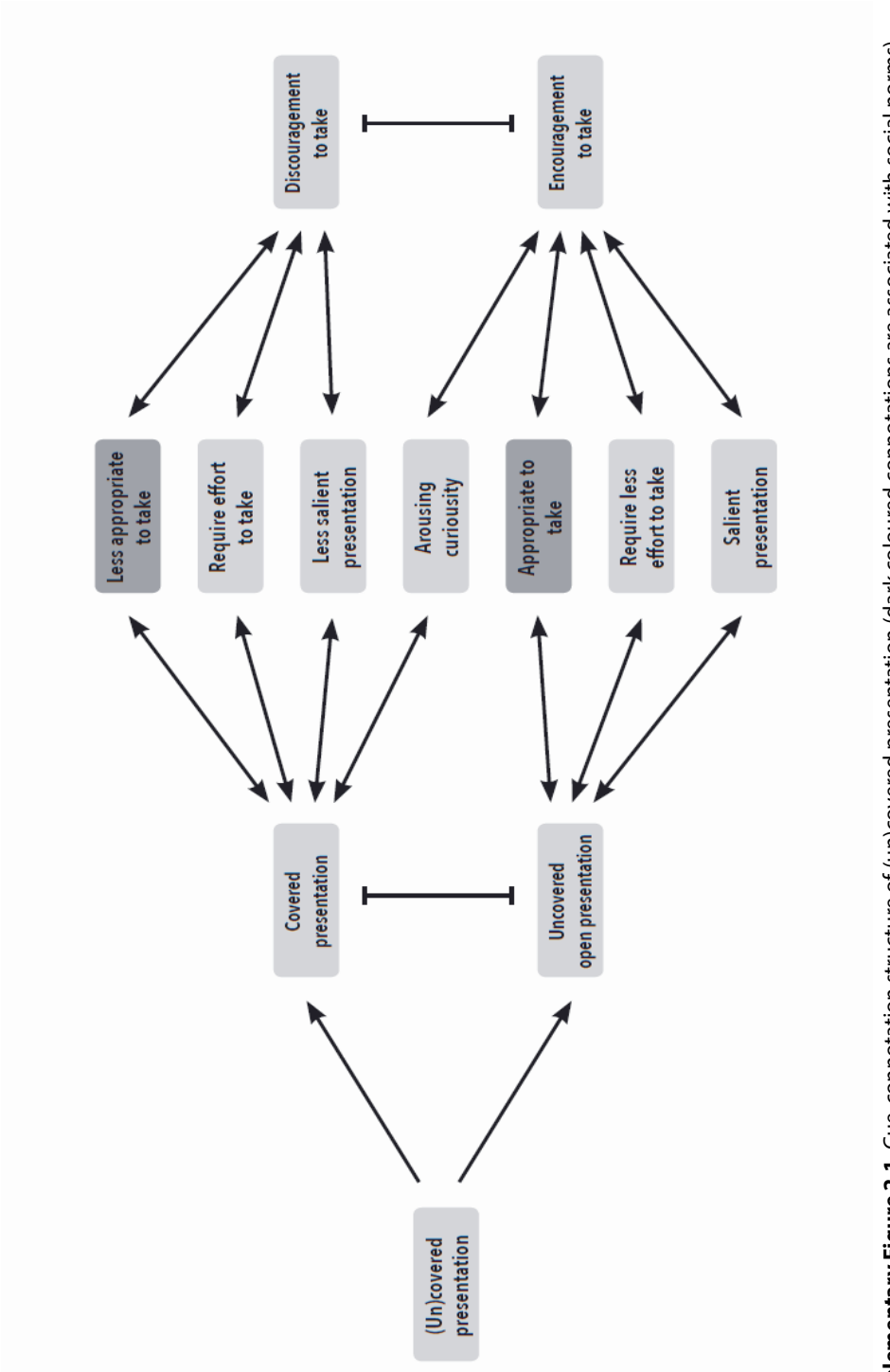
Notable presentation	Upright standing product plates[1,2]	
	Elevated presentation[2]	Elevation of container
		Elevation of plate
	Forward-tilted presentation[2]	Forward-tilted containers
		Forward-tilted product plates
	Shortened container[2]	
Placement	Middle placement[1]	Bowl in the middle
		Container 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

Note: [1]Descriptive social norm connotation, [2]Injunctive social norm connotation

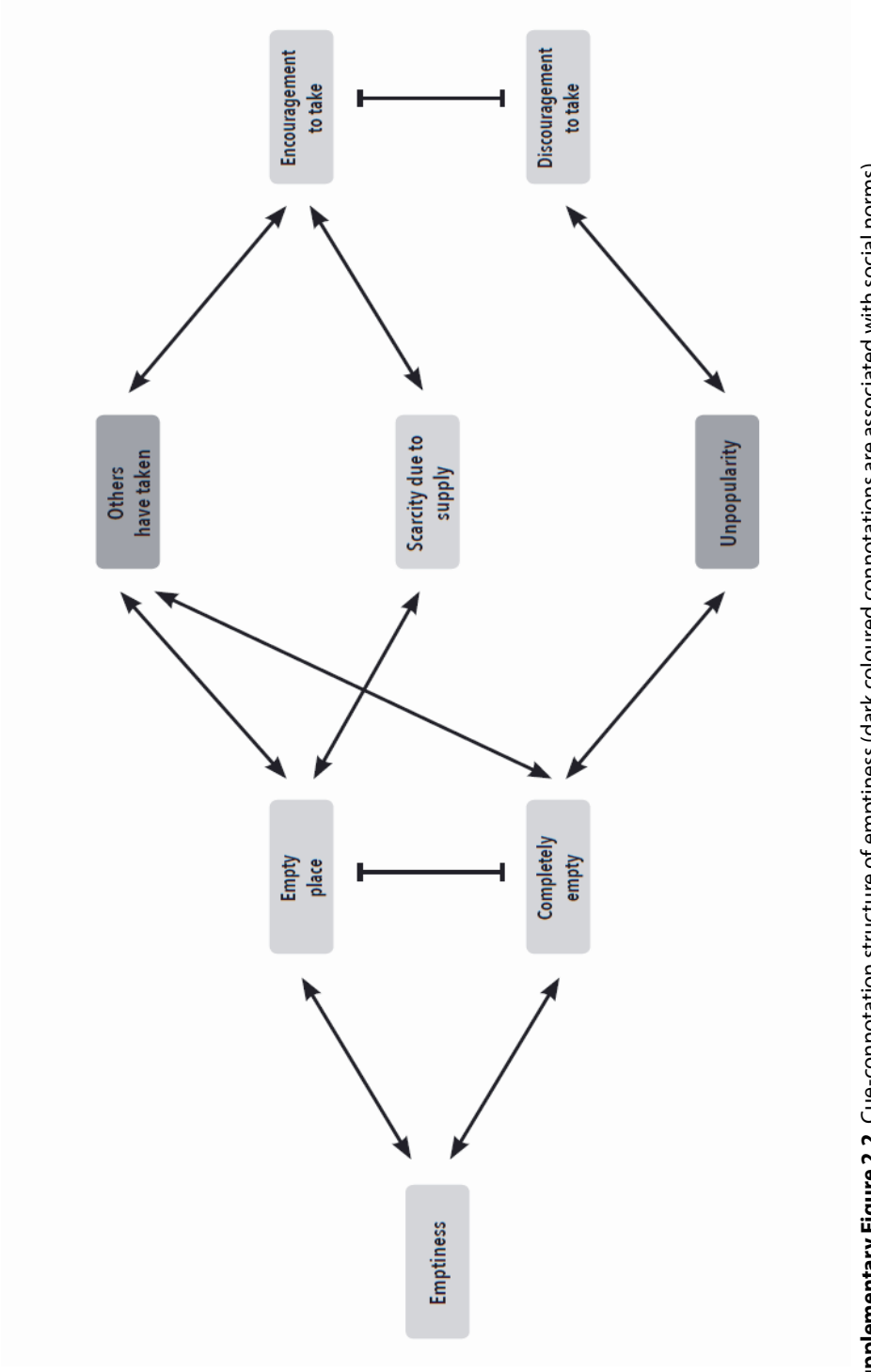
Supplementary Table 2.2. Physical cue codes occurring 10 or more times

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

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

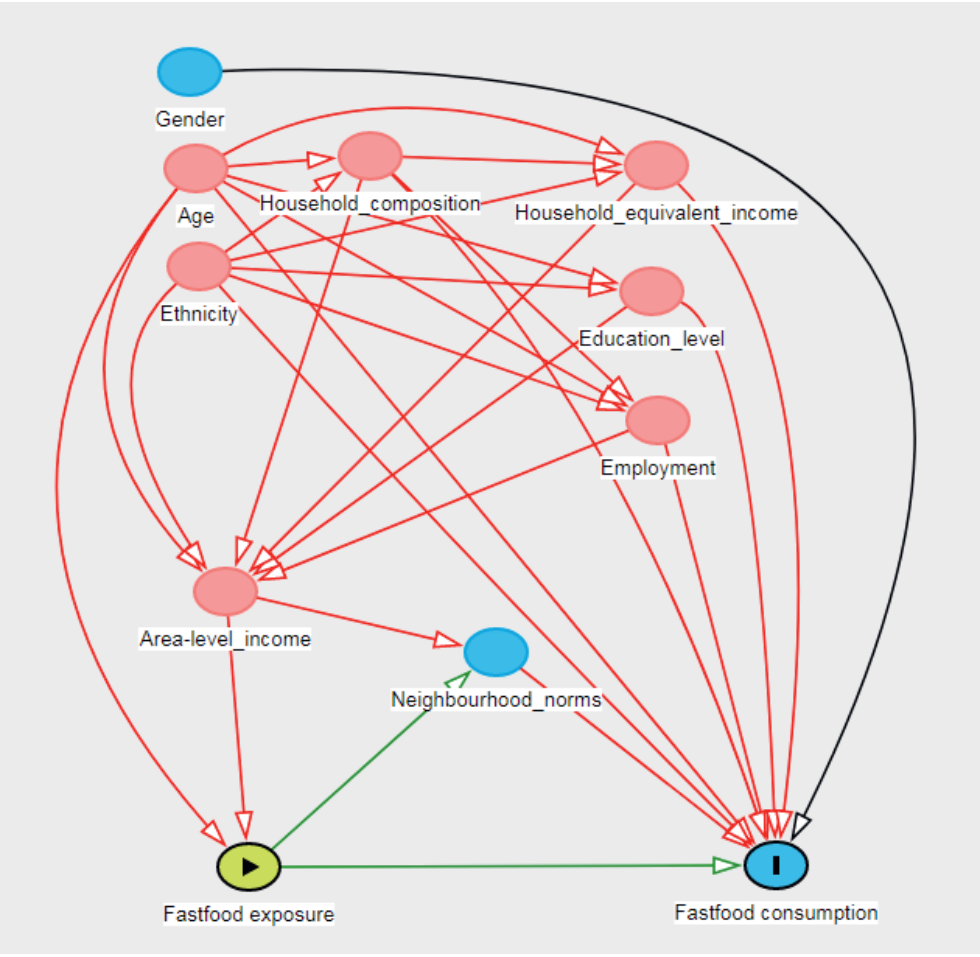


Supplementary Figure 2.1. Cue-connotation structure of (un)covered presentation (dark coloured connotations are associated with social norms)



Supplementary Figure 2.2. Cue-connotation structure of emptiness (dark coloured connotations are associated with social norms)

Supplementary material Chapter 3



Supplementary Figure 3.1. DAG representing assumed causal pathways between fast food outlets, fast food consumption and covariates. Created with Dagitty (Textor, van der Zander, Gilthorpe, Liskiewicz, & Ellison, 2016).

Supplementary material Chapter 4

Supplementary information 4.1 Trade-off task (scarcity manipulation) versions

Supplementary information 4.1.1. Trade-off task (scarcity manipulation) from Study 1, presented is the scarcity condition, translated from Dutch to English

Introduction
Because of an anniversary of your study, Wageningen University wants to give a party for all students of your study. The party will be held in the café of the Forum. The area is empty and available from 21.00 until 03.00 hours.
Imagine that *you* are chosen to organize this party.

Instruction
Your task is to choose which goods and services need to be ordered and arranged. Try to put yourself in the role of the organization. Imagine you want this party to be a success. Your choices are important, because these determine the content of the party. To thank you for your input, your name will be written on the invitation.

Below you will see 9 categories of goods and services that may be important for the party. Every category consists of 3 different options. You may assume all options within a category are equally expensive.

From the following rows of 3 options, **you may choose only 1 option (by ticking the box) that you want for the party.**

1. Personnel
Which personnel do you want to hire? (Maximum 1 option possible)

❒ DJ
❒ Toilet personnel
❒ Bar personnel

2. Promotion
Which promotion option do you want? (Maximum 1 option possible)

❒ E-mail
❒ Facebook
❒ Posters/flyers

3. Facilities 1
Which facility do you want to arrange? (Maximum 1 option possible)

❒ Standing tables
❒ Dance floor
❒ Lounge corner / seating area

4. Facilities 2
Which facility do you want to arrange? (Maximum 1 option possible)

❒ Bicycle shed
❒ Cloakroom
❒ Smoking area

5. Drinks
Which drink do you want to arrange? (Maximum 1 option possible)

❒ Beer
❒ Wine
❒ Soda

6. Music to be played
Which music do you want to be played? (Maximum 1 option possible)

❒ 90's hits
❒ Top 40
❒ Dance

7. Times of playing music
At which time do you want to play music? (Maximum 1 option possible)

❒ 21.00-23.00 hours
❒ 23.00-01.00 hours
❒ 01.00-03.00 hours

8. Part of karaoke activity
Which part of the karaoke activity do you want to arrange? (Maximum 1 option possible)

❒ Microphone
❒ Beamer with screen for the lyrics
❒ CD with music in karaoke verison muziek (instrumental)

9. Further items
Which further item do you want to arrange? (Maximum 1 option possible)

❒ Glasses
❒ Beer tap
❒ Music (CDs)

Supplementary information 4.1.2. Trade-off task (scarcity manipulation) from Study 2, presented is the scarcity condition, translated from Dutch to English

Introduction
Wageningen University exists for 100 years in 2018. Let's party! How would you organize the party? Please think along with us.

The party will be held in an area with a bar and toilets, but for the rest the area will be empty . The area is available from 21.00 until 03.00 hours.

Imagine that *you* are chosen to organize this party for your fellow students.

Instruction
Your task is to choose which goods and services need to be ordered and arranged. The university has already composed a list with categories and options. Try to put yourself in the role of the organization. Imagine you want this party to be a great success. Your choices are important, because these determine the content of the party.

Below you will see 8 categories of goods and services that may be important for the party. Every category consists of 3 different options. You may assume all options within a category are equally expensive.

From the following rows of 3 options, **you may choose only 1 option (by ticking the box) that you want for the party.**

1. Personnel
Which personnel do you want to hire? (Maximum 1 option possible)

❒ DJ
❒ Photographer
❒ Bar personnel

2. Promotion
Which promotion option do you want? (Maximum 1 option possible)

❒ E-mail
❒ Facebook
❒ Posters/flyers

3. Facilities 1
Which facility do you want to arrange? (Maximum 1 option possible)

❒ Standing tables
❒ Dance floor
❒ Lounge corner / seating area

4. Drinks
Which drink do you want to arrange? (Maximum 1 option possible)

❒ Beer
❒ Wine and liquor
❒ Soda

5. Music to be played
Which music do you want to be played? (Maximum 1 option possible)

❒ 90's hits
❒ Top 40
❒ Dance / techno

6. Times of playing music
At which time do you want to play music? (Maximum 1 option possible)

❒ 21.00-23.00 hours
❒ 23.00-01.00 hours
❒ 01.00-03.00 hours

7. Part of karaoke activity
Which part of the karaoke activity do you want to arrange? (Maximum 1 option possible)

❒ Microphone
❒ Beamer with screen for the lyrics
❒ CD with music in karaoke verison muziek (instrumental)

8. Bar items
Which items do you want to at the bar? (Maximum 1 option possible)

❒ Glasses
❒ Beer tap
❒ Glass rinser

Supplementary information 4.1.3. Trade-off task (scarcity manipulation) from Study 3 and 4, presented is the 'no-scarcity extra' condition, translated from Dutch to English

Introduction
Wageningen University exists for 100 years in 2018. Let's party! How would you organize the party? Please think along with us.

The party will be held in an area with a bar and toilets, but for the rest the area will be empty. The area is available from 21.00 until 03.00 hours.

Imagine that *you* are chosen to organize this party for your fellow students.

Instruction
Your task is to choose which goods and services need to be ordered and arranged. The university has already composed a list with categories and options. Try to put yourself in the role of the organization. Imagine you want this party to be a great success. Your choices are important, because these determine the content of the party.
Below you will see 10 categories of goods and services that may be important for the party. Every category consists of 3 different options. You may assume all options within a category are equally expensive. Each category is based on a certain budget, but there is room for an extra option.

For each category, **you may choose all options (by ticking the box) that you want for the party. The last option is still open, please only fill this in if you readily want to choose something extra.**

1. Personnel
Which personnel do you want to hire? (More options possible)

❒ DJ
❒ Toilet personnel
❒ Bar personnel
❒ Doorkeeper
❒ .....

2. Promotion
Which promotion option do you want? (More options possible)

❒ E-mail
❒ Facebook
❒ Posters/Flyers
❒ During lectures
❒ .....

3. Facilities
Which facility do you want to arrange? (More options possible)

❒ Standing tables
❒ Dance floor
❒ Lounge corner/Seating area
❒ Wardrobe
❒ .....

4. Drinks
Which drink do you want to arrange? (More options possible)

❒ Beer
❒ Wine
❒ Soda
❒ Cocktails
❒ .....

5. Music to be played
Which music do you want to be played? (More options possible)

❒ 80's/90's hits
❒ Top 40
❒ Dance / Techno
❒ Rock
❒ .....

6. Times of playing music
At which time do you want to play music? (More options possible)

❒ 21.00-23.00 hours
❒ 23.00-01.00 hours
❒ 01.00-03.00 hours

7. Part of karaoke activity
Which part of the karaoke activity do you want to arrange? (More options possible)

❒ Microphone
❒ Beamer with screen for the lyrics
❒ CD with music in karaoke version music (instrumental)
❒ Stage
❒ .....

8. Event
In addition to karaoke, (an) event(s) can be arranged. Which event(s) do you want to arrange? (*More options possible*)

❒ Joint activity (e.g. games, dance workshop)
❒ Speech (for example, by the head of the university)
❒ Live band
❒ Happy hour
❒ .....

9. Items for the bar
Which item for the bar do you want to arrange? (More options possible)

❒ Drinking glasses
❒ Refrigerators
❒ Beer tap
❒ Rinsing tube
❒ .....

10. Stage setting
Which stage setting do you want to arrange? *(More options possible)*

❒ Decoration
❒ Illumination and disco lights
❒ Snacks
❒ Welcome drink
❒ .....

Supplementary information 4.2. Measurements of states related to scarcity (Study 1)

Cognitive engagement in making choices was assessed with a three item measure inspired by Vohs et al. (2014), (e.g. "I was thinking actively while making choices"). Items were answered on a 7-point Likert scale measuring the degree of agreement, ranging from 1 (strongly disagree) to 7 (strongly agree). The scale was reliable, Cronbach's α = .82 and a mean score was computed. Self-reported cognitive load was measured with one item developed by Paas (1992); Paas and Van Merriënboer (1994) that was validated against different levels of task complexity in the domains of statistics and geometrics (Paas, Van Merriënboer, & Adam, 1994). Participants were asked to rank on a seven-point Likert scale "How much effort did you put in this task?", ranging from 1 (very low effort) to 7 (very high effort). Affect was with assessed with one item "How do you feel at this moment?". The answer scale ranged from 1 (very negative) to 7 (very positive).

Supplementary Table 4.1. Results of t-tests comparing the two conditions on scarcity related states in Study 1

	Scarcity condition (*N* = 41)	**No-scarcity condition (*N* = 40)**	***t*-test**	
Scale (range 1-7)	***M* (*SD*)**	***M* (*SD*)**	**(*df* = 79)**	**Cohen's *d***
Engagement	5.23 (0.94)	4.67 (1.20)	2.37*	.53
Cognitive load	4.51 (1.10)	3.85 (1.41)	2.37*	.52
Affect[a]	4.85 (1.11)	5.10 (1.24)	-0.95	.21

Note: * $p < .05$

Supplementary Table 4.2. Means, *SD*s, and correlations of the variables under study in Study 2 ($N = 95$)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Age	-																	
2. Gender (% males)[b]	.04	-																
3. Hunger[a]	.02	.16	-															
4. Healthy eating goal[a]	-.08	.13	.02	-														
5. Restraint eating goal[a]	-.06	-.01	-.02	.30**	-													
6. Need for more[a]	.10	.10	.08	-.20	.00	-												
7. Making trade-offs[a]	.02	.05	.02	-.07	-.13	.62**	-											
8. Engagement[a]	-.14	.15	-.07	.12	.02	-.03	.12	-										
9. Indecisiveness[a]	-.07	-.06	.13	-.08	.05	.20	-.49**	.11	-									
10. Cognitive load[a]	.05	.13	.03	.15	-.10	.11	.24*	.42**	.25*	-								
11. Affect[a]	-.03	.08	-.01	.01	-.05	.01	.04	.27**	-.21	.05	-							
12. Stress[a]	-.02	-.03	.04	.03	.03	.13	.17	-.05	.36**	.16	-.29	-						
13. Boredom[a]	.13	-.06	-.03	-.08	.10	.19	.10	-.03	-.01	.01	-.01	-.01	-					
14. Liking of consumed snacks[a]	-.12	.02	.02	-.04	-.07	-.08	.07	.23*	.07	.08	.34**	-.13	.00	-				
15. Desire for snacks[a]	-.08	.24*	.35**	.10	-.17	.08	.08	.10	-.09	.10	.03	.11	-.10	.07	-			
16. Inhibition of eating[a]	-.05	.13	.11	-.14	-.11	-.06	-0.14	-.06	.05	.02	.00	.08	.00	.19	.24*	-		
17. Calories consumed	.18	.27**	.27**	.14	-.04	.21*	.03	.17	-.14	.09	.06	.04	.07	-.11	.30**	-.07	-	
18. Log calories consumed	.11	.27**	.29**	.04	-.13	.19†	.07	.06	-.10	-.03	.10	.13	-.06	-.16	.42**	-.02	.78**	-
Mean	20.83	12.6	3.37	5.49	4.40	4.75	4.22	5.63	2.50	4.39	5.71	2.04	3.68	5.47	14.41	3.73	129.69	1.90
SD	2.20		1.67	1.01	1.28	1.39	1.78	.82	1.04	1.43	.81	1.12	1.55	1.06	3.73	1.55	136.18	.48

Note: * correlation significant at $p < .05$, ** correlation significant at $p < .01$, † correlation marginally significant at $p = .071$. [a] measured by a 7-point Likert scale ranging from 1-7. [b] Spearman's rho correlation (all others are Pearson correlation coefficient).

Supplementary Table 4.3. Results of t-tests comparing the two conditions on scarcity related states in Study 2

Scale (range 1-7)	Scarcity condition (*N* = 49) *M* (*SD*)	No-scarcity condition (*N* = 46) *M* (*SD*)	*t*-test (*df* = 93)	Cohen's *d*
Engagement	5.67 (0.85)	5.59 (0.79)	*ns*	.10
Cognitive load	4.57 (1.34)	4.20 (1.51)	*ns*	.26
Affect	5.80 (0.82)	5.61 (0.80)	*ns*	.23
Stress[a]	2.10 (1.23)	1.98 (1.00)	*ns*	.11

Note: ** $p < .01$. [a] assessed with "How stressed were you during the task?".

Supplementary Table 4.4. Post hoc results (Dunnett's tests) comparing both no-scarcity conditions with the scarcity condition on scarcity related states in Study 3

	Conditions				
Scale (range 1-7)	Scarcity (*N* = 39) *M* (*SD*)	No-scarcity (*N* = 38) *M* (*SD*)	No-scarcity extra (*N* = 38) *M* (*SD*)	Cohen's *d* of scarcity vs no-scarcity	Cohen's *d* of scarcity vs no-scarcity extra
Engagement	5.14 (.79)[a]	4.86 (1.06)[a]	4.39 (1.40)[b]	0.15	0.66
Cognitive load	4.36 (1.33)[a]	4.24 (1.40)[a]	3.71 (1.59)[a]	0.09	0.44

Note: Means with different superscripts differ significantly ($p < .05$)

Supplementary Table 4.6. Results of t-tests comparing the two conditions on scarcity related states in Study 4

Scale (range 1-7)	Scarcity condition (*N* = 59) *M* (*SD*)	No-scarcity condition (*N* = 63) *M* (*SD*)	*t*-test (*df* = 120)	Cohen's *d*
Engagement	5.84 (0.76)	5.48 (0.67)	2.79**	.50
Cognitive load	4.64 (1.52)	4.44 (1.34)	0.77	.14
Affect[a]	5.78 (0.81)	5.67 (0.74)	0.80	.14
Stress[a]	2.19 (1.29)	2.16 (1.13)	0.13	.02

Note: ** $p < .01$

Supplementary Table 4.5. Means, *SD*s, and correlations of the variables under study in Study 4 ($N = 122$)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Age	-																	
2. Gender (% males)[b]	-.11	-																
3. Hunger[a]	-.03	-.22*	-															
4. Healthy eating goal[a]	.08	.20*	-.25**	-														
5. Restraint eating goal[a]	.15	.24**	-.22*	.23*	-													
6. Need for more[a]	-.06	-.08	-.00	-.01	.19*	-												
7. Making trade-offs[a]	-.07	-.04	.01	-.04	.06	.72**	-											
8. Engagement[a]	-.07	-.04	-.14	-.12	.04	.16	.25**	-										
9. Indecisiveness[a]	.07	-.09	.05	-.22*	-.04	.12	.37**	.07	-									
10. Cognitive load[a]	.02	.04	-.10	-.03	-.18*	.06	.15	.29**	.19*	-								
11. Affect[a]	.15	.03	-.23*	.15	.06	.12	.08	.18*	-.14	.07	-							
12. Stress[a]	.01	.03	-.06	-.03	-.04	.06	.13	.15	.33**	.24**	-.21*	-						
13. Boredom[a]	-.03	-.14	.09	.13	.13	.25**	.22*	-.06	-.08	-.07	.08	.02	-					
14. Liking of consumed snacks[a]	-.04	.21*	-.19*	.06	.05	-.03	.01	.15	.03	.13	.23*	-.01	.10	-				
15. Desire for snacks[a]	-.21*	-.09	.19*	-.07	-.06	-.01	.02	.18*	-.00	.06	-.01	.01	-.03	.15	-			
16. Inhibition of eating[a]	-.19*	.07	-.03	.03	.19**	.12	.10	.03	.05	.03	-.18	.05	.01	.09	.24**	-		
17. Calories consumed	-.03	-.21*	.22*	.01	-.09	-.01	.03	.09	-.09	.08	.15	.03	.07	.02	.29**	-.27**	-	
18. Square root calories	-.03	-.21*	.22*	-.01	-.09	.03	.06	.09	-.07	.09	.17†	.02	.10	.07	.32**	-.24**	.97**	-
Mean	20.26	16.4	2.16	5.61	4.41	4.13	4.24	5.66	2.68	4.54	5.72	2.17	3.48	5.53	3.40	3.53	131.78	10.39
SD	2.10		1.11	.90	1.34	1.60	1.79	.73	1.14	1.43	.77	1.20	1.17	1.07	1.02	1.63	115.48	4.90

Note: * correlation significant at $p < .05$, ** correlation significant at $p < .01$.

[a] measured by a 7-point Likert scale ranging from 1-7. [b] Spearman's rho correlation (all others are Pearson correlation coefficient).

Supplementary material Chapter 5

Supplementary information 5.1. Pilot study food rating

A clear distinction in palatability and healthiness was warranted to induce the choice more as a trade-off reflecting the motivation to enjoy palatable foods versus the motivation to adhere to long-term health goals. Therefore, products presented in the food shopping task had to include an equal amount of relatively palatable but unhealthy foods products as well as relatively healthy foods that were less palatable. Our selection of products was based on pilot studies of (Gardner, Wansink, Kim, & Park, 2014) and (Salmon et al., 2014), showing that two products within food pairs indeed differed on palatability and healthiness. The 5 'rewarding' high sugar/fat snack-type products that we selected were chocolate cookie, two types of crisps, chocolate bar, and waffle, and the other 5 more neutral products were unsalted peanuts, muesli bar, rice waffles, pear and apple (both groups of 5 products were matched on savoury and sweet foods). To further validate the classification of the selected products, a pilot study was conducted in a separate sample of 44 participants (29.5% male) with a mean age of 30.98 (SD = 8.75). Most participants were British (43.2%) and English (25.0%). The sample size was based on a power calculation in which we aimed to achieve a power of 0.90 and estimated a medium effect size of 0.5. Participants who were fluent in English were recruited via Prolific and received £0.45 upon completion of the study. Pictures of food products were from the food image data base of Blechert et al. (2014). After providing informed consent, they evaluated the palatability with two items ("How much do you like the taste of the product?" and "How much do you enjoy eating the food product?") and the healthiness with two items ("How healthy to you think the food product is?" and "How nutritious do you think the food product is?") of the 10 food products on 7-point scales ranging from 1 (not at all) to 7 (very much) (based on Gardner et al., 2014 and Salmon et al., 2014).

See Supplementary Table 5.1 for means and standard deviations of the ratings of each product. Because the apple was perceived almost as palatable as some of the rewarding foods, and the aim was to make a clear distinction between the groups of products, we decided to eliminate this product from the choice set. Consequently, to retain an equal amount of products in each group, also waffle was removed as this product was scored as the least palatable and most healthy option of the rewarding food products. Paired t-test showed that the group of 4 rewarding foods were on average indeed perceived as more palatable (M = 5.99, SD = 1.14) than the group of 4 neutral foods (M = 4.25, SD = 1.20), t (43) = 6.49, p < .001, d = 1.49, and as less healthy (M = 1.81, SD = 0.64) than the healthy foods (M = 4.63, SD = 0.88), $t = t$ (43) = -20.32, p < .001, d = 3.67.

Supplementary Table 5.1. Mean scores (*SD*) of each of the food products in the Pilot Study food rating

Rewarding food group	Palatability	Healthiness	Healthy food group	Palatability	Healthiness
Chocolate cookie	6.10 (1.35)	1.92 (0.84)	Unsalted peanuts	4.51 (1.99)	4.19 (1.33)
Crisps 1	6.09 (1.45)	1.83 (0.85)	Muesli bar	4.39 (1.79)	4.20 (1.45)
Crisps 2	5.89 (1.48)	1.82 (0.82)	Rice waffles	3.41 (2.00)	6.13 (0.97)
Chocolate bar	5.90 (1.58)	1.67 (0.66)	Pear	4.70 (2.08)	6.13 (0.97)
Waffle	5.53 (1.62)	2.22 (1.06)	Apple	5.47 (1.51)	6.18 (0.95)

Note: Scored on a 7-point scale. Apple and waffle were removed from the food groups in the online food shopping task.

Supplementary information 5.2. Pilot study testing PRD manipulation and food choice task

The primary aim of this non-preregistered pilot was to test the feasibility of the PRD manipulation and a food shopping task in a community sample. The secondary aim was to test whether PRD affected food choice.

Participants and procedure

Participants were recruited via posters and flyers during an open-campus day which was especially held for children and their parents. Inclusion criterion was a minimum of 18 years old. In total, 118 participants participated of which 17 were excluded (seven had an allergy related to the foods, and ten were accompanied by their child or partner). Hence, the analytic sample consisted of 101 participants (M_{age} = 43, *SD* = 12.48, 61% female) who were compensated with the three food products that they chose as part of the experiment. The experiment was advertised as a game to gather groceries. Experiments were run from 10.00 to 16.00 h on a walk-in basis in a computer room. After providing informed consent, they answered questions about their age, gender, hunger level, healthy eating and restraint goals. Next, they played the card game after which they filled in the Experienced PRD scale (see Study 1). The points earned with the card game were used as resources to 'purchase' three food products in an online food shopping task, where it was explicitly stated that they had to choose foods that they desired most at that moment and that they would receive them immediately after the task. The foods shown in the shopping task were pictures taken from the actual products. Based on the *Pilot study food rating* (see Study 2), the unhealthy rewarding options were chocolate cookie, two sorts of crisps, chocolate bar, and waffle, and the healthy, neutral options were apple, pear, rice waffles, muesli bar, and unsalted nuts. All items were presented as one serving (e.g. a little bag of crisps, one pear, a portion package of 5 thin rice waffles). After the food selection, participants were instructed to walk to an adjacent room where they received the food products and the debriefing. The ethical committee of social sciences of the university approved the study.

Results

Correlations and comparability

There was a significant correlation between gender and unhealthy food choice, Spearman's rho = .25, p = .013. A chi-square analyses indicated that women were more likely to choose unhealthy foods than men, x^2 =3.27, p = .07. Age was negatively correlated with unhealthy choices, , Spearman's rho = - .31, p = .002.

Conditions did not differ in pre-test variables hunger, age and gender. They did differ on one of the healthy eating / dietary restraint items, the PRD condition (M = 5.87, SD = .82) had a higher healthy eating goal than the control condition (M = 5.47, SD = .96), t(99) = -2.24, p = .028. Hence, age, gender, and healthy eating goal were used as covariates in the test of hypothesis.

Manipulation check

The PRD condition (M = 5.04, SD = .96) experienced more PRD than the control condition (M = 1.99, SD = 1.09) (on a 7-point scale), $t(99) = -14.91$, p <.001, so the manipulation appeared successful.

Test of hypotheses

An ANCOVA of PRD on unhealthy food choices, controlling for age, gender and healthy eating goal, revealed no main effect, $F(1,96) = 0.08$, p = .78. There was no difference in choosing unhealthy foods between the control condition (M_{adj} = 1.21, SE = .13) and PRD condition (M_{adj} = 1.16, SE = .14)

Exploratory analyses

For exploratory purpose, interactions were tested between condition and the control variables using bootstrapping in PROCESS (Hayes, 2017). Controlling for age, gender, and healthy eating goal, a significant interaction between condition and hunger was found, $F(1, 94) = 4.61$, p = .03, R^2-change = 0.04. Simple effects of condition on food choice were non-significant at low level of hunger (-1SD), B = 4.46, $t(94) = 1.59$, p = .11, CI[-0.11, 1.03], moderate level of hunger (+1SD), B = -.47, $t(94) = -1.38$, p = .17, CI[-0.90, 0.16]. Testing this interaction without two participants who scored the highest on hunger, i.e. 6 on a 7-point scale, revealed a non-significant interaction effect between hunger and condition on rewarding food choice controlling for the covariates, $F(1, 92) = 2.93$, p = .09, R^2-change = 0.04. Other interaction effects between condition and control variables were all non-significant, p > .08.

Discussion

The manipulation appeared again successful, but no main effect of condition on rewarding food choices was found. Exploratory analyses revealed that condition interacted with hunger level. Although not significant, a trend was observed that the PRD condition

chose more rewarding foods when low in hunger level. This pilot study had considerable methodological limitations. Participants selected foods from a computer screen and the idea of receiving the selected foods from the researcher may have influenced their selection. Also, as participants entered (and left) the computer room at any time during the open-campus event, some bringing their children, it was a non-ideal, rather chaotic setting for a laboratory experiment.

Supplementary Table 5.2. Means, *SD*s, and correlations (Spearman's rho) of the variables in Study 2

	1	2	3	4	5	6	7	8	9
1. Rewarding food choice	-								
2. Chronic PRD	.01	-							
3. Sensitivity to palatable food	.20**	.07	-						
4. Hunger	.19**	-.00	.35**	-					
5. BMI	.01	.01	.19**	-.01	-				
6. Dietary concern	.04	.07	.54**	.16**	.28**	-			
7. Age	.01	-.10	-.06	-.08	.19**	-.00	-		
8. Gender[a]	.04	-.00	.28**	.04	-.09	.25**	.17**	-	
9. Education level	-.10	-.09	-.05	-.05	.12	.11	.26**	.03	-
Mean PRD (*N* = 145)	1.74	3.08	2.88	3.81	26.19	13.88	30.60	56.6[a]	
SD	.99	.91	.91	1.65	8.37	30.50	10.32		
Mean control (*N* = 142)	1.66	3.11	2.90	3.58	26.43	14.32	30.55	59.9[a]	
SD	1.02	.96	.92	1.75	8.70	3.72	10.75		
Mean overall	1.70	3.09	2.89	3.70	26.31	14.10	30.57	58.2[a]	
SD	1.00	.93	.91	1.70	8.52	3.61	10.52		

Note: ** correlation significant at $p < .01$. [a] percentage males.

Supplementary Table 5.3. Means, *SD*s, and correlations (Spearman's rho) of the variables in Study 3

	1	2	3	4	5	6	7
1. Rewarding food choice	-						
2. Chronic PRD	.06	-					
3. Sensitivity to palatable food[a]	.25***	.04	-				
4. Hunger	.07	-.04	.17**	-			
5. Dietary concern[b]	-.25***	-.05	-.20**.	-.11	-		
6. Age	-.14*	-.07	-.27***	-.05	.05	-	
7. Education level[b,c]	-.18**	-.05	.08	-.06	.15*	-.25***	-
Mean PRD condition (*N* = 134)	1.51	1.94	3.00	2.82	3.62	13.19	*NA*
SD	.99	0.79	1.02	1.61	.94	1.14	NA
Mean control condition (*N* = 126)	1.33	1.93	3.18	3.17	3.64	14.82	*NA*
SD	.87	0.75	.94	1.64	.95	1.32	*NA*
Mean overall	1.42	1.93	3.09	2.99	3.63	48.75	*NA*
SD	.93	.77	.98	1.63	.94	14.05	*NA*

Note: * correlation significant at $p < .05$ ** correlation significant at $p < .01$. *** correlation significant at $p < .001$. *NA* = not applicable. [a] Present Food subscale of Power of Food Scale (Lowe et al., 2009). [b] two missing values. [c] Recoded from 9 categories to 4: low, middle, high, and other.

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SUMMARY

It is increasingly acknowledged that factors external to the individual are essential determinants of dietary patterns. The current physical food environment characterized by a high availability and easy accessibility of inexpensive, energy-dense, palatable foods is widely held responsible for unhealthy dietary patterns. Given socioeconomic disparities in diet healthfulness, much research has focused on the differential role of healthy and unhealthy food access and cost among different socioeconomic groups. The overabundance of cheap, unhealthy foods may be a crucial permissive factor in unhealthy diets, but it does not fundamentally explain how the food environment or an individual's disadvantaged socioeconomic condition may lead to overconsumption of unhealthy foods. Generally, our understanding of how an unhealthy food environment steers unhealthy food consumption, and how this may be of particular importance for individuals with low socioeconomic status, is still limited.

The main aim of this thesis is to provide insights into potential psychological processes that may explain how aspects of the physical food environment and socioeconomic context may steer unhealthy food consumption. Throughout this thesis, contemporary psychological theories on contextual influences on motivational and decision-making processes are applied specifically to the food environment and food consumption. Part 1 of this thesis (Chapters 2 and 3) focuses on *social norms* that may be communicated by physical food environments on the in-store/restaurant and neighbourhood level, and thereby influence consumption. In part 2 (Chapters 4 and 5), the focus is on *resource scarcity* and *relative deprivation*, which may explain how an individual's deprived socioeconomic context stimulates unhealthier food consumption when unhealthy foods are direct available.

In **Chapter 1**, the general introduction, I introduce major societal trends in the increase in unhealthy diets that serve as the point of departure of this thesis. The diet-related diseases including obesity, diabetes, and cardiovascular diseases that are reaching epidemic levels in various parts of the world can be attributed to increased unhealthy food consumption. Moreover, it has been reliably established that there are socioeconomic differences in consumption patterns: people with lower socioeconomic status tend to consume relatively less healthy foods. Dominant contextual explanations for these trends include the wide availability and easy accessibility of inexpensive, unhealthy foods, particularly among lower socioeconomic groups. In this chapter, psychological processes are briefly introduced that could provide a more fundamental explanation of how the physical food environment and an individual's socioeconomic context may steer unhealthy food consumption. For each of these processes, i.e. social norms, resource scarcity, and relative deprivation, a brief description of the selected theoretical framework is provided. This chapter concludes with an overview of the research questions and corresponding methodologies of each of the studies described in the subsequent chapters.

The first part of the thesis aims to explore how the actual, real-world food environment may convey social norms regarding common and appropriate eating and thereby encourage consumption. This social interpretation of physical food environments is examined in two studies that differ in their level of observation of the food environment, as well as in their methodological approach.

In **Chapter 2**, the aim is to provide a new understanding of how physical aspects in micro food environments may influence consumption, by proposing that social norms are embedded in physical cues in these environments. In this mixed-methods study, in-store/restaurant food environments were analysed through a social norm lens, so as to make an inventory of physical cues in food environments that may communicate social norm messages. It was demonstrated that a great variety of physical cues in self-service food environments (e.g. food traces, covered presentation, product availability) may communicate normative messages about other consumers' behaviour or the popularity of/demand for a product (i.e. descriptive norms) and/or the appropriateness of consumption (i.e. injunctive norms). Among a sample of laypeople, a descriptive norm concerning others' behaviour appears easier to recognize than an injunctive norm regarding informal rules about appropriate behaviour. The findings from this study suggest that social norms may be inferred from a wide variety of physical cues in the outside-the-home, in-store/restaurant food context, and that these may constitute a potential psychological process that influences food consumption.

In **Chapter 3**, the proposition that the physical food environment conveys social norms regarding common and appropriate consumption is examined on the level of the built, neighbourhood environment. We tested whether social norm perceptions regarding fast food consumption in the neighbourhood mediated the relationship between residential exposure to fast food outlets and fast food consumption. Fast food outlet exposure was objectively assessed as the count of fast food outlets within a 400m walking distance buffer around the post codes of respondents on a Dutch panel. No direct association between residential fast food exposure and frequency of fast food consumption was found. However, it was demonstrated that both descriptive and injunctive social norms mediated the association between exposure and consumption. Those who were more exposed to fast food outlets in their direct neighbourhood perceived 'unhealthier' social norms (descriptive and injunctive), and these 'unhealthier' norms were associated with a higher frequency of fast food consumption. Hence, this chapter provides the first correlational evidence for the idea that social norms may be inferred from the built physical food environment. Together, the findings from **Chapters 2 and 3** indicate that social norms may constitute a relevant psychological process that explains how the real-world physical food environment may guide food consumption.

The second part of this thesis aims to investigate psychological processes that could explain how a person's specific socioeconomic condition or context increases unhealthy food consumption. In a series of experiments, two distinct psychological theories addressing subjective evaluative interpretations of the socioeconomic context (i.e. resource scarcity and relative deprivation) were applied to actual food consumption.

In **Chapter 4**, the aim is to experimentally examine whether experiences of resource scarcity in an absolute sense (i.e. having too few resources) result in a higher consumption of presented snacks. Scarcity experiences, including preoccupations with immediate problems, have been proposed to lead to a decreased mental bandwidth and so more impulsive behaviour. In our studies, resource scarcity was manipulated by a self-developed trade-off task, in which participants' resources were either restricted (scarcity condition) or unrestricted (no-scarcity condition). Two lab experiments were conducted among students of Wageningen University. In the first lab experiment, a non-hypothesized interaction effect between scarcity and hunger bordered on significance. Scarcity appeared to increase snack consumption under low, but not high, hunger levels. Possibly, people are more sensitive to scarcity under situations where strong primary motives for eating are less relevant/influential. In the second lab experiment, participants were explicitly instructed to have eaten prior to participation so as to decrease their level of hunger. A difference in snack consumption between the two conditions could not be replicated in this experiment. Overall, we could not provide conclusive evidence for the notion that resource scarcity results in unhealthier food consumption.

In **Chapter 5**, the aim is to test whether the subjective experience of personal relative deprivation (PRD, i.e. being worse off than others) results in a higher preference for palatable, high-caloric snack-type foods. PRD, when paired with feelings of injustice, has been demonstrated to increase the preference for immediate, small rewards over larger benefits in the long term. PRD was manipulated by a computer card game in which participants experienced that they earned fewer (PRD condition) versus equal (control condition) resources relative to a fictitious player. The points earned served as resources to be spent on foods in a grocery shopping task. In an online experimental study, no main effect of the PRD manipulation on food choice was found. However, the manipulation appeared to have a differential effect for different levels of chronic PRD. Although simple effects bordered on significance, a higher number of snack-type food products were selected by participants that were relatively deprived in the card game and also experienced higher chronic relative deprivation. In a lab-in-the-field experiment, where a diverse community sample made real (non-hypothetical) food choices, it was demonstrated that those in the PRD condition selected more snack-type foods compared to those in the control condition, when particularly sensitivity to palatable food was controlled for. Overall, although the results need to be interpreted with caution, this

study revealed some preliminary causal evidence that relative deprivation results in an unhealthier food choice.

In **Chapter 6**, the general discussion, I present an overview of the main findings of this thesis and a theoretical reflection on them, and I discuss methodological issues and practical implications. Moreover, I provide perspectives for future research that contributes to the overarching aim of an improved understanding of how and when individuals' specific physical and social contexts shape dietary patterns. Theoretically, the results of this thesis contribute to better insights into how specific psychological processes may be relevant to the domains of the physical food environment and unhealthy food consumption. Specifically, the findings from part 1 indicate that the real-world physical food environment may be a relevant source of social norm perceptions about what is common and appropriate food consumption. Moreover, the findings reinforce recent notions that the mere physical availability of foods does not directly lead to consumption of those foods. Rather, our findings highlight the importance of human social cognition when a person is interpreting physical contexts, as they show that perceptions of social norms may be a psychological mechanism in the relation between the physical food environment and consumption. The findings in part 2 are somewhat inconclusive, but they indicate that deprivation in a relative sense through upward social comparison may result in unhealthier food choice, but that deprivation in an absolute sense does not consistently result in unhealthier food consumption. This provides preliminary causal evidence for previous suggestions that the relative component of deprivation is more important than absolute or objective measures in the association with overweight and obesity. Moreover, evidence-based insights that PRD affects decision-making processes and various (non-food) behaviours suggest that actual food consumption may be considered a new behavioural consequence of this adverse psychological state. Hence, although conclusions can only be drawn with some reservation, this thesis contributes to a better theoretical understanding of how a person's socioeconomic condition or context may affect unhealthier food consumption. In the section about methodological issues, this chapter also briefly discusses the rationale of measuring overt food consumption as a behavioural measure of unhealthy diets. Moreover, I discuss advantages and disadvantages of each of the included methodological approaches with respect to the type of evidence it may provide. While acknowledging the preliminary nature of our findings, in a practical sense, this thesis suggests that social norms and PRD may be relevant psychological processes that need to be taken into account when the aim is to stimulate healthier consumption and reduce health inequalities through improved diets.

ABOUT THE AUTHOR

Curriculum Vitae

Sofie van Rongen was born on December 13, 1988 in Riyadh, Saudi Arabia. In 2007, she finished secondary school at Teylingen College Leeuwenhorst in Noordwijkerhout. That year she started at University College Utrecht, where she majored in cognitive neuroscience and psychology. She studied one semester abroad at the University of California Santa Barbara, USA. After obtaining her bachelor's degree (*cum laude*), Sofie started with the Research Master Cognitive and Clinical Neuroscience at Maastricht University. She developed a special interest in the psychological aspects of obesity. She performed her master's thesis at PsyQ in Rotterdam, where she worked on a research project studying the added value of preoperative cognitive behavioural therapy to bariatric surgery. In 2013, she obtained her master's degree. She started working as a research-assistant at the project of her master's thesis and as a psychologist at Sint Franciscus Gasthuis, where she guided patients in the trajectory of bariatric surgery. In 2015, she started as a PhD candidate at the Strategic Communication Group at Wageningen University as part of a five-year VIDI project of professor Emely de Vet, who later initiated the chair group of Consumption and Healthy Lifestyles. During her PhD trajectory, Sofie was a board member (PhD-representative) of the Association of Researchers in Psychology and Health. In addition, she paid a three-month research visit to the Institute for Physical Activity and Nutrition, Deakin University in Melbourne, Australia. Since September 2020, Sofie works as a lecturer-researcher at the bachelor programme Nutrition and Dietetics at The Hague University of Applied Sciences.

List of Publications

van Rongen, S., Poelman, M. P., Thornton, L., Abbott, G., Lu, M., Kamphuis, C. B. M., Verkooijen, K., & de Vet, E. (2020). Neighbourhood fast food exposure and consumption: the mediating role of neighbourhood social norms. International Journal of Behavioral Nutrition and Physical Activity, 17, 61.

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*, 104414. * both first authors.

van Rongen, S., Verkooijen, K., & de Vet, E. Dealing with too little: The direct experience of scarcity does not affect snack intake. (2019). *Applied Psychology: Health and Well-Being, 11*(3), 459-483.

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Completed Training and Supervision Plan

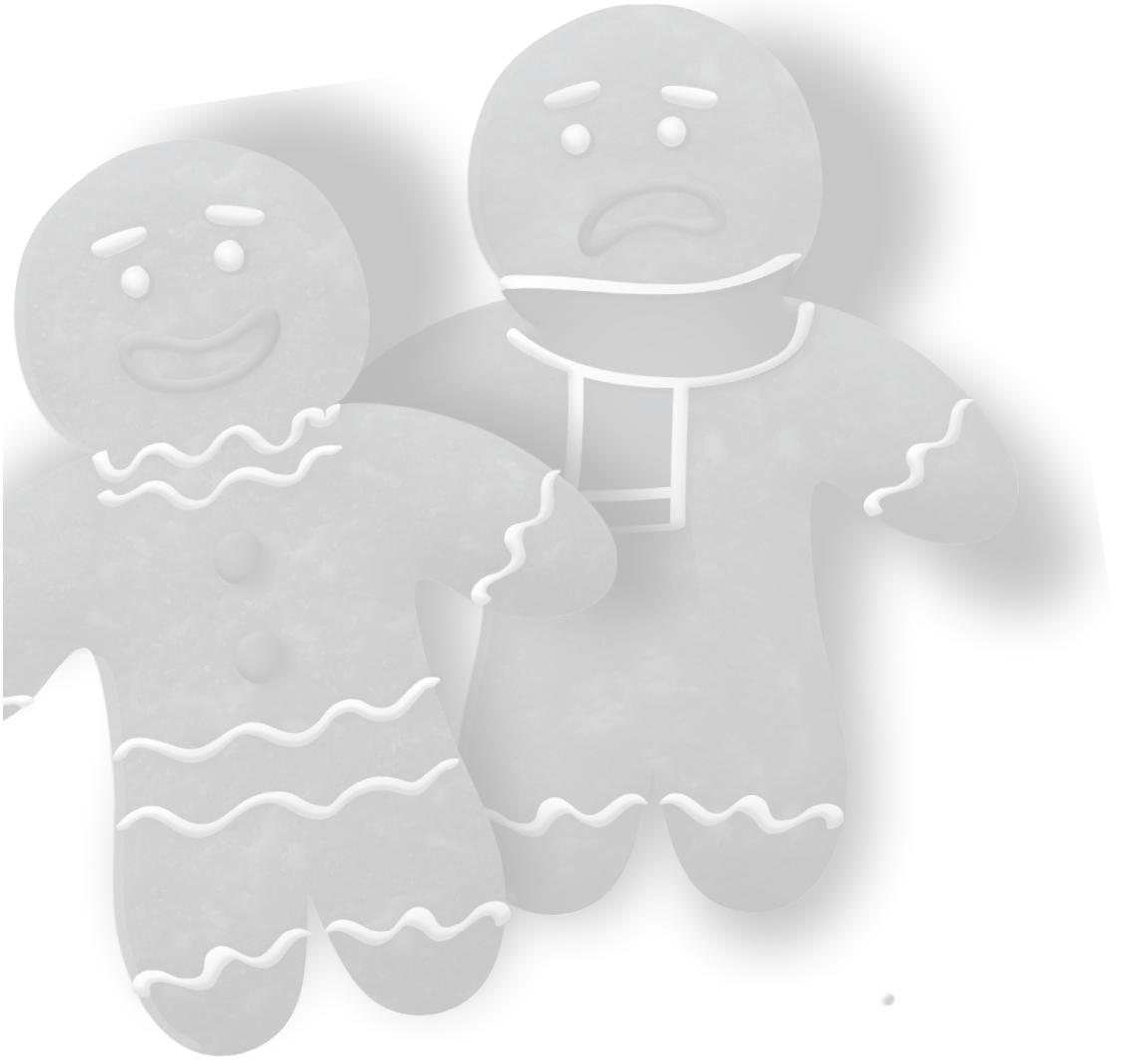
Wageningen School of Social Sciences (WASS)
Sofie van Rongen

Name of the learning activity	Department/Institute	Year	ECTS*
A) Project related competences			
Research proposal writing	WUR	2015	6.0
Social class, Social Cognition and Social Attainment	KLI	2018	1.0
Research visit Australia	IPAN, Deakin University, Melbourne	2019	6.0
Conference presentations			
'What do adolescents think that their peers are eating at school?'	EHPS, Aberdeen, United Kingdom	2016	1.0
'Having too little: The induction of a scarcity mindset and its effect on snack consumption'	EHPS, Padova, Italy ARPH, Tilburg, the Netherlands	2017 2018	1.0
'Identifying normative cues in food environments: a mixed method photo study'	WINK Nudging conference, Utrecht, the Netherlands NEFCA Etmaal, Ghent, Belgium	2017 2018	1.0
'Earning less than you deserve. Does personal relative deprivation lead to more indulgent food choices?'	ISBNPA, Prague, Czech Republic ARPH, Egmond aan Zee, the Netherlands	2019 2019	1.0
'Neighbourhood fast food exposure and consumption: The mediating role of neighbourhood social norms'	SENS Research Symposium, Geelong, Australia ARPH, Egmond aan Zee, the Netherlands	2019 2020	1.0
B) General research related competences			
WASS Introduction course	WASS	2015	1.0
Information Literacy	Wageningen UR library	2015	0.6
Philosophy and ethics of food science and technology	VLAG, WUR	2016/2017	1.5
Sensory perception and food preference: Affective drivers of food choice	VLAG, WUR	2016	1.1

Behavioural and experimental economics	UEC, WUR	2016	2.0
Planning Health Promotion Programmes: An intervention mapping approach	CREATE, Padova	2017	0.8
Reviewing a scientific paper	WGS	2017	0.1
Introduction to R	WASS	2019	2.0
Psychology of Health and environment behavior Categorisation and evaluation	WASS	2015	0.5
Mixed Methodology in Health Psychology	CREATE, Aberdeen	2016	0.8
C) Career related competences/personal development			
ARPH board member (PhD representative)	ARPH	2017-2020	6.0
Teaching assistant BSc courses and supervision BSc and MSc theses	COM, CHL, WUR	2016-2020	4.0
Training communicating with children	Wetenschapsknooppunt, WUR	2017	0.5
Advanced speaking skills	Wageningen in'to languages	2016	0.4
Total			**39.3**

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

Abbreviations:
ARPH = Association for Researchers in Psychology and Health
CHL = Consumption and Healthy Lifestyles
COM = Strategic Communication
CREATE = Collaborative Research and Training in the EHPS
UEC= Urban Economics
EHPS = European Health Psychology Society
IPAN = Institute of Physical Activity and Nutrition
ISBNPA = International Society of Behavioral Nutrition and Physical Activity
KLI = Kurt Lewis Institute
NEFCA = Netherlands – Flanders Communication Association
SENS = School of Exercise and Nutrition Sciences
VLAG = Voeding, Levensmiddelentechnologie, Agrobiotechnologie en Gezondheid
WASS = Wageningen School of Social Sciences
WeVo = Werkgroep Voedingsgewoonten
WGS = Wageningen Graduate School
WINK = Welfare Improvement through Nudging Knowledge
WUR = Wageningen University & Research



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