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Abstract

Introduction

In sensory science liking ratings are commonly used to understand and predict food intake and choice. And indeed, higher liked products are more often chosen than lower liked products. However, there is more to food choice than sensory liking per se, as many highly liked products fail on the market. A broader perspective on how consumers experience a food product is needed, where we take into account that individuals experience and attach emotions and cognitive associations to foods. Measuring these, in addition to liking, might explain and predict food choice better.

Aim

The aim of this thesis was to test if food-evoked emotional and cognitive associations explain and predict food choice better than sensory liking per se. Hereby we focused on the sensory and packaging product properties. In addition, we investigated the link between sensory properties and emotional responses to foods; and the influence of the context appropriateness on choice.

Methods

We conducted a series of product profiling experiments of test products (breakfast drinks) with regular consumers. Participants rated emotional responses and liking to a set of tasted test products, and subsequently, after an interval of one week, participants' actual choice was observed, after again tasting the series of product samples (presented blind) to choose from. In the following study we took the same measures, but now included the products packaging. Thus, participants rated emotional responses also to the product's package and they chose one product after viewing the packages of all test products (without tasting). Two dessert products were included in the product set to assess the impact of eating occasion appropriateness. The test products were also evaluated by a trained panel on sensory characteristics using descriptive analysis. In the last study, we assessed cognitive terms (emotional and functional words) participants associate with sensory attributes and the products' package. And, participants rated liking and chose, after an interval of one week, a product based on the products' packages.

Results

The measured emotional responses could be decomposed in two dimensions, i.e. valence (pleasant to unpleasant) vs. arousal (calm to excitement). The combination of emotion valence and liking scores predicted individual choice based on the products taste for over 50% of all participants and was a better predictor of choice than liking scores alone. The combination of liking, valence and also

arousal resulted in the best prediction for package-based choice with correct predicted individual choices for 41% of all participants. Furthermore, we demonstrated that the match, between the cognitive associations to the products sensory and packaging cues, was positively related to choice. However, liking ratings outperformed the product-package-match in predicting individual product choice. In particular, expected liking (based on the product's package) predicted 25% more individual choices correct than the product-package-match. Furthermore, we demonstrated that a product was more likely to be chosen when the package provided context appropriate information (i.e. breakfast context for breakfast drinks). Lastly, we found that texture-related attributes were drivers of positive emotions and that specific taste-related attributes were drivers of specific arousal emotions.

Conclusion

Emotional and cognitive responses to foods are relevant drivers of choice behaviour. Food-evoked emotional responses predicted choice consistently better than liking scores alone. However, the combination of liking scores and emotions was the best predictor of food choice based on the product's taste and packaging. Hence, emotions may explain and guide consumers' choice behaviour. Furthermore, product profiles, based on cognitive product associations, seem to be related to choice behaviour; but it is still unclear what their contribution is in predicting choice based on liking per se.

In addition, it was shown that appropriateness also influences package-based choice. Lastly, links between sensory and emotional profiling were identified which offer a possible application of the findings on food-evoked emotions in product development.

Contents

Chapter 1

General introduction

Food intake has a major impact on our health (1). Eating unhealthy, i.e. eating energy dense and nutrient poor food, may result in a positive energy balance, that is, higher energy intake than expenditure (2). This leads in the long term to weight gain and obesity. On the other hand, choosing and consuming healthy food, i.e. low energy dense foods and nutrient varied foods, decreases the daily energy intake (3, 4). With the increased number of public health problems related to obesity (2), it is important to understand how to prevent unhealthy eating behaviour and how healthy choices can be promoted.

To understand individuals' dietary choices and intake we need to understand the factors that influence individuals' food choice behaviour and in particular how people choose between a series of comparable alterative products (5, 6). For example, the challenge in understanding and foreseeing food choices is not so much about whether an individual chooses between a dairy product (e.g. yoghurt) for dessert vs. meat as a main dish, but about the choice between several alternatives within a certain food category like a creamy caramel-flavoured yogurt or a fruity low fat one. In sensory science it is common practice to use traditional hedonic liking (sensory pleasure) to understand and predict preferences and food choice behaviour (7-13). And indeed products with a higher liking score are chosen more often than products with a lower liking score (7). However, there is more to food choice than sensory liking per se, as illustrated by market failure of the majority of newly launched products that previously obtained high liking ratings by consumer panels (14).

There are several reasons for that. First, affective drivers (e.g. emotions) play an important role in product experience and enhance the hedonic impact (pleasure) of a product (15). Second, consumers attach also cognitive associations and meanings to a product through experience and previous usage. Hence, individuals attach affective (emotions) and cognitive associations (e.g. product's functionality) to a product, which are not fully captured by liking ratings. Hereby it matters if the focus is on intrinsic (sensory) or extrinsic (packaging) product cues. Both elicit in part different emotions and cognitive associations (16, 17) (see also Figure 1.1). How these associations are related (match) and how they contribute to explaining/predicting actual food-choice behaviour are important questions in this thesis.

Our understanding of the influence that affective and cognitive associations have on food choice and on consumer behaviour is still limited. Studies have indicated that these product associations discriminate products more effectively than hedonic measurements (liking scores) (18-21). Less clear, however, is if food-evoked emotions and cognitive associations serve as potential drivers and/or predictors of actual food choice, which goes beyond appraisal or intention to choose. Further, food emotions can be organised in valence (pleasantness) and arousal (activation) dimensions and

it is unclear how these dimensions separately contribute to food choice behaviour. Therefore, in this thesis we studied the role of emotions (valence and arousal) and cognitive associations with foods in explaining and predicting actual food choice. Special attention has been paid to the measure of choice. We set up a measure that simulates a real life eating occasion environment and observed actual consumer behaviour.

The research described in this thesis investigates the role of emotions in food choice taking into account first the intrinsic (sensory) and later also the extrinsic product properties (e.g. brand, package). Then, the impact of not only emotion-related associations but also broader cognitive associations (conceptualisations) on choice is studied. The research provides some insights into the influence of context appropriateness on choice and describes a possible application of the findings on food-evoked emotions.

This introduction starts with a brief overview of general food choice determinants, with a focus on the food product itself. This will be followed by a description of the additional proposed determinants of choice, namely food-evoked emotions and conceptualisations, and how they can be measured. Lastly, the aim and thesis outline are described.

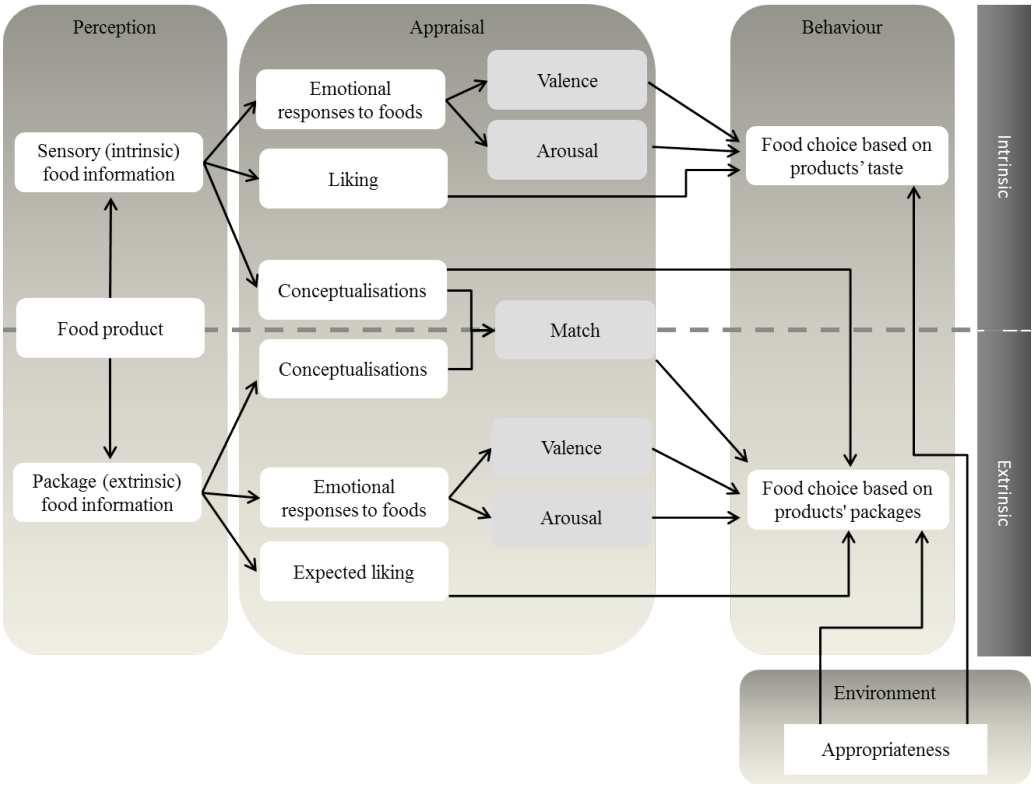

Figure 1.1 Illustration of the proposed model to explain how emotional and conceptual responses to foods and liking contribute to food choice. In this model, sensory (intrinsic) and packaging (extrinsic) information are antecedent to liking and conceptual and emotional responses (which can be decomposed into a valence and arousal dimension) to foods, subsequently all variables influence food choice.

Food choice

The broadest set of behaviours that defines food choice is the selection of all foods and beverages, including all aspects that influence the what, how, when and with whom foods are consumed. The interrelated determinants can be organized in biological, psychological, social and cultural aspects (6). In this thesis the focus is on the moment of choice, thus the moment when an individual selects a particular product among several alternatives (5, 6). The determinants of this more restricted food choice moment are categorized in three domains: determinants related to the food product itself (e.g. sensory appeal, energy content, packaging, expectations about taste and health), to the choice environment (e.g. availability, price and context appropriateness of the food product) and to the person who choses (e.g. age, gender, concerns, experiences and beliefs) (6). In the following mainly

the first two domains are discussed, the food and the environmental cues as appropriateness. The persons' characteristics and concerns, i.e. beliefs, social norms, values and personal goals, are out of the scope of this thesis.

We will mainly focus on the domain 'food' throughout this thesis. Predominant factors influencing food preference and food selection at the moment of choice are taste, convenience and health (6, 22). Previous studies used the Food Choice Questionnaire to investigate factors that influence individuals' dietary choices. The product's sensory appeal appears to be one of the most important motives of food choice (22-24). Sensory appeal involves the hedonic evaluation (liking) of the smell, the appearance, the texture and the taste of the food (22, 25). Nevertheless, we believe that the sensory cues of a food product are evaluated in a more elaborative way than sensory appeal or sensory liking can capture. As mentioned previously, affective and cognitive driven associations with a food product might play a crucial role in product choice (Figure 1.1). Furthermore, environmental cues as appropriateness (i.e. whether a food product matches the consumption context) are also relevant in food choice (26-29). The thesis will provide some insights on the impact of appropriateness on food choice (chapter 6).

Affective drivers of food choice: Emotional profiling

The measure of food choice in emotional profiling

The idea that emotions are involved in decision-making processes is not new. Decision-making models evolved from purely rational processes into more affective processes to explain individuals' choice behaviour (30, 31). Taking an example from marketing research, it has been demonstrated that product-elicited emotions of non-food products (movies) play a role in post-purchase product satisfaction. However, there are some notable issues in studies that investigate the relationship between product-evoked emotions and product satisfaction and/or product choice. For one, studies on product-related emotions often use proxy measures for choice, e.g. purchase intention or post-purchase satisfaction instead actual choice behaviour (31-35).

Second, those choice estimates are commonly assessed by questionnaires often in controlled (lab) environments that hardly mimic naturalistic settings like retail or real life eating and drinking situations. However, real life settings are recommended in the food research area (36, 37). A balance needs to be found between real life settings and a controlled environment (37). In the research studies presented in this thesis food choice was measured in a simulated cafeteria setting that mimics a natural out-of-home eating and drinking environment. Thus, instead of self-report

measures, actual behaviour was observed, i.e. participants actually chose one food product out of several alternatives (chapter 2-6).

Up till now our understanding of the direct link between emotional responses to foods and how they relate to actual choice behaviour is still limited. We will narrow this research gap and we will investigate this relationship focusing first on the sensory (intrinsic) product properties (upper part of Figure 1.1; chapter 2, 3), and later on also on the extrinsic product properties (lower part of Figure 1.1; chapter 4).

Methods in emotional profiling of foods

Recently several researchers focused on the development of methods to measure emotional responses to foods. This has its origin in the special nature of food-related emotions, which are predominantly positive, also denoted as 'hedonic asymmetry' by Desmet and Schifferstein (38). Standard methods to measure emotions that have an origin in clinical psychology, e.g. the Profile of Mood Sates and MAACL-R (39, 40), however, primarily focus on negative emotions, and are therefore not suitable for emotion research in the food domain. These methods often also lack the variety of emotions required in food research as consumers tend to use a large lexicon of emotional terms to describe food and consumption experiences (19).

An emotion is defined by Mulligan and Scherer (41) as an affective episode, with goal directed intention, includes a physical element (e.g. arousal, expression) and is elicited and guided by an appraisal of a stimuli. Hence, an emotion has a physical and cognitive (intentional) element and researchers can target one of these elements in method development. One research area focuses on the physical component and measures the heart rate frequency, skin conductance, body temperature and facial expressions of respondents towards food stimuli (42, 43). These measures have the advantage to provide a direct implicit measure and avoid any cognitive biases of the response. However, the interpretation of these responses is difficult because they cannot differentiate between the various specific emotions elicited in response to food stimuli (19, 42).

Another research area captures emotions through explicit self-report food emotion questionnaires. They contain a wide range of specific and complex (higher order) emotion terms necessary in emotional profiling (19). Assessing these specific emotions requires subjects to become aware of and to evaluate an emotion experience. Until now the assessment of these specific emotions is inaccessible for the implicit measures discussed above. In self-report measures the list of emotion terms and the assessment procedures during product evaluation became a main focus in

questionnaire development and will be discussed in the following section.

Word lists in emotional profiling of foods

Richins (44) was the first to establish a list of specific emotions suitable in the food consumption area, the consumption emotion set (CES). The CES contains 42 frequently used emotions that individuals associate with a consumption context. This list was further developed by Laros and Steenkamp (45) who extended the work on the content and structure of emotions in consumer behaviour. They proposed a hierarchical approach with positive and negative affect at the superordinate level, eight basic emotions on the medium level and a subordinate level which is based on the CES by Richins (44) (see for a review Jiang, et al. (15)).

Nowadays, one of the most frequently applied emotion word lists is the EsSense Profile Method™ (19) which has recently been used in various studies measuring food-evoked emotions for unbranded and branded food products (16, 21, 46, 47). The EsSense Profile™ includes a large number (39) of emotion terms based on the observation that people tend to describe food products using a large variety of terms (46, 48). The EsSense Profile™ served also as a starting point for newly developed emotion questionnaires. The EsSense word list was adapted by adding/removing emotional terms based on consumer input to a specific product category (16, 20, 49). Another emotion questionnaire uses whole sentences instead of single terms to measure emotional responses to foods (21). Thus, new questionnaires have been developed of which the EsSense Profile™ appears to be the best validated one in the field of sensory science.

The EsSense Profile™ depends on the usage of emotion words. However, emotions can be difficult to express with words (50-52). An interesting complementary tool is the Product Emotion Measurement Instrument (PrEmo®) because it is a pictorial tool and hence does not require verbalization of emotions (50). PrEmo® is a cross-cultural validated tool based on 12 emotions expressed by animations of a cartoon character.

Up till now it is unclear if food-evoked emotions measured with the above described tools play a role in actual food choice behaviour. This thesis provides insights whether food emotions can help to understand choice behaviour (chapter 2, 3, 4).

Dimensions in emotional profiling of foods

When it comes to the interpretation of food-evoked emotions there is some debate about the appropriate level of content and specificity at which emotions should be structured. In some stu-

dies emotions are decomposed into a limited number of general emotion dimensions, like positive and negative affect, whereas others use a comprehensive set of specific emotions (19, 44, 53). In this thesis both levels were studied; the distinct set of specific emotions of PrEmo® and EsSense Profile™, and broader general factors. In case of the latter, we adopted the circumplex model of affect, assuming that a specific set of emotions can be decomposed in at least two qualities: valence and arousal, that can be mapped in an affective space comprised of two orthogonal axes, ranging from unpleasant to pleasant and from calm to excitement/arousal (54, 55). This dimensional approach offers a way to structure extended lists of specific emotion terms (as used in several of the available questionnaires for measuring food-evoked emotions, for example the EsSense Profile™ (19)) into a more superordinate level to facilitate comparison with findings from other studies using different instruments to measure food-evoked emotions (see also Laros and Steenkamp (45)).

Food stimuli in emotional profiling

Actual food choice does not only depend on the sensory properties or the memory of the sensory taste but on the whole product consumption experience (15). Recent studies showed that brand, packaging and the product name also affect the emotions evoked by a food (15, 16, 21, 46). Furthermore, food choice is often based on packaging because in modern western society the majority of the foods are packaged. Schifferstein, et al. (56) identified different sources of food-related emotions that can be linked to different stages of product usage, i.e. choosing a product on a supermarket shelf (buying), opening a package, cooking (processing) and eating the food (consuming). Hence, in emotional profiling it matters which part of the food product information (intrinsic or extrinsic) is evaluated by consumers. It has been also shown that the intrinsic (sensory) and the extrinsic (packaging) product properties elicit in part different emotions (16, 21, 46). Nevertheless, it is unclear how emotions elicited by sensory and packaging cues will affect food choice behaviour (Figure 1.1).

Cognitive drivers of food choice: Conceptual profiling

Apart from emotions, individuals attach meanings and associations to objects they interact with, from now on referred to as conceptualisations. Conceptual profiling is defined as capturing and measuring cognitive associations in response to food products and was introduced by Thomson, et al. (57). Conceptualisations can be divided in three categories; emotional ('the cookie makes me feel happy'), abstract ('the cookie is trendy') and functional ('the cookie is filling') conceptualisations. These product associations might influence unconsciously or consciously later behaviour towards that product (58, 59). However, the role of product-evoked conceptualisations in preference

formation and choice behaviour is under researched. Little is known on how these profiles are related (match) and how they contribute to observed food choice behaviour (middle part of Figure 1.1, chapter 5). Therefore, the next step in this thesis project was to measure not only the emotional responses to foods but also broader conceptualisations consumers attach to foods. Conceptual profiles to the products sensory and packaging cues were assessed.

Conceptual profiling and Emotional profiling

Emotional and conceptual profiling have a theoretical and practical overlap, both measure emotions evoked by a food product and both provide a richer product profile than a single liking score (16, 19, 20, 59). However, conceptual profiling goes beyond emotional profiling because it takes into account the meaning/associations consumers attach to a product. Hence, conceptual profiling covers a broader range of the product consumption experience. There are important theoretical distinctions between emotional and conceptual profiling which influenced the terminology used in this thesis. In emotional profiling it is assumed that the respondent feels the particular emotions during or after product consumption.

In contrast, conceptual profiling assumes to measure associations stored in memory that have an emotional connotation or trigger an emotion response. This results in a debate about what emotion questionnaires are actually measuring; an emotion (actual experience) or an emotional association (similar to appraisal). This is a highly relevant issue that deserves more attention. It is, however, beyond the scope of this thesis. We will use the expressions 'emotions', 'emotion response', or 'emotional associations' to refer to affective concepts and expressions throughout the thesis, being aware that they may not reflect purely experienced emotions.

Conceptual profiling and food choice

A few researchers applied conceptual profiling in food research after Thomson, et al. (57) introduced it and demonstrated the practical application in food research studies. Crocker and Thomson (60) and Ng, et al. (16) showed that conceptual profiling successfully differentiates between beverages from the same product category. Thus, conceptual profiling could be used as a successful tool to discriminate between products with subtle sensory differences and similar in liking. However, the application of interest here extends on product differentiation and concerns how conceptual profiling can be used in food choice prediction.

The approach to align the conceptual profiles of a product's intrinsic (e.g. taste) and extrinsic (e.g. packaging and brand) attributes is promoted as a promising concept to explain and predict

products' market success (16, 21, 57, 59). Consonance between product elements is created if, for example, the product's taste evokes a similar conceptual profile as the product's package. So far only Thomson and Crocker (59) tested this assumption and showed that the match between the product and the brand could in part explain consumer's choice behaviour. However, the impact of this matching concept on choice behaviour is not fully explored and requires further clarification. For instance, it remains unclear if this gauged match can be used to understand and predict food choice behaviour beyond liking scores (middle part of Figure 1.1, chapter 5).

Aim and thesis outline

The main aim of this thesis is the development and description of a model including emotional and conceptual responses to foods (based on intrinsic and extrinsic properties) to explain and predict subsequent food choice. Such an extended model and its predictive ability is compared to models based on sensory liking alone. In addition, we investigate the performance (differential ability) of verbal and non-verbal emotion measurement tools when sampling a series of products from the same product category. Finally, the influence of user context appropriateness on product choice is examined.

In the first study we used a verbal and a non-verbal tool to measure emotions, PrEmo® and EsSense Profile™, and assessed their ability to differentiate between products from the same category. Furthermore, we assessed actual choice and we investigated the relationship between food-evoked emotions, choice behaviour and liking of unbranded tasted food products (chapter 2). This dataset was further used to test if food-evoked emotions predict actual food choice better compared to liking (chapter 3). In the second study we repeated the measure of emotions and choice of unbranded products and took the same measures (emotions and choice) but now based on evaluation of the products' packages. Again the discriminative and predictive ability of food-evoked emotions in comparison to liking was assessed (chapter 4). In the third study we gauged conceptualisations based on tasting (sensory properties) and products' package evaluation and tested if the match between these conceptual profiles predicts actual choice (chapter 5). In the second study we also included two different product categories in the same user context and we were able to investigate the effect of context appropriateness on food choice (chapter 6). Additionally, the products used in the second study were separately profiled using Sensory Description (DA) techniques by a trained sensory panel in addition to the consumer panel emotional evaluations. In chapter 7 we describe the relationship between the sensory and emotional evaluations of foods and the implications of this relationship for product development. Finally, the main findings are discussed and directions for future research are presented in a General Discussion section (chapter 8).

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Chapter 2

The role of emotions in food choice and liking

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Abstract

Consumer liking ratings of food products often fail to predict market success. In addition to sensory tests, it is thought that food-evoked emotions provide a sensitive measure to describe products in a way that adds to information from liking. In this study two different tools were used to measure emotional responses to foods, PrEmo® and EsSense Profile™ to differentiate between similar products from the same product category. Additionally, we investigated the relationship between food-evoked emotions, liking and choice behaviour. Participants (n = 123) tasted seven test products, scored liking, and evaluated each product with PrEmo® and EsSense Profile™. In a separate breakfast session we assessed the participants' actual food choice (their preferred breakfast drink out of seven). The results showed that PrEmo® and EsSense Profile™ differentiated successfully between similar groups of breakfast drinks. We also found that liking is only partly associated with the emotion responses to the products. Thus, emotional profiles provide new information not captured by liking scores. Furthermore, food choice was related to mainly positive emotions, suggesting that food-evoked emotions can add to liking ratings in explaining choice behaviour.

Introduction

Understanding food choice and consumer behaviour

In sensory science acceptance (liking) has been the main measure used to understand preference and food choice behaviour (1-6). Indeed, products with a higher liking score are chosen more often than products with lower liking scores (1). However, there is more to food choice than sensory liking per se, as illustrated by market failure of newly launched products that previously stood the test of consumer panels. A broader perspective on how consumers experience a food product is needed, where we consider all associations that consumers assign to a product based on experience and learning. Part of these associations has emotional connotations. Hence, it can be informative to assess consumers' emotional responses to foods, in addition to liking (7-9).

Measuring emotional responses to food

Consumers experience mainly positive emotions in response to food products (10). As a consequence, methods to measure emotional responses with an origin in clinical psychology, like the Profile of Mood Sates and MAACL-R (11, 12) are unsuitable for food research because they contain a too high number of negative emotional terms and they lack the variety of emotions required in food research (13). Several food-specific questionnaires have been developed of which the EsSense Profile™ appears to be best validated and gains influence in the field of sensory science. EsSense Profile™ includes a large number (39) of emotion terms based on the observation that people tend to describe food products using a large variety of terms (8, 14).

Valuable as the EsSense Profile™ has proven to be, a restriction to its application is its reliance on a list of verbal labels with sometimes subtle differences, e.g. 'merry' and 'joyful'. This presupposes a certain extent of cognitive deliberation and articulateness in respondents. Emotions can be difficult to express with words and across cultures and language differences in the 'emotional' lexicon exist, also when it comes to foods (15-17). Research would benefit from additional tools, preferably instruments complementary to the existing ones. An interesting option is the Product Emotion Measurement Instrument (PrEmo®) (15). PrEmo® is a cross-cultural validated tool based on 12 emotions expressed by animations of a cartoon character, and does not require verbalization of emotions. PrEmo® was, however, not developed as a food product-specific instrument and may lack sensitivity and specificity to sufficiently differentiate between emotional profiles of similar foods. Also, the small number of emotions (12) may not be sufficient for people to express the variety of emotions evoked by foods. In the present study we used both emotion measurement tools, PrEmo® and EsSense Profile™ to measure emotional responses to foods.

Relationship between product-evoked emotions and liking

Food-related emotions partly tap into the same dimensions as liking (e.g. pleasantness, satisfaction). Nevertheless, findings from several studies confirm that measurement of food-evoked emotions gives new information beyond liking and that food products can be differentiated more effectively based on their emotional profiles as compared to liking only (7, 8, 14, 18-20). It is less clear which (part of the) emotional responses give new information and how to determine this. One possible approach is to consider the strength of the association between emotion ratings and liking. Emotions that strongly correlate with liking have low distinctive value compared to liking, whereas emotions that weakly correlate with liking are of special interest, as they apparently convey information not captured by liking. There is some evidence suggesting that emotional profiles in response to foods can be mapped into an emotional space represented by two orthogonal dimensions, a valence dimension (positive-negative, unpleasant-pleasant) and an activation dimension (low-high arousal) (17). Whereas valence positively correlates with liking, activation does not show a straightforward relation with liking and, hence, seems to capture some unique information on how consumers experience a food product.

Do emotion measurements enrich our understanding of consumers' actual choice behaviour? To our best knowledge, studies on emotional responses to foods have so far included attitudinal measures and/or preference ratings- as an index of the consumer's satisfaction with the product and as a likelihood estimate of the consumer's future choice behaviour towards the product. However, we feel that the ultimate behaviour of interest is actual choice and consumption. The second aim of this study is to further examine the relationship between food-evoked emotions, liking and actual choice behaviour.

Objectives and hypotheses

To recap, this study had two objectives: First, to test if PrEmo® and EsSense Profile™ differentiate between similar products from the same product category; second, to explore the relationship between food-evoked emotions, liking and food choice behaviour.
We expected that emotional profiling of the products with PrEmo® and EsSense Profile™ would result in new information that exceeds the information gained from liking scores. Since it concerns similar food products we expected that the differences in emotional profiles would be mainly expressed in terms of intensity and to a lesser extent in the type of emotions.

Methods

Participants

One hundred twenty-three healthy, Dutch speaking women (n=90) and men (n=33) were recruited from Wageningen and the surrounding areas. Main inclusion criterion was previous experience with the product category (defined as at least being incidental users of breakfast drinks). None-product users were excluded because previous research on food-evoked emotions with the EsSense Profile™ showed that non-users have altogether different emotion responses to non-used products with a focus on negative emotions while product users in general have stronger positive emotions (13). Additional inclusion criteria were aged 18 – 55 years, and normal weight to slightly overweight (BMI 18.5 – 27 kg/m^2). Exclusion criteria were a change of body weight of > 5 kg during the last two months, having food allergy or food intolerance, and, for women, being pregnant or lactating. Table 2.1 shows participant characteristics, including a categorization of use of breakfast drinks in incidental, regular and frequent use. Participants were kept ignorant of the exact aim of the study and were informed that we were interested in differences between users and non-users of breakfast drinks in product evaluation. Participants received financial compensation for participation and completed a consent form. The study was approved by the Medical Ethical Committee of Wageningen University.

Table 2.1 Participant characteristics (means± SD) and classification in incidental, medium, and frequent users of breakfast drinks. Non-users (criteria= never in lifetime) were excluded from the study.

N = 123	33 male, 90 female
Age (y)	26.27±10.41
BMI (kg/m2)	21.90±2.01
Users of breakfast drinks	
Incidental users	N= 27 ; criteria= 1-14 ever in lifetime
Regular users	N= 68 ; criteria= 1 - 9 times a year
Frequent users	N= 28 ; criteria= 10 or more times a year

Products

Products used were commercially available breakfast drinks at the time of the study. Our primary interest was not this specific type of product, but to test whether PrEmo® and EsSense Profile™ were able to differentiate between similar products from the same product category.

In a pilot study (data not reported) a group of volunteers (n=15) tasted a range of 18 breakfast drinks (samples presented unbranded) and scored each product on liking (9-point scale). Subsequently, we selected seven test products for use in the main study that best fitted two criteria: First, products had to be close in liking based on the pilot data. Second, products had to differ on sensory attributes other than liking (e.g. dairy-based drinks vs. juice-based drinks, more viscous yoghurt-like drinks vs. liquid milk-like drinks). It has been proposed that sensory attributes influence emotional product conceptualisations (9, 19). It appears that sensory diversity is associated with differences in emotional profiles, which is why we selected products close in liking but showing different sensory profiles to increase the likelihood to detect differences in emotional profiles. The number of test products used (n=7) succeeded the optimal number of 2 samples per test (to minimize order effects and respondent fatigue) as recommended in a recent methodological paper on the EsSense Profile™ (14). In this paper a small (0.2 units or less among means on a 5-point scale) but significant effect of number of samples on positional response on overall liking and emotion scores across serving positions was reported, indicating that liking and emotional ratings may decrease slightly for those samples presented at the end of a series. These effects are minimized by limiting the number of products per test to two. However, to assess actual food choice in a realistic and meaningful way, one needs a reasonable number of options to choose from. Hence, we decided on seven products to offer participants a real choice, and combined this with several precautions to reduce respondent fatigue (offering small portions per tasting and breaks between test blocks), and checked for potential order effects in the emotional responses (see Statistical analyses). Table 2.2 shows an overview of product characteristics of the seven products used in this study, including information on the brand, flavour and a short description of the sensory attributes. In the remainder of this paper, products will be referred to by a letter code (A – G: see Table 2.2). Importantly, as our primary interest in this study was in emotions evoked by intrinsic food properties the breakfast drinks were presented unbranded (without brand or packaging information) during all measurements of this study.

Table 2.2 Product information on the seven test products with the letter code used throughout this paper for each breakfast drink, the product brand, the flavour, and a short description of each breakfast drink.

Letter code	Product brand	Flavour	Short product description
A	Campina, "Good morning" [a]	Orange, mango and banana	Dairy based, liquid breakfast drink with grains
B	Hero, "Fruit Breakfast" [b]	Forest fruit	Juicy based liquid breakfast drink with grains
C	Hero, "Fruit Breakfast" [b]	Orange and banana	Juicy based liquid breakfast drink with grains

D	Campina, "Good morning"[a]	Peach and apricot	Dairy based liquid breakfast drink with grains
E	Campina, "Good morning"[a]	Strawberry, kiwi and banana	Dairy based liquid breakfast drink with grains
F	Friesche Vlag, "Breaker"	Strawberry and banana	Dairy based semi-liquid (yoghurt like) breakfast drink, no grains
G	Friesche Vlag, "Breaker"	Peach	Dairy based semi-liquid (yoghurt like) breakfast drink, no grains

[a] Translated from the Dutch product brand name Campina, "Goede Morgen"
[b] Translated from the Dutch product brand name Hero, "Fruit Ontbijt"

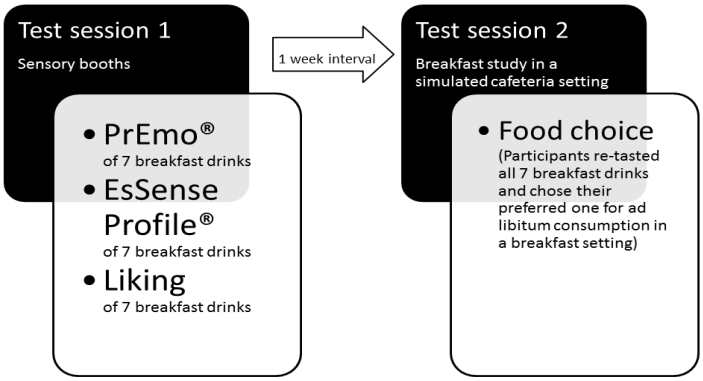

Figure 2.1 Schematic overview of the two test sessions. In test session 1 emotional responses to the seven tasted breakfast drinks were measured using PrEmo® and EsSense Profile™ and liking scores were obtained. In test session 2 we assessed actual food choice.

Procedure

In a within-subject design, participants took part in two test sessions with an interval of one week in between. See Figure 2.1 for a schematic overview of the two test sessions. Testing took place in the morning in two time slots, at 7.30 am and at 9.30 am, which is congruent with the normal mealtime for breakfast. Participants were scheduled at the same time slot for both sessions. They were not allowed to eat 2 h before the start of each test session.

During the first session, which took approx. 70 min, testing was conducted in individual sensory

testing booths. Before the test, participants were given written instructions that they would receive seven samples of breakfast drinks to taste. Each sample (refrigerated at 4 °C until the moment of serving) was presented in a 60 ml transparent cup containing 15 ml of each product and a teaspoon. Participants were instructed to stir the sample with a spoon, and then take a spoonful to taste the product.

The first session consisted of two blocks that were separated by 10 min breaks to minimize respondent fatigue. In block one, participants evaluated each sample using PrEmo® over a 25 min period. In block two, which took approx. 35 min, they did the same but now using EsSense Profile™ and in addition rated overall liking for each sample.

Hence, at the first session, participants tasted a spoonful of the test product and were instructed to report the product-evoked emotions using PrEmo®. This was repeated for all seven products. Between stimuli, participants had a 1 min break, in which they rinsed their mouth with water and ate unsalted crackers. The presentation order of the seven breakfast drinks was randomized across participants. After a 10 min break, participants evaluated the same seven test products using the EsSense Profile™. For each sample, at the end of each emotion rating, participants were instructed to taste the sample at hand once more and rate its overall liking on a 100-mm visual analogue scale anchored "dislike extremely" and "like extremely".

All participants first completed PrEmo® and then the EsSense Profile™. The fixed order of tests was based on a claim that PrEmo® relies on more intuitive and unconscious emotion processing. According to Desmet, et al. (15) "asking participants to describe their emotional response will require cognitive involvement, which may influence the measurement". Running EsSense Profile™ ratings prior to PrEmo® would prime the emotional lexicon in our subjects.

One week later, actual food choice was measured in the second session. The session consisted of a breakfast study in a realistic eating environment in the research facilities of the Restaurant of the Future (RotF) in Wageningen. The RotF allows studying food choice behaviour in a natural out-of-home eating and drinking setting. Participants were instructed to come to the RotF within a certain time slot in the morning. Once they arrived, they went to a dedicated room for this study and were asked to taste again all seven breakfast drinks (unbranded samples) and to point out the one they preferred to have for breakfast (no other breakfast products were served). The selected product was presented to the participants in oblique cups containing twice the standard serving for one person per product. Participants were seated at two large tables joining other participants already seated.

Emotion measurements

PrEmo®

The Product Emotion Measurement Instrument (PrEmo®) is a non-verbal emotion measurement tool developed by Desmet, et al. (15) and further developed and commercially marketed by Susagroup, The Netherlands (www.susagroup.com). PrEmo® covers a set of 12 emotions that are universally recognized, six positive (*desire*, *satisfaction*, *pride*, *hope*, *joy*, and *fascination*) and six negative emotions (*disgust*, *dissatisfaction*, *shame*, *fear*, *sadness*, and *boredom*). PrEmo® is a computerized tool that assesses to what extent the emotions expressed by an animated cartoon character correspond to the participants' feelings towards the stimulus (see www.premotool.com for an example animation). In each animation, a cartoon character expresses a different emotion in approximately 1 s. The cartoon expresses an emotion with movement (facial and bodily expressions) and sound. Participants score the extent to which they experience this emotion on a 5-point scale with the stanines "not at all", "slightly", "moderately", "very" and "extremely" by ticking a box on the screen. Participants are instructed to run the complete set of emotions for each sample. Despite the fact that PrEmo® was not developed as a food-specific emotion measurement instrument, in our view the tool is complementary to the EsSense Profile™ questionnaire in that it is a pictorial instrument, cross-cultural validated tool that does not require verbalization of often complex emotions.

EsSense Profile™ Method

EsSense Profile™ measures the explicit emotional response to food products by participant ratings on 39 emotional words on a 5-point intensity scale stanines "not at all", "slightly", "moderately", "very" and "extremely" (for additional details see King & Meiselman, 2010 (13)). The questionnaire was provided to the participants via a computer, using EyeQuestion software (Logic8 BV). In this paper all terms are presented in English; however, we used a Dutch version of the scale.

Statistical analyses

SPSS 20.0 (IBM, New York USA) was used for the statistical analysis of the data. As a first quality check of the data, we tested for potential effects of order of sample presentation on repeated sample evaluation. We compared emotional responses to the samples across serving positions for PrEmo® and the EsSense Profile™ (i.e. 7 products for which serving order was randomized across subjects). Following the approach of King, et al. (14), the means per emotion term per positional

response were calculated and included in a mixed model ANOVA to check for any order effects. This procedure (data not reported) revealed no indications for systematic order effects of serving position on emotion ratings for PrEmo® or for EsSense Profile™. In further analyses presentation order was, therefore, not taken into account anymore.

To test for differences in emotional profiles and liking between the products we performed mixed model ANOVA' s on each emotion and liking (dependent variable), using participant as random factor and Product (seven breakfast drinks) as fixed factor. Results are reported corrected for multiple comparisons (Bonferroni corrected, adjusted p-value for the number of comparisons for PrEmo® and EsSense Profile™ respectively). Bonferroni multiple comparison tests are reported to indicate significant differences between the products.

The relationship between liking and each of the emotion terms from PrEmo® and EsSense Profile™ was evaluated by Pearson correlation coefficients (r), resulting in123 x 7 observations.

The relationship between mean emotion and liking scores (averaged across all participants) and choice (the number of participants that chose a particular product) was evaluated by Kendall's τ. To test which emotions contribute significantly to choice (choice frequencies) a Partial Least Squares Regression (PLS-R) analysis was performed on the emotion data averaged across participants. PLS-R was performed in the program Unscrambler (CAMO ASA, Oslo, Norway).

Results

PrEmo®

Separate mixed model ANOVA's per emotion, using participant as random factor and Product (seven breakfast drinks) as fixed factor revealed a significant main effect of Product for all 12 emotions ($p \leq 0.0042$, adjusted). Table 2.3 shows the mean emotion values per product and the significant differences between three groups of breakfast drinks based on Bonferroni multiple comparisons. However, within the groups there were no significant differences in emotional responses to the tasted breakfast drinks, except for *boredom*, being significantly different between the products C and D.

Group 1 includes two dairy breakfast drinks A and E, group 2 includes drinks B, C and D, and group 3 contains two viscous drinks F and G (see Figure 2.2). All the positive emotions were rated highest in intensity for the two viscous drinks F and G and lowest for the fruit juicy drinks B and C and the

dairy breakfast drink D (see Figure 2.2 and Table 2.3). Moreover, the drinks B, C and D were rated highest on the negative emotions *disgust* and *dissatisfaction*.

Table 2.3 PrEmo®: The table displays the mean values of each emotion elicited by the seven breakfast drinks.

	Product						
	A	**B**	**C**	**D**	**E**	**F**	**G**
Boredom*	$0.54^{a,b,c}$	$0.64^{a,c}$	$0.50^{a,b}$	0.73^{c}	$0.61^{a,c}$	0.38^{b}	0.35^{b}
Desire*	$1.24^{a,d}$	$0.92^{a,c}$	$0.91^{a,c}$	0.80^{c}	$1.32^{b,d}$	1.67^{b}	1.63^{b}
Disgust*	$0.85^{a,c}$	$1.27^{b,c}$	1.50^{b}	1.32^{b}	0.67^{a}	0.56^{a}	0.78^{a}
Dissatisfaction*	0.78^{a}	1.32^{b}	1.36^{b}	1.28^{b}	0.70^{a}	0.54^{a}	0.76^{a}
Fascination*	$1.50^{a,c}$	$1.26^{c,d}$	$1.44^{c,d}$	1.08^{d}	$1.50^{a,c}$	2.02^{b}	$1.86^{a,b}$
Fear*	$0.45^{a,b}$	$0.74^{b,c}$	0.94^{c}	$0.74^{b,c}$	0.36^{a}	0.27^{a}	0.42^{a}
Hope*	$1.28^{a,b}$	1.02^{b}	1.15^{b}	1.02^{b}	$1.37^{a,b}$	1.59^{a}	1.58^{a}
Joy*	$1.55^{a,c}$	$1.18^{a,d}$	$1.33^{c,d}$	1.03^{d}	1.65^{c}	2.25^{b}	2.11^{b}
Pride*	1.00^{a}	$0.78^{a,c}$	$0.83^{a,c}$	0.62^{c}	$1.12^{a,b}$	1.41^{b}	1.39^{b}
Sadness*	$0.20^{a,b}$	$0.21^{a,b}$	0.33^{a}	$0.23^{a,c}$	$0.13^{b,c}$	0.06^{b}	$0.13^{b,c}$
Satisfaction*	1.85^{a}	1.37^{b}	1.35^{b}	1.28^{b}	2.00^{a}	2.26^{a}	2.10^{a}
Shame*	$0.23^{a,b}$	0.37^{a}	0.35^{a}	0.33^{a}	$0.21^{a,b}$	0.14^{b}	$0.19^{a,b}$

*Indicates significant differences between the means of the emotion terms elicited by the seven products using the mixed model ANOVA procedure. Values within rows with different lowercase superscripts are significantly different according to Bonferroni multiple comparisons test with a significance level of $p < 0.0042$ (Bonferroni correction: 0.05/12).

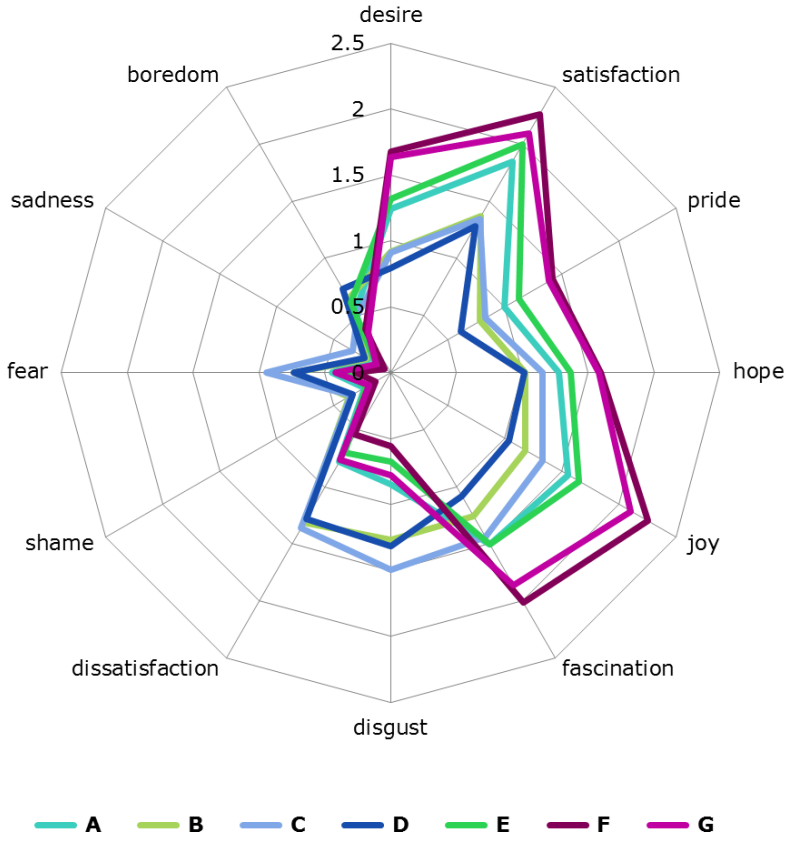

Figure 2.2 PrEmo® mean emotional responses to the seven tasted breakfast drinks (A – G), measured on a 5-point scale, 0= not at all and 4 = extremely. Products differed significantly on 12 emotions presented in the spider plot.

EsSense Profile™ method

Again, mixed model ANOVA's were performed per emotion using participant as random factor and Product (seven breakfast drinks) as fixed factor. The results yielded a significant main effect ($p \leq 0.0013$, adjusted) of Product for 29 out of 39 emotions (see Figure 2.3 and Table 2.4 for the emotion means and significant differences between the breakfast drinks). For 10 emotions (*active*, *adventurous*, *daring*, *energetic*, *free*, *guilty*, *quiet*, *tame*, *wild* and *worried*) no effects of Product were found. The results show that products could be differentiated on a large number of emotions which is in line with consumers indeed using a large number of emotion words to evaluate products.

Visual inspection of the emotional profiles elicited by the products showed that emotional responses predominantly differed in magnitude between products, irrespective of the type of emotion. This was as expected as it concerns similar products. Interestingly, EsSense Profile™ forms similar groups of breakfast drinks as PrEmo® based on multiple comparison tests. We found significant differences in emotional responses between the groups and no significant differences within the groups.

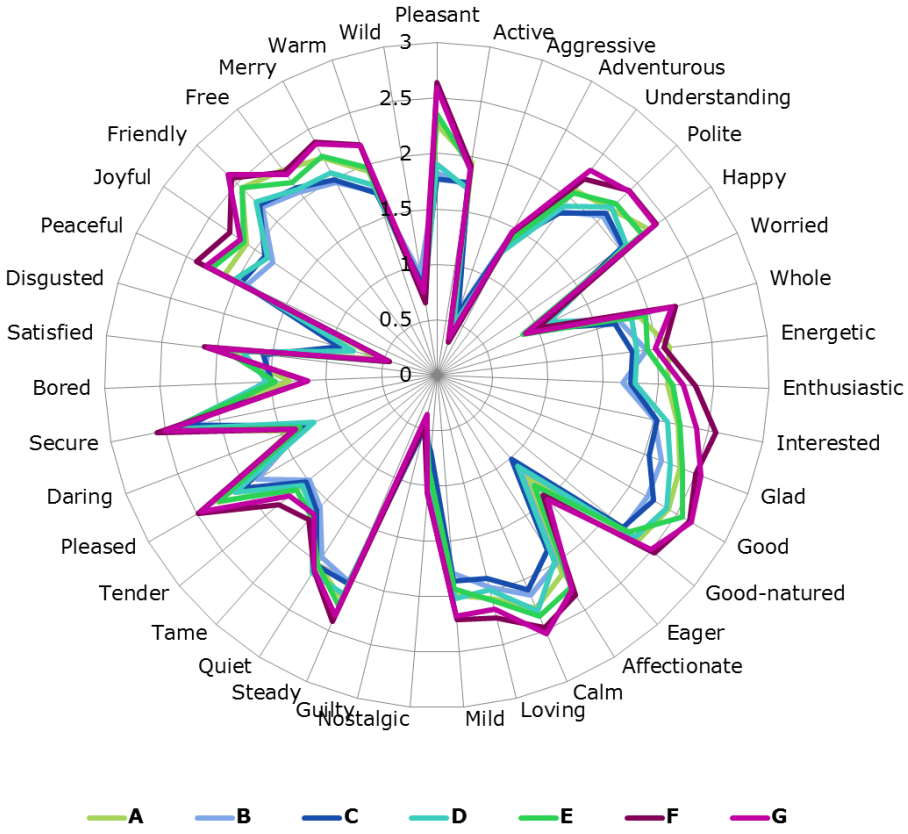

Figure 2.3 EsSense Profile™ mean emotional responses to the seven tasted breakfast drinks (A – G), measured on a 5-point scale, 0= not at all and 4 = extremely. Products differed significantly on 29 emotions presented in the spider plot.

Table 2.4 EsSense Profile™: The table displays the mean values of each emotion elicited by the seven breakfast drinks.

	Product						
	A	**B**	**C**	**D**	**E**	**F**	**G**
Active	1.94	1.73	1.76	1.71	1.89	1.91	1.88
Adventurous	1.46	1.46	1.33	1.26	1.35	1.46	1.46
Affectionate*	2.12^{a,b}	2.01^{a,c}	1.87^{a}	1.98^{a,d}	2.26^{b,c,d}	2.34^{b}	2.28^{b,c}
Aggressive*	0.46^{a,b}	0.60^{a}	0.59^{a,c}	0.47^{a,b}	0.33^{b}	0.32^{b}	0.36^{b,c}
Bored*	1.33^{a}	1.56^{a}	1.49^{a,b}	1.53^{a}	1.46^{a,b}	1.17^{b}	1.16^{b}
Calm*	2.28^{a,b}	2.15^{a}	2.11^{a}	2.31^{a,b}	2.36^{a,b}	2.47^{b}	2.53^{b}
Daring	1.41	1.28	1.28	1.19	1.33	1.37	1.37
Disgusted*	0.53^{a,c}	0.90^{b,c}	0.92^{b}	0.78^{a,b}	0.45^{a}	0.45^{a}	0.46^{a}
Eager*	1.21^{a,b}	1.11^{a,c}	1.01^{a}	1.10^{a,c}	1.33^{a,b}	1.44^{b,c}	1.50^{b}
Energetic	2.11	1.90	1.77	1.81	1.91	2.07	1.98
Enthusiastic*	2.08^{a,c,d}	1.67^{b}	1.75^{b,d}	1.79^{b,c}	2.13^{a,c}	2.33^{a}	2.23^{a}
Free	2.32	2.07	2.11	2.10	2.17	2.29	2.26
Friendly*	2.44^{a,b}	2.19^{a}	2.22^{a}	2.26^{a}	2.44^{a,b}	2.57^{b}	2.61^{b}
Glad*	2.34^{a,d}	2.16^{b,d}	2.05^{b}	2.25^{b,c,d}	2.37^{a,c,d}	2.50^{a,c}	2.54^{a}
Good*	2.41^{a,b}	2.19^{a}	2.25^{a}	2.39^{a,b}	2.55^{b}	2.63^{b}	2.65^{b}
Good-natured*	2.35^{a,b,c}	2.18^{a}	2.16^{a}	2.31^{a,b,c}	2.24^{a,c}	2.54^{b}	2.49^{b,c}
Guilty	0.42	0.41	0.50	0.42	0.40	0.46	0.36
Happy*	2.32^{a,b,c}	2.02^{a}	2.04^{a}	2.07^{a,c}	2.24^{a,b,c}	2.40^{b}	2.39^{b,c}
Interested*	2.22^{a,c}	2.00^{a}	2.02^{a}	2.12^{a,c}	2.24^{a,b,c}	2.57^{b}	2.39^{b,c}
Joyful*	2.09^{a,b,c}	1.80^{a}	1.89^{a}	1.86^{a,c}	2.11^{b,c}	2.27^{b}	2.15^{b,c}
Loving*	2.07^{a,b,c}	1.97^{a,c}	1.89^{a}	1.99^{a,b,c}	2.09^{a,b,c}	2.25^{b}	2.17^{b,c}
Merry*	2.21^{a,b,c}	1.96^{a}	1.99^{a}	2.07^{a,c}	2.24^{a,b,c}	2.37^{b}	2.36^{b,c}
Mild*	1.98^{a,b}	1.79^{a}	1.86^{a}	2.02^{a,b}	1.93^{a,b}	2.21^{b}	2.18^{b}
Nostalgic*	0.94^{a,b}	0.76^{a}	0.68^{a}	0.89^{a,b}	0.85^{a,b}	1.07^{b}	1.05^{b}
Peaceful*	2.12^{a,b,c}	1.90^{a}	1.95^{a}	2.02^{a,c}	2.25^{b,c}	2.40^{b}	2.31^{b}
Pleasant*	2.26^{a,c}	1.83^{b}	1.77^{b}	1.90^{b,c}	2.36^{a}	2.64^{a}	2.59^{a}
Pleased*	2.28^{a,c}	1.88^{b}	2.02^{a,b}	2.11^{a,b,c}	2.27^{a,c}	2.49^{c}	2.46^{c}
Polite*	2.17^{a,b}	2.07^{a}	2.11^{a}	2.19^{a,b}	2.24^{a,b}	2.41^{b}	2.40^{b}
Quiet	2.02	1.94	2.02	2.11	2.02	2.08	2.07
Satisfied*	1.93^{a,c}	1.54^{b}	1.58^{b}	1.76^{b,c}	1.94^{a,c}	2.11^{a}	2.08^{a,c}
Secure*	2.46^{a,b}	2.24^{a}	2.28^{a}	2.44^{a,b}	2.49^{a,b}	2.58^{b}	2.50^{a,b}

Steady*	2.19^{a,b}	2.02^{a}	2.04^{a}	2.15^{a,b}	2.26^{a,b}	2.41^{b}	2.35^{b}
Tame	1.61	1.59	1.63	1.68	1.71	1.74	1.67
Tender*	1.59^{a,b}	1.49^{a}	1.52^{a}	1.57^{a}	1.63^{a,b}	1.85^{b}	1.72^{b}
Understanding*	2.08^{a}	1.85^{b}	1.83^{b}	1.90^{b}	2.06^{a,b}	2.21^{a}	2.31^{a}
Warm*	1.94^{a}	1.75^{b}	1.73^{b}	1.80^{b}	1.98^{a,b}	2.20^{a}	2.19^{a}
Whole*	1.90^{a}	1.72^{a}	1.67^{a}	1.83^{a}	1.96^{a,b}	2.24^{b}	2.20^{b}
Wild	0.76	0.93	0.82	0.72	0.75	0.67	0.76
Worried	0.93	1.03	0.98	1.11	0.85	1.00	0.89

*Indicates significant differences between the means of the emotion terms elicited by the seven products using the mixed model ANOVA procedure. Values within rows with different lowercase superscripts are significantly different according to Bonferroni multiple comparisons test with a significance level of $p < 0.0013$ (Bonferroni correction: 0.05/39).

Liking

See Table 2.5 for the mean liking scores of the seven breakfast drinks and an overview of the results of Bonferroni multiple comparison tests showing which products differed significantly from each other in liking. Overall, two groups could be identified from which the more viscous drinks F and G and the two dairy drinks A and E were liked most, whereas drink D and the juice-based drinks B and C were liked less.

Table 2.5 Table 2.5 shows the mean liking scores ± ***SD*** of the products. Liking was measured on a 100-mm visual analogue scale anchored "dislike extremely" and "like extremely".

	Product						
	A	**B**	**C**	**D**	**E**	**F**	**G**
Liking*	56.55 ± 21.8^{a}	42.61 ± 25.3^{b}	43.06 ± 26.4^{b}	46.99 ± 22.5^{b,c}	55.29 ± 21^{a,c}	64.24 ± 23.4^{a}	61.89 ± 24.8^{a}

*Indicates significant differences between the means of the emotion terms elicited by the seven products using the mixed model ANOVA procedure. Values within rows with different lowercase superscripts are significantly different according to Bonferroni multiple comparisons test with a significance level of $p < 0.0013$ (Bonferroni correction: 0.05/39).

Liking and EsSense Profile™ method and PrEmo®

Table 2.6a gives an overview of the relationship between intensity ratings of emotions (EsSense Profile™) and liking in response to breakfast drinks determined by Pearson correlations (r). To interpret the strength of the association between emotions and liking, Cohen's (21) guide-lines were

applied: r = 0 - 0.3 = small; r = 0.3 - 0.5 = moderate; r > 0.5 = strong. According to Cohen's criteria 17 out of 39 emotions measured with EsSense Profile™ had a small correlation with liking; *aggressive*, *adventurous*, *bored*, *calm*, *daring*, *guilty*, *mild*, *nostalgic*, *polite*, *quiet*, *steady*, *tame*, *tender*, *wild*, and *worried*. Eighteen emotions were moderately associated with liking; *active*, *affectionate*, *eager*, *energetic*, *free*, *friendly*, *glad*, *good-natured*, *interested*, *joyful*, loving, *merry*, *peaceful*, *satisfied*, secure, *understanding*, *warm*, and *whole*. The remaining six emotions were strongly associated with liking: *disgusted*, *enthusiastic*, *good*, *happy*, *pleased* and *pleasant*.

Table 2.6b provides a comparable overview of the relationship between the emotional responses measured with PrEmo® and liking ratings. According to Cohen's guidelines, *boredom*, *sadness* and *shame* had a weak association with liking. The emotions moderately associated with liking were *dissatisfaction*, *fascination*, *fear*, *hope*, and *pride*. The emotions *desire*, *disgust*, *joy*, and *satisfaction* showed a strong association with liking.

Table 2.6a Effect size interpretation of correlations between emotions EsSense Profile™ and liking

Emotion	Pearson's *r*	Effect size Cohen's criteria
Pleasant	0.78	Strong
Pleased	0.64	Strong
Disgusted	– 0.61	Strong
Enthusiastic	0.61	Strong
Happy	0.56	Strong
Good	0.53	Strong
Interested	0.50	Moderate
Joyful	0.48	Moderate
Merry	0.48	Moderate
Glad	0.47	Moderate
Energetic	0.43	Moderate
Active	0.42	Moderate
Satisfied	0.45	Moderate
Eager	0.43	Moderate
Whole	0.43	Moderate
Warm	0.41	Moderate
Friendly	0.39	Moderate
Understanding	0.39	Moderate
Peaceful	0.37	Moderate
Affectionate	0.34	Moderate
Free	0.33	Moderate
Good-natured	0.33	Moderate
Secure	0.32	Moderate
Loving	0.31	Moderate
Polite	0.30	Small
Steady	0.30	Small
Aggressive	– 0.28	Small
Adventurous	0.27	Small
Daring	– 0.28	Small
Bored	– 0.27	Small
Mild	0.26	Small
Tender	0.25	Small
Calm	0.20	Small
Worried	– 0.18	Small

Wild	0.17	Small
Nostalgic	0.16	Small
Guilty	– 0.12	Small
Tame	0.05	Small
Quiet	0.04	Small

Table 2.6b Effect size interpretation correlations between emotions PrEmo® and liking

Emotion	Pearson's *r*	Effect size Cohen's criteria[a]
Disgust	–0.58	Strong
Satisfaction	0.54	Strong
Joy	0.53	Strong
Desire	0.51	Strong
Dissatisfaction	–0.50	Moderate
Fear	–0.45	Moderate
Pride	0.43	Moderate
Hope	0.39	Moderate
Fascination	0.37	Moderate
Shame	–0.20	Small
Sadness	–0.20	Small
Boredom	–0.14	Small

Table 2.6a+b: Estimate of the strength of the association between liking scores and emotions involved in EsSense Profile™ (6a) and PrEmo® (6b). Effect size estimates are based on Pearson's r.
[a] In the third column Cohen's (21) guide-lines for magnitude of the Pearson r were applied: small = $r < 0.3$; moderate = $0.3 < r < 0.5$; strong = $r > 0.5$.

Actual food choice, emotional responses and liking

Actual food choice in the breakfast study centred around three products. 42% of the participants chose breakfast drink F, 33.3 % chose drink G, 11% drink E, whereas the remaining 15% was distributed across the other four drinks. Note that the two viscous drinks F and G together were chosen by 75% of the participants.

A strong correlation, 0.78 (Kendall's τ), was found between liking and the frequency with which a product was chosen during the breakfast study. Thus, the best-liked products were the most frequently chosen products.

To identify which PrEmo® emotions were strongly associated with choice, only strong correlations (Kendall's $\tau > 0.8$) were considered. These were *desire*, *disgust (-)*, *dissatisfaction (-)*, *fear (-)*, *sadness (-)*, *satisfaction*, and *shame (-)*. PLS-R analysis identified which emotions contributed significantly to predict choice (correlation coefficient between observed and predicted choice: 0.88, $p<0.05$). Choice was well predicted by one positive emotion (*joy*, regression coefficient: 0.51, $p<0.05$) and one negative emotion (*dissatisfaction*, regression coefficient: -0.40, $p<0.05$). To identify which EsSense Profile™ emotions were related to choice, again strong correlations (Kendall's $\tau > 0.8$) were considered between choice and emotions, and this resulted in 16 emotions, i.e. *affectionate*, *disgusted (-)*, *eager*, *enthusiastic*, *interested*, glad, *loving*, *merry*, *peaceful*, *pleasant*, *satisfied*, *secure*, *steady*, *tender*, *warm*, and *whole*. PLS-R revealed that choice is predicted well (correlation coefficient 0.88) by one positive emotion (*happy*, regression coefficient 0.42, $p<0.05$) and one negative emotion (*bored*, regression coefficient: -0.47, $p<0.05$).

Discussion

The main findings of the present study are twofold: First, both methods used to measure food-evoked emotions (PrEmo® and EsSense Profile™) proved to be able to differentiate between food products from the same product category and resulted in similar distinguishable groups of products. Second, association strength between liking scores and emotions as measured with the tools PrEmo® and EsSense Profile™ reveals that only a small part of the emotions is strongly associated with liking, indicating that those emotions may have little added value compared to measuring liking. However, the majority were weakly associated with liking. These emotions are i) relevant to the product category and ii) do distinguish between several products within a category, providing new information about the products not captured by liking and iii) may increase our understanding of food choice. Correlation analysis revealed actual food choice for breakfast drinks to be associated mainly with emotions with a positive valence (pleasant).

Overall, participants used a large number of predominantly positive emotion words to express their emotional responses to the breakfast drinks. This is consistent with the hedonic asymmetry of the food-related emotion lexicon (10), and with previous studies reporting an extended set of words necessary to describe the emotional responses to chocolate (7, 9), wine (22) and potato chips (7).

In line with our expectations, PrEmo® and EsSense ProfileTM could distinguish between products from the same product category that differed on several sensory attributes. However, when discriminating between two products from the same brand that were highly similar on most sensory attributes except for flavour, PrEmo® and EsSense ProfileTM lacked discriminative

sensitivity. For PrEmo®, no previous studies on discriminating food products have been reported. In contrast to our finding, King and Meiselman (13) and Ng, et al. (19) did find differences between the emotional responses to different flavours of the same food products (i.e. salty flavoured crackers and blackcurrant squashes) or varying in other sensory characteristics. Overall, it seems that the discriminative ability of EsSense ProfileTM and PrEmo® is limited when aiming at a distinction between highly similar products. Further exploration of subtle differences in emotions evoked by food products could benefit from combining self-report measures with methods that are thought to be more sensitive to implicit or fast and automatic responses, for example autonomic measures such as skin conductance and heart rate (23) or brain imaging techniques such as functional MRI (24).

Comparing the results of PrEmo® and EsSense Profile™ we observed that the product-evoked emotional profiles predominantly differed in terms of intensity but not so much on pattern or type of emotions. The discriminative ability of the two methods varied strongly between the products. For instance, product E and B differed on six emotions measured with PrEmo® and on nine emotions of EsSense Profile™, whereas F and B differed on 11 emotions measured with PrEmo® and 28 with EsSense Profile™. It is unclear whether this signifies a meaningful finding.

Based on the present study we cannot conclude that one measurement tool outperforms the other. Both methods effectively differentiate between the seven products but differ, not surprisingly, in the number of emotions that differentiate between the products. Choosing one method above the other should be guided by the aim of a study, the characteristics of the target group and facilities at the test location. EsSense Profile™ provides a broader and more detailed list of emotional terms. Consequently, one gets a more detailed emotional profile of a product. This could have added value for marketing purposes or for example, a competitor analysis. EsSense Profile™ has been translated in several languages and has been used globally. Also, EsSense Profile™ can be used as a paper-and-pencil questionnaire, which could be more appropriate when running studies in a natural setting (field or at home studies) (13, 25). The length of the profile can be a challenge in some testing situations, but recently a shorter version (EsSense25) has been developed, tested and validated (26), that was not available yet at the time the present study was performed.

On the other hand, PrEmo® is a non-verbal, and hence, language independent tool which can be used across different languages, nationalities and cultures. This is not a minor issue, as it was recently demonstrated that with translation of emotion questionnaires originally developed in other languages, great caution is needed because of differences in the semantic relationships among words in different languages (17). Moreover, some of our participants reported that PrEmo®

had a more appealing interface and, due to its animated cartoon format, was more 'fun' to do. This might be relevant when working with groups with a limited attention span such as children or elderly. For these groups, the EsSense25 – a shorter version of the EsSense Profile™, could also be a good option (26).

Using different measurement tools to assess emotional responses to food products from the same product category is extended by the work of Ng, et al. (19). Here, the EsSense Profile™ discriminated successfully between 11 blackcurrant squashes, but resulted in a less sensitive discrimination when compared to a consumer defined CATA measurement tool (product category specific) tested in a between-subject design. Similar findings were reported by Spinelli, et al. (17) in a study that compared consumer emotional responses to products within a specific product category (i.e. chocolate and hazelnut spreads) using two questionnaires: A newly developed product specific questionnaire (*EmoSemio*), based on the identification of emotions that consumers associate with these product, and EsSense Profile™. The product specific questionnaire was found to discriminate more effectively across products compared to EsSense Profile™ which the authors ascribe to factors such as the product-specific and language-specific nature of the EmoSemio questionnaire, a different way to express emotions (not a single adjective but full sentences to reduce ambiguity) and a reduced length (23 instead of 39 items). Hence, tailoring the emotion measurement tool by implementing a consumer defined and product and language specific emotional lexicon improves discriminative sensitivity, but it is time and budget consuming.

When exploring food-evoked emotional profiles in relation to actual food choice, the obvious question is whether emotion scores provide additional information that goes beyond traditional liking ratings. The present findings indicate that actual food choice is predominantly linked with valence (negative-positive) of food-evoked emotions.

The present work has some strengths and limitations worthwhile to discuss. To our best knowledge, this is the first study combining emotional profiling of food products with actual food choice behaviour using the same seven test products. In addition, we combined a verbal and a non-verbal emotion measurement tool in a within-subject design for all products tested. The decision to always collect PrEmo® data before EsSense Profile™ may, however, have biased the test of discriminative ability of the two methods. Ideally, this test should be replicated with the two methods being applied on separate testing days and in random order, to assess effects of test order on test performance.

Another potential limitation of the present study is that variability across participants in their previous experience with breakfast drinks was higher than we aimed for. We intended to include a

large sample of regular users, as it is known that in none-users food products hardly elicit emotions (13). However, available time and budget for recruiting impelled us to include a group of incidental users as well. In addition, the recruitment of product users only also resulted in a sample that unintendedly consisted of three times more women than men. We tested for potential gender differences (data not reported), but found no indication for differences in emotion ratings for these particular products (breakfast drinks) between male and female participants.

A third limitation is that although the test was done in a realistic consumption context, to choose a food product after tasting seven of them is an unrealistic situation that seldom occurs in real life situations where product choice is often based on packaging only (e.g. in a supermarket).

Finally, product testing involved a number of sequential tastings and emotion ratings per participant that well exceeded the number of samples recommended for this type of research, namely two to three (14). Hence, there was a risk that the participants' ability to respond in an unbiased way and without some element of fatigue was compromised. However, our data showed little evidence for systematic effects of order of sample presentation, biased responses or fatigue. Nevertheless, defining the optimal number of sequential tastings/ratings is certainly an issue of importance, and it would be helpful if future studies report on these methodological matters more often in order to come to a better understanding of which factors restrain the number of samples, the number of ratings and in which testing conditions.

In the present study, the emotional profile of the product was based on the intrinsic sensory product properties. Still, it has been shown that choice behaviour and emotional responses to food products are also influenced by extrinsic properties (i.e. package, labelling, and brand information) (20, 27, 28). Future studies should take into account the full product experience. An interesting question arising is how the (mis)match between emotional responses elicited by unbranded and branded product affects acceptance, product satisfaction and choice behaviour.

In conclusion, this study shows that both emotional measurement tools successfully differentiated between subcategories of products from a specific product category and provided new information not conveyed by liking. Liking scores were only partly related to the emotional terms measured with the PrEmo® and EsSense Profile™. Food choice was found to be related with mainly positive, indicating that choice may in part be guided by food-evoked emotions that go beyond liking.

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Chapter 3

Evoked emotions predict food choice

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Abstract

In the current study we show that non-verbal food-evoked emotion scores significantly improve food choice prediction over merely liking scores. Previous research has shown that liking measures correlate with choice. However, liking is no strong predictor for food choice in real life environments. Therefore, the focus within recent studies shifted towards using emotion-profiling methods that successfully can discriminate between products that are equally liked. However, it is unclear how well scores from emotion-profiling methods predict actual food choice and/or consumption. To test this, we proposed to decompose emotion scores into valence and arousal scores using Principal Component Analysis (PCA) and apply Multinomial Logit Models (MLM) to estimate food choice using liking, valence, and arousal as possible predictors. For this analysis, we used an existing data set comprised of liking and food-evoked emotions scores from 123 participants, who rated 7 unlabeled breakfast drinks. Liking scores were measured using a 100-mm visual analogue scale, while food-evoked emotions were measured using 2 existing emotion-profiling methods: a verbal and a non-verbal method (EsSense Profile and PrEmo, respectively). After 7 days, participants were asked to choose 1 breakfast drink from the experiment to consume during breakfast in a simulated restaurant environment. Cross validation showed that we were able to correctly predict individualized food choice (1 out of 7 products) for over 50% of the participants. This number increased to nearly 80% when looking at the top 2 candidates. Model comparisons showed that evoked emotions better predict food choice than perceived liking alone. However, the strongest predictive strength was achieved by the combination of evoked emotions and liking. Furthermore we showed that non-verbal food-evoked emotion scores more accurately predict food choice than verbal food-evoked emotions scores.

Introduction

Consumers show high variability in food choice behavior. The motivators influencing this type of choice behavior are complex and include psychological, physiological, situational, socio-cultural, and intrinsic & extrinsic product characteristics (1). Despite the complexity of this behavior, choosing what to eat or what to drink is often governed by a fast intuitive process rather than by relatively slow process that involves reasoning (1,2). Within this two-system view, intuition is defined as a fast, automatic, effortless, associative, implicit, and an emotionally charged process that is often controlled by habit. Reasoning, on the other hand, involves a slower, serial, effortful, flexible, and a more likely consciously controlled and monitored process (2,3).

One characteristic of intuition is its emotional basis (2–4). Slovic et al. (3) argued that although rational analysis is important in some situations, reliance on an intuitive system that includes fast emotional processing is more efficient for survival than reasoning. Given the strong relation between nutrition and survival, it is not surprising that emotional valence, measured in liking, was found to be strongly related to experimentally controlled food choice behavior (5,6). However, the relation between food choice and liking seems to be weaker in real world situations (5). This is exemplified by chocolate consumption; although chocolate is highly liked, actual consumption of chocolate varies between consumers and heavily depends on many more factors than merely liking. Therefore, the field of sensory, consumer and food science shifted its focus towards identifying additional motivators for food choice behavior and how these motivators interact with liking.

In recent years, considerable attention is given to food-evoked emotions as motivators for food choice, leading to the introduction of several emotion measurement instruments and guides for measuring food-evoked emotions (1,7–12). To our best knowledge, the majority of these instruments within the field of sensory, consumer and food science are verbal; participants are instructed to rate emotions that are presented either as single terms or as questions. One popular verbal method is EsSense Profile (13). EsSense Profile allows for measuring 39 emotions via self-reported intensity scores on a 5-point scale ranging from 0 (not at all) to 4 (extremely). EsSense Profile contains mainly positive emotion terms, since studies have indicated that consumers use (mildly) positive rather than negative emotions when describing their food experiences, a phenomenon called "hedonic asymmetry" (10,11,13).

A verbal instrument involves translation of the 'emotional lexicon' across cultures and languages, which may complicate interpretation as well as comparisons across studies (14–17). Furthermore, the intuitive nature of emotions would advocate for a more implicit type of measurement (1,14). A

non-verbal emotion measurement instrument may address these problems. One such instrument is the Product Emotion Measurement Instrument (PrEmo) (14). PrEmo is an emotion measurement instrument that measures the self-reported intensity of 12 emotions on a 5-point scale similar to EsSense Profile. However, PrEmo presents animated cartoon characters that express emotions instead of presenting emotions verbally. Despite its advantages over a verbal method, PrEmo has been criticized for its low number of (positive) emotions and for not being tailored to food-evoked emotions specifically (13). Therefore PrEmo may lead to less sensitivity to distinguish between food products.

Most emotion theorists agree that emotions contain at least two qualities: valence and arousal. These can be mapped in an affective space comprised of two orthogonal axes, ranging from unpleasant to pleasant and from calm to excitement, for valence and arousal, respectively (18–21). Not surprisingly, data from food-evoked emotion studies also decompose in these latent variables indicating that emotion measurement provides information on valence as well as arousal for each food product (7,22). Previous studies also indicated (sometimes indirectly) a strong relationship between valence and liking. Indeed, many emotion scores correlate moderately to highly with liking scores (7,22,23).

However, little is known about whether food-specific emotional profiles contain additional information over liking, in explaining or predicting subsequent food choice behaviour. To our best knowledge most studies on food-related emotions have included attitudinal measures (preference or liking ratings) as an index of the consumer's satisfaction and/or as an estimate of food choice or consumption behavior. However, the ultimate behavior of interest should not be expressed intention but actual choice and/or consumption. Furthermore, previous studies have mostly focused on distinguishing between products based on group averaged emotions scores and not on predicting individualized food choice behavior. These two issues are addressed in the current study by focusing on predicting individualized choice-behavior of the consumer based on liking and emotion measurements.

We hypothesized that product valence and product arousal, in addition to product liking, better predict individualized product choice than merely product liking. To test this hypothesis we used a data set of an experiment in which consumers were invited to rate food products using EsSense Profile, PrEmo, and a VAS liking scale. With a 1-week delay, consumers were re-invited and instructed to choose one product for consumption in a simulated cafeteria setting created in the Restaurant of the Future (RotF), situated in Wageningen, The Netherlands. The RotF is a field laboratory that allows studying food choice behavior in a simulated out-of-home eating and drinking setting.

To elucidate the association with choice, we used product liking, product valence, and product arousal, as predictors in Multinomial Logit Models (MLM) (24–26). These models allow estimation of choice between multiple alternatives. Possible predictors can include variables associated with the choice alternatives (e.g. emotion scores, liking or test setting) and individual-specific variables (e.g. gender or age).

Methods

The data we used is part of an ongoing series of studies conducted at the Wageningen University (acquired by S.G.). Additional results from these studies will be reported elsewhere (see e.g. (27)).

Participants

One hundred twenty-three healthy, Dutch speaking, participants (90 women) were recruited from Wageningen and surrounding areas. Inclusion criteria were: previous experience with the product category (defined as at least being incidental consumers of breakfast drinks), aged 18 – 55 years, and normal weight (BMI 18.5 – 27 kg/m^2). Exclusion criteria were: a change of body weight of more than 5 kg during the last two months, having food allergy or food intolerance, and, for women, being pregnant or lactating. Table 3.1 shows participant characteristics, including a categorization of breakfast drink consumption in incidental, regular and frequent consumers.

Participants were ignorant to the exact aim of the study and were informed that the researchers were interested in product evaluation differences between consumers and non-consumers of breakfast drinks.

Participants received financial compensation for participation and completed a consent form. Furthermore, the Medical Ethical Committee of Wageningen University gave ethical approval for the study.

Table 3.1 Participant characteristics

	Incidental users (N= 27) Criterion: 1-14 ever in lifetime		Regular users (N=68) Criterion: 1 - 9 times a year		Frequent users (N=28) Criterion: 10 or more times a year	
Gender	Female	Male	Female	Male	Female	Male
N	23	4	47	21	20	8
Age (y)	26.13 (9.44)	32.25 (9.54)	25.85 (11.51)	26.14 (10.22)	25.1 (8.77)	29.38 (12.52)
BMI (kg/ m2)	22.35 (2.16)	23.38 (1.36)	21.63 (2.02)	22.24 (1.95)	21.85 (1.84)	21.62 (1.83)

Participant characteristics (means± sd) and classification in incidental, medium, and frequent users of breakfast drinks. Non-users (criterion: never in lifetime) were excluded from the study.

Products

The products used in this study were breakfast drinks. These drinks were commercially available at the time of the study. Table 3.2 shows an overview of the breakfast drinks, including information on brand, flavor and a short description of the sensory attributes. In the remainder of this paper, the breakfast drinks will be referred to as product A – G (see Table 3.2).

As our primary interest in this study was on intrinsic product properties and the emotions they evoke, the breakfast drinks were presented unbranded (without brand or packaging information) during all measurements of this study.

Table 3.2 Product information for the seven test products

Letter code	Product brand	Flavour	Short product description
A	Campina, "Good morning" [a]	Orange, mango and banana	Dairy based, liquid breakfast drink with grains
B	Hero, "Fruit Breakfast" [b]	Forest fruit	Juicy based liquid breakfast drink with grains
C	Hero, "Fruit Breakfast" [b]	Orange and banana	Juicy based liquid breakfast drink with grains
D	Campina, "Good morning" [a]	Peach and apricot	Dairy based liquid breakfast drink with grains

E	Campina, "Good morning"[a]	Strawberry, kiwi and banana	Dairy based liquid breakfast drink with grains
F	Friesche Vlag, "Breaker"	Strawberry and banana	Dairy based semi-liquid (yoghurt like) breakfast drink, no grains
G	Friesche Vlag, "Breaker"	Peach	Dairy based semi-liquid (yoghurt like) breakfast drink, no grains

[a] Translated from the Dutch product brand name Campina, "Goede Morgen"
[b] Translated from the Dutch product brand name Hero, "Fruit Ontbijt"
The table shows the product information of all products that were used in the study.

Design & Procedure

Participants took part in two test sessions with an interval of one week. Testing took place in the morning, either at 7:30 am or at 9:30 am. Participants were scheduled at the same time slot for both sessions and were not allowed to eat two hours before the start of each test session.

Session 1

At the start of session 1, participants were seated in secluded sensory testing booths and were given written instructions, describing the experiment.

The first test session consisted of two blocks, separated by a 10-minute break to minimize fatigue. During block 1, participants evaluated product-evoked emotions using the emotion profiling method PrEmo (~25 minutes), whereas participants evaluated product-evoked emotions using EsSense Profile (~35 minutes) in block 2.

Both blocks were divided in seven randomized trials (one per product). During every trial, a test sample of a breakfast drink (15 ml) was served in a transparent cup (refrigerated at 4 °C until the moment of serving) together with a teaspoon. Participants were instructed to first stir the breakfast drink, and then to taste a spoonful of the drink. Subsequently, the participant was tasked to score his or her evoked emotions using the emotional profiling method. Following emotion profiling during block 2, participants were instructed to taste the current breakfast drink once more and rate its overall liking on a 100-mm visual analogue scale, anchored "dislike extremely" and "like extremely". The trials were separated by a one-minute break, in which participants had to clean their palate and rinse their mouth with water and unsalted crackers.

Session 2

During session 2, actual food choice was measured. Participants were instructed to come to the RotF and were seated at two large tables joining other participants. They were then presented with seven samples of the breakfast drinks served in transparent cups as described in session 1, which were placed in a randomized order on a tray. Participants were instructed to taste all seven unlabeled breakfast drinks and to point out which one they preferred to have for breakfast (no other breakfast products were served).

Statistical analysis

All analyses were performed in R (www.r-project.org, version 3.0.2, 2013-09-25).
First, the emotion scores of all participant-product combinations (861, i.e. 7 products for 123 participants) were concatenated to form an 861 × 12 matrix **P** and an 861 × 39 matrix **E** for the PrEmo and EsSense Profile data, respectively. Subsequently, the mean score per emotion was removed per participant, eliminating possible offset-biases between participants. In other words, the average emotion response was removed per participant, such that the focus is on within-participant variability across products.

To form a succinct representation of the data, the demeaned matrices **P** and **E** were decomposed into principal components (PCs) by using singular value decomposition. The scores on the first two PCs were used for further analysis. To provide insight in these PCs for both data sets, we will show a biplot of the components and indicate their associated explained variance.

Multinomial logit models (MLMs) were used to predict product choice. MLMs are provided in package mlogit (version 0.2-4). For the current study, we used two PC scores from the emotion data as well as perceived liking ratings. Because PC-scores and liking ratings are expressed in different units, we centered and scaled these data to a standard deviation of 1, such that their beta estimates within the MLMs can be compared. Because we were interested in the predictive value of the independent variables on product choice as well as finding an optimal model, we constructed a total of 7 statistical models (see Table 3.3). These models contained different combinations of the independent variables and were compared in terms of model performance. Performance was assessed using likelihood ratio tests between the model fits. These tests allow evaluating whether addition or replacement of independent variables significantly increases the goodness of fit. Comparisons were executed in a stepwise forward selection procedure: a procedure in which models of increasing complexity are evaluated in each step. When model comparisons are made, we

will report the associated χ^2 statistic. For the optimal model, we will report the corresponding beta estimates. Furthermore, MLMs rely on the independence of irrelevant alternatives (IIA) hypothesis (i.e., the assumption that choice estimation on one alternative is independent from the other alternatives). This hypothesis was tested with the Hausman-McFadden Test (28), which evaluates the degree of change in parameter estimates in the model when one choice alternative is removed from the data, compared to the original model.

Table 3.3 Constucted Multinomial logit models.

Model ID	Dependent Variable	Independent variable(s)
1	Choice	Liking
2		PrEmo PC1
3		EsSense PC1
4		Liking, PrEmo PC1
5		Liking, EsSense PC1
6		Liking, PrEmo PC1, PrEmo PC2
7		Liking, EsSense PC1, EsSense PC2

This table shows all MLMs that were constructed along with their identifier (model ID).

The quality of fit for the MLMs was assessed in 2 ways. First, we indicated the effect size by reporting McFadden's adjusted r^2. Note that McFadden indicated that r^2 values between 0.2 to 0.4 represent an excellent fit (29). Furthermore, we regarded the MLM as a machine-learning algorithm and evaluated its predictive value by leave-one-out cross-validation (LOOCV). LOOCV allows for an unbiased prediction estimate, because the choice of every single individual is predicted independently from all other individuals. Figure 3.1 shows a schematic overview of the LOOCV process. For every cycle in the LOOCV procedure, data from a single subject was isolated first; the so-called left one out (LOO) subject. Subsequently the emotion data of n-1 subjects was decomposed into PCs via a principal component analysis (PCA), independently from the data of the LOO subject. The resulting rotation matrix of this PCA was used to perform the same PCA rotation on the emotion data of the LOO subject. Next, the MLM was estimated using the PC1 scores and liking as independent variables, and choice as dependent variable. Finally, the estimated parameters of the MLM were used to generate a choice prediction for the LOO subject. Per individual, this prediction provided a choice probability for each of the 7 products. To indicate the predictive value of the optimal model, we converted these choice probabilities to a rank-order per participant, running from 1 (product with highest chance of being chosen) to 7 (product with lowest chance being chosen). To graphically show the result,

we will plot the frequency of final product choices per predicted rank and indicate performance on chance level for comparison. Within this graph perfect prediction performance would reflect in all final product choices predicted as rank 1, while the worst performance would reflect all final product choices predicted as rank 7.

Because PCs are recalculated for n-1 participants within each LOOCV-cycle, the emotion loadings on the PCs are prone to (small) deviations. To provide information on this, the emotion loadings on PC1and PC2, along with their deviation are provided in Table S1* of the supplementary materials. Furthermore, we carried out additional analyses to indicate whether the remaining principal components contained any additional predictive strength (see Supporting Information S1*.).

Data availability

The emotion-measurement datasets are given in Table S2* and Table S3*.
*The supporting information is not included in this thesis, but is available online via the PLoS ONE publication.

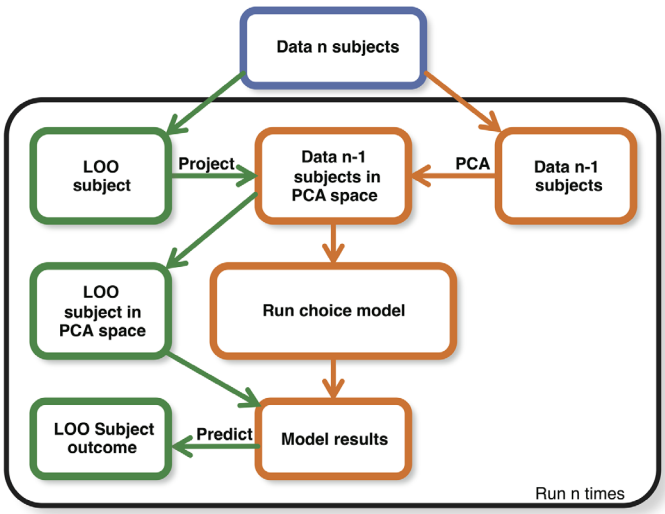

Figure 3.1 Schematic overview of the Leave One Out Cross Validation (LOOCV). This schematic overview shows how the LOOCV was implemented for unbiased prediction of individualized product choices. The complete data set is indicated in blue. Data operations with the independent individual are given in green, while data operations with the data from all remaining individuals are given in orange. The data operations within the plane that is bordered in black were repeated for every individual.

Results

Table 3.4 shows the relative popularity of all product alternatives in the experiment. Product F and product G clearly stood out from the rest, as these were chosen most often. As expected this effect was also reflected in the perceived liking associated with these products.

Figure 3.2 provides two biplots of the emotion data in which the first principal component (PC1) is plotted against the second principal component (PC2) for EsSense Profile and PrEmo data, respectively. Within these plots, every data point represents the emotions for a single product scored by a single participant. PC1 reflected emotions ranging from unpleasant to pleasant and explained 41% and 65% of the total variance for EsSense Profile and PrEmo data, respectively. PC2 reflected emotions ranging from tranquil to energetic and explained 9.2% and 7.6% of the total variance for EsSense Profile and PrEmo respectively.

Figure 3.3 shows a matrix indicating the Pearson correlation values between all used independent variables. As expected, Liking, Premo PC1 and EsSense Profile PC1 show high correlations ($0.53 \geq r \leq 0.71$). Furthermore, PC2 of both emotion measurement methods show a weak correlation ($r = 0.18$).

To test the hypothesis that 1) measuring emotions has additive predictive value over merely perceived liking for choice and 2) whether a more intuitive method better predicts choice than a verbal method, we estimated the MLM models presented in Table 3.3 and compared their goodness of fit. First, we compared Model 1 to 2 and 1 to 3. These model comparisons showed that models that contain either PrEmo PC1 or EsSense PC1, significantly better predict product choice than a model containing only liking (Premo: $\chi^2 = 12.47$, $p<0.001$, EsSense: $\chi^2 = 1.77$, $p<0.001$). However, comparisons between Model 2 and Model 4 as well as Model 3 and Model 5 indicated that the combination between PC1 and perceived liking was favorable over only PC1 (Premo: $\chi^2 = 10.07$, $p<0.005$, EsSense: $\chi^2 = 4.94$, $p<0.05$). When comparing Model 4 to Model 5, the model containing PrEmo PC1 significantly improved the model fit over EsSense Profile PC1 ($\chi^2 = 15.82$, $p<0.001$). Further model comparisons with Model 6 and Model 7, indicated that adding PC2 as extra independent variable, did not significantly improve the model fits (Premo: $\chi^2 = 3.6$, $p=0.06$, EsSense: $\chi^2 = 0.60$, $p=0.44$).

For Model 4, the best fitting model (McFadden adj. $r^2 = 0.202$), PrEmo PC1 ($\beta = 0.78$, $p < 0.001$) and perceived liking ($\beta = 0.55$, $p < 0.005$) were both positively associated with product-choice. Testing the IIA hypothesis (i.e. the assumption of independence between choice alternatives) showed that IIA could not be rejected ($\chi^2(7) = 9.57$, $p=0.21$).
To indicate the predictive value of several models, we performed LOOCVs on Model 1 to Model

5. Figure 3.4 shows the outcome of the LOOCV predictions. The figure shows the percentage of empirical product choices as a function of predicted rank. As can be seen, the models perform far above chance level (dashed line). The best fitting model (Model 4, containing Liking and Premo PC1 as independent variables) correctly predicted 54.5% of all empirical choices as rank 1 and 25.2% as rank 2.

Table 3.4 Product choice and liking details.

Product	**A**	**B**	**C**	**D**	**E**	**F**	**G**
Choice (%)	5.7	3.3	2.4	3.3	10.6	41.5	32.5
Liking	56.5 ±	42.6 ±	43.1 ±	47.0 ±	55.3 ±	64.2 ±	61.9 ±
(1-100)	21.8	25.3	26.4	22.5	21.0	23.4	24.8

The table shows the percent choice of each product and their associated percieved liking (mean ± sd).

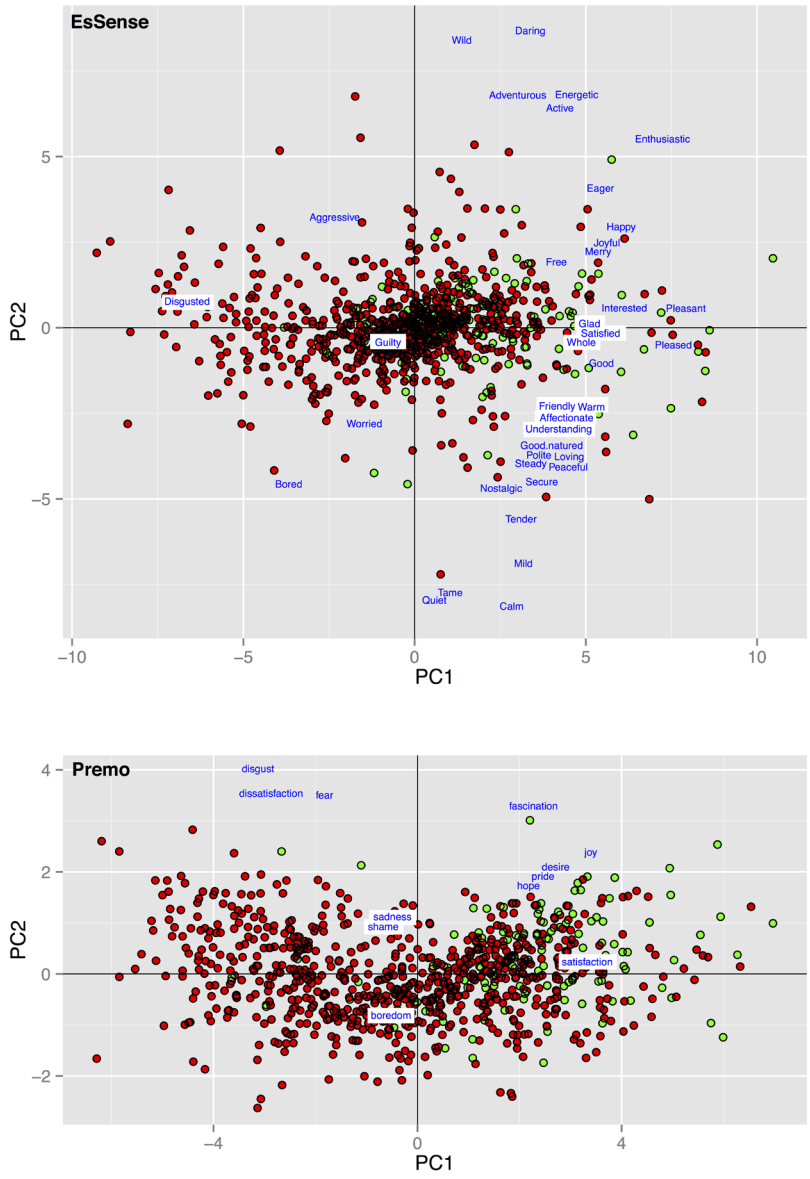

Figure 3.2 PCA biplots of EsSense and PrEmo emotion data. The figure shows a biplot a PCA performed on the EsSense and PrEmo emotions. Every data point represents all rated emotions per method that were rated by a participant on a single product. The data points are colored based on empirical choice; chosen products are colored green and not chosen products are colored red. In blue we plotted the loadings of all emotion variables.

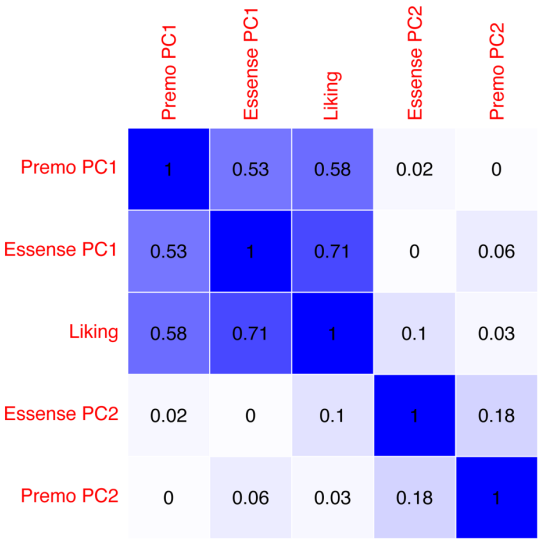

Figure 3.3 Correlations between the independent variables. The figure shows the Pearson correlations between the independent variables that were used in the analysis. The figure indicates high correlations between liking and the valence components from the emotion measurement methods. Furthermore, there is a weak correlation between the arousal components of the emotion measurement methods.

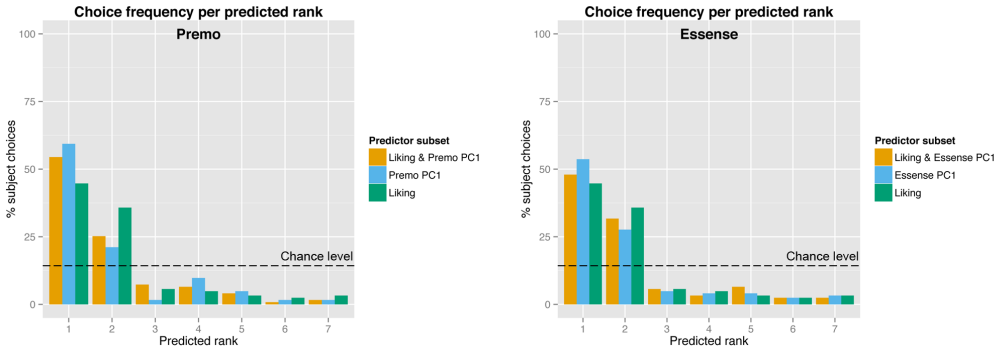

Figure 3.4 Result of the LOOCV predictions. This figure shows the prediction outcomes of the LOOCV using different subsets of the predictors Liking, Premo PC1 and Essense PC1. For the prediction, the multinomial logit model was used to create a distribution of p-values that represented the chances for every product to be chosen by each individual. These p-values were transformed in ranks; the product with the highest predicted chance of being chosen received rank 1 and the product with the lowest predicted chance of being chosen received rank 7. In the figure we show the percentage of final product choices per predicted rank (e.g. product choice for 54% of the participants, was (correctly) predicted as rank 1 by the model when using Liking & Premo PC1 as predictors). The dashed line indicates how the model would perform on chance level (14.3%). Note that an improvement in prediction performance would reflect a distribution change from right to left in the plot.

Discussion

The aim of this study was to investigate the added predictive value of food-evoked emotions for food-choice in a simulated eating environment. For this purpose, we used a data set in which food-evoked emotions, perceived liking, and 1-week delayed food choice of 7 breakfast drinks were measured. We showed, for the first time, that measuring food-evoked emotions, in addition to merely perceived liking, improves the estimation of individualized food choice. Cross-validation of the results showed that we were able to successfully predict product choice, for over 50% of the individuals. The number of correct predictions rose to nearly 80% when looking at the top 2 product candidates.

Liking, valence & arousal as predictors for choice

Although previous studies showed that product liking is associated with product choice, measuring merely product liking is an insufficient predictor for product choice. Therefore increasing interest has been given to food-evoked emotions. In previous research it was argued that emotions drive choice behavior, and measuring these emotions allows for differentiation between products (7,13,22,30,31). In line with this research we showed that product liking is indeed a significant predictor for 1-week-delayed product choice. However, a model containing merely product liking only moderately fitted the choice behavior (see Figure 3.4). To indicate the additive predictive value of evoked emotion measurement we decomposed the emotion data into PCs. As expected, the first two PCs of the emotion scores could be interpreted as product valence and product arousal. Model comparisons showed that product valence was a strong predictor for food choice. Also, adding product valence as an extra predictor in addition to product liking, significantly improved the model fit for choice estimation indicating that both valence and liking contain mutually exclusive information, despite their high correlation (see Figure 3.3).

To our surprise, we found no significant relation between arousal and choice on a group level, indicating that valence scores extracted from emotion data provide sufficient information. These results are also illustrated in figure 3.2. The figure shows that chosen products received more positive valence scores. However, chosen products are almost equally distributed over the entire arousal axis. We conclude from this finding that there is large agreement between participants in associating perceived valence and product choice, whereas the associating between perceived arousal and choice appear to be subject to large interindividual differences. This result does not necessarily mean that arousal and choice are unrelated. Not finding a relation on a group level may be explained by previous work on optimal arousal theory. The optimal arousal theory assumes that

the stimulus' arousal level is evaluated with respect to the optimal arousal level of the individual at the moment of consumption (32). In other words: the ideally induced arousal level of e.g. a breakfast drink within a consumer depends on the optimal arousal level of that consumer during breakfast. If the optimum arousal level differs highly between individuals, perceived arousal scores may not or weakly associate with product choice in a group analysis. Here, we did not have information on the optimal arousal level of participants. To improve choice estimation, we, therefore, recommend measuring appropriate personal characteristics in future research.

Our analysis was centered on the first two principal components within both datasets. These components have a clear interpretation. Additional analysis presented in Supporting Information S1* shows that several smaller principal components in the EsSense Profile data set contained additional predictive strength. However, we found these components hard to interpret. Further analysis on these components showed that they are far less stable than PC1 (see Table S1* and Supporting Information S1*).

Verbal versus Non-verbal measurement of emotions

Within our study we used EsSense Profile as well as PrEmo to measure food evoked-emotions. Whereas EsSense Profile is a verbal emotion measurement instrument, PrEmo presents emotions non-verbally as animated cartoon characters. Although both methods perform well on discriminating products, it remained unclear how both methods performed as predictor for product choice.

PCAs showed that the first two PCs in EsSense Profile data capture far less variance than in PrEmo. This difference indicates that a larger proportion of the variance within the PrEmo dataset captures valence information compared to EsSense Profile. This could be explained by the dichotomous distribution of emotions in PrEmo; the instrument measures 6 positive and 6 negative emotions, while EsSense Profile is very imbalanced with 25 positive, 3 negative and 11 uncategorized emotions (13). Model comparisons showed that product valence measured by PrEmo (PrEmo PC1), as well as product valence measured by EsSense Profile data (EsSense PC1) improve choice estimation. However, a direct comparison between PrEmo and EsSense Profile showed that data measured by PrEmo better predicts product choice.

A possible reason for this result is that emotional content in non-verbally expressed emotions is processed more intuitively and, therefore, more closely resembles intuitively experienced emotions. Evidence for this hypothesis stems from EEG-experiments showing that emotion processing is faster for facial expressions than for emotional words (33–35).

Furthermore, the average liking scores for each product fluctuated around neutral (50% of the scale), while the standard deviations ranged between 20 and 25% of the liking scale. This result indicates that there is a considerable amount of dislikers for each product. This may sound counterintuitive as the sample included only consumers of breakfast drinks. However, being familiar with and a user of the product category, does not imply that each product is equally well liked. Because the range of emotions in PrEmo is more dichotomously distributed, the instrument may allow product dislikers to express their disliking more accurately, while EsSense Profile is "*aimed at product users who typically like the product*" (13) and may, therefore, capture disliking less accurately.

A further limitation in the comparison between both methods is that all participants first completed PrEmo followed by EsSense Profile within the experiment. The fixed order of tests was based on the intuitive nature of PrEmo. According to Desmet et al. (2000) "*asking participants to describe their emotional response will require cognitive involvement, which may influence the measurement*". Therefore, running EsSense Profile ratings prior to PrEmo, would induce priming of the emotional lexicon within the participants. However, we cannot exclude the possibility of experiment fatigue experienced by the participants, leading to less reliable scores on the EsSense Profile method.

Future work

Here, we focused on evoked-emotions based on blind product evaluation (i.e. products were presented without brand or package information). In contrast, consumers are provided with much more information when making decisions about product choice and product consumption in a real world setting. Therefore, we need to investigate how packaging affect food-evoked emotions and whether potential differences in evoked emotions alter the relation between evoked emotions and product choice. Furthermore, more information is needed on personal characteristics such as attitudes to food as well as optimal evoked arousal levels to improved food choice estimation.

Conclusion

In the current study, we showed that we were able to indicate the relation between evoked emotions and food choice using a combination of existing methods. MLMs showed that evoked emotions better predict food choice than perceived liking alone. However, the combination of emotion- and liking measures had the strongest predictive value for product choice. With cross-validation we showed that we were able to predict individualized choice with high accuracy. Furthermore we showed that measurement of non-verbal food-evoked emotions more accurately predict product choice than verbal food-evoked emotions.

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Chapter 4

What reported food-evoked emotions may add: A model to predict consumer food choice

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Abstract

Food-evoked emotions provide information that goes beyond the information from traditional hedonic ratings. The objectives of our study were: (i) to investigate how intrinsic (sensory) and extrinsic (packaging) cues affect consumers' emotional responses to foods, and (ii) to explore whether emotional responses to these cues combined with liking, predict actual food choice. Participants (n= 103) rated emotional responses to seven products under a blind taste, a package and a package and taste condition using the EsSense Profile™. During the blind taste condition participants also scored liking of the products. Test products were breakfast drinks and desserts. Food choice was measured in two breakfast sessions. In a blind taste session, participants chose one out of the seven foods to consume for breakfast. In a package session, participants based their choice on the package of the seven foods without tasting them. Results showed that emotions evoked by food products could be organized in a two dimensional space, representing a valence (pleasantness) and an activation/arousal dimension. Specific emotional profiles generated for products differed across the blind taste, package and the package and taste condition, meaning that intrinsic and extrinsic product properties elicit in part different emotions. Liking and valence together had the strongest predictive value for product choice based on the product's taste. The combination of liking, valence and arousal had the strongest predictive value for package-based choice. In conclusion, food-evoked emotions add predictive value to solely liking ratings, and may guide consumers' product choice behaviour.

Introduction

Measuring food-evoked emotions is currently a topical issue in sensory science. This was boosted by some recent studies indicating that emotional profiles of food products discriminate products more effectively than hedonic measurements (liking scores) alone (1-5). In recent years, several tools have been developed to measure food-evoked emotions ranging from self-report instruments, observational methods (e.g. facial expressions) to measurements of more implicit and/or physiological affective measures such as autonomous nervous system parameters (e.g. galvanic skin conductance, heart rate) and affective brain function (functional MRI) (11-13). To our best knowledge, the majority of these instruments are, however, verbal self-report instruments; participants are instructed to rate emotions that are presented as single terms or as questions. In some studies emotions are conceptualized as general emotions, like positive and negative affect, whereas others use a comprehensive set of specific emotions (7, 14, 15). This results in a continuing debate about the (hierarchical) structure and content of emotions; broad general factors vs. a distinct set of specific emotions. For the present study we adopted a circumplex model of affect, a hierarchical structure approach, assuming that a specific set of emotions can be decomposed in at least two qualities: valence and arousal, that can be mapped in an affective space comprised of two orthogonal axes, ranging from unpleasant to pleasant and from calm to excitement/arousal (16, 17). This dimensional approach offers a way to structure extended lists of specific emotion terms (as used in several of the available questionnaires for measuring food-evoked emotions, for example the EsSense Profile™ Method (7)) into a more superordinate level to facilitate comparison with findings from other studies using different instruments to measure food-evoked emotions (see also Laros and Steenkamp (18).

When measuring food-evoked emotions, it matters whether the focus is on sensory product properties (e.g. taste, texture) or on extrinsic properties (e.g. brand, package, product name). Different conditions such as blind product presentation, package or food name only or presenting taste and package together, may evoke different emotions that can vary both in degree and kind (3, 19, 20). For example, it has been proposed that foods that are easily associated with emotional connotations (e.g. 'comfort foods' such as chocolate), extrinsic cues such as food names, package labels or brand information may elicit existing emotional associations (21). These extrinsic cues may result in stronger emotional ratings than the foods' sensory delivery (19). In addition, type of emotional response may differ across blind and package conditions due to a mismatch between the expected performance (based on package), and actual food product performance. This was reported in two recent studies where different emotional profiles were found across blind, package and informed (package and taste) conditions for different commercial blackcurrant squashes (3, 20). Hedonic evaluation (liking) and choice behaviour are known to be differentially influenced by

sensory (e.g. taste, smell, texture) and extrinsic product properties such as package elements or labels (22). In various laboratory (23, 24) and real life studies (25), liking ratings have been shown to relate to food choice and food intake. In a recent study (26) we demonstrated that food-evoked emotions better predict food choice than liking scores alone. However, combining emotion scores with liking ratings resulted in the best prediction of choice for tasted products without packaging information. Hoppert, et al. (27) investigated the effect of packaging information on food choice in a laboratory setting and showed that packaging information (e.g. fat content label) influenced preference and choice in a different way than sensory information. This study monitored multiple repeated choices from a fixed set of products (yoghurts), but without consumption of the chosen products afterwards. Yoghurt products were better liked with an increasing level of the actual fat content, but liking diminished when a high fat content was presented on the product label. The authors conclude that ignoring these conflicting relationships between sensory and extrinsic properties, may lead to an over- or underestimation of the importance of one class of attributes for food choice (27). This study, however, was performed in an experimental setting and it remains to be seen whether the effects will generalize to acceptance ratings and choice behaviour in more natural situations (8, 28).

For the present study we integrated the findings presented above and present a more comprehensive model (see Figure 4.1) to explore how food-evoked emotional responses contribute to food choice along with liking. In this model, sensory properties such as taste, odour and texture, and properties such as package and label information are antecedent to the emotional responses (decomposed in valence and arousal dimensions) and to liking, though in distinct manners, and in turn affect food choice and consumption.

The objectives of the present study were to: (i) explore how sensory and extrinsic (packaging) cues affect consumers' emotional responses to a set of products from one product category, using commercial breakfast drinks and desserts as the vehicle, and (ii) investigate whether emotional responses (decomposed in valence and arousal dimensions) to the products' taste and packaging contribute to liking in predicting actual food choice and with participants actually consuming the chosen product afterwards.

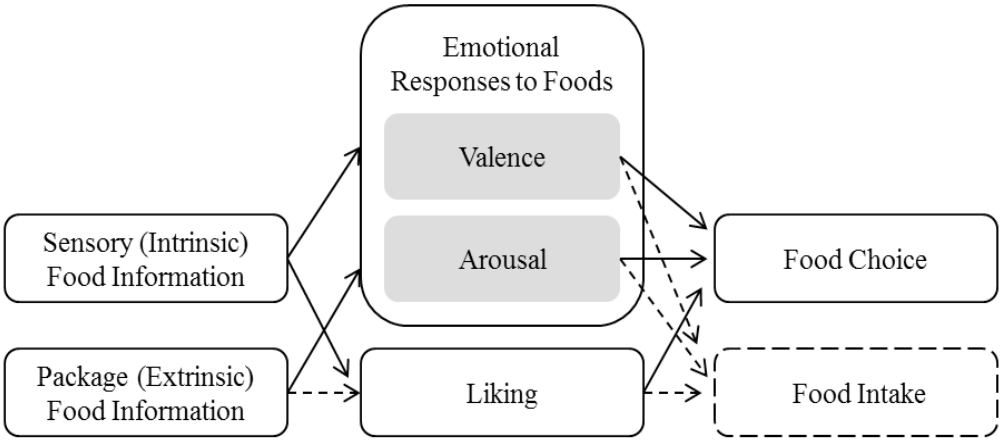

Figure 4.1 Flow chart of the proposed model to illustrate how food-evoked emotional responses and liking contribute to food choice. In this model, sensory and packaging information are antecedent to liking and emotional responses (which can be decomposed into a valence and arousal dimension) to foods, subsequently both influence food choice and intake. Solid lines demonstrate the relationships investigated in this study. Broken lines and broken line box are added to complete the model but were not investigated in the current study.

Methods

Participants

One hundred and three healthy Dutch-speaking adults (M/F: 51/52, age: 25.6±8.5 years, BMI: 22±1.9 kg/m^2) completed this study. Inclusion criteria were age between 18 and 55 years, being a consumer of breakfast drinks (defined as consuming a breakfast drink at least once per year) and normal body weight (BMI between 18.5 and 27 kg/m^2). Exclusion criteria were pregnancy or lactation, loss or gain of 5 kg of body weight or more during last 2 months, being on a diet, allergy or sensitivity to food ingredients such as cow's milk protein, dietary fructose and other relevant allergies. Participants were unaware of the exact aim of the study; they were informed that we investigated differences in product evaluation between users and non-users of breakfast drinks. All participants signed informed consent and received financial compensation for participating. The study was approved by the Medical Ethical Committee of Wageningen University.

Products

The test products were five breakfast drinks and two dessert products (Table 4.1). All of them were commercially available products in supermarkets at the time of the study. Products were stored and refrigerated at 4 °C until the moment of serving. Four breakfast drinks were yoghurt-based (two liquid and two more viscous) and one was fruit-juice based. The desserts were both dairy products (a creamy fruit yoghurt and vla (vanilla custard)), and were included into the current study design to investigate how consumption context appropriateness (whether a food product and its labelling match the consumption context like breakfast or dinner) affects food choice and consumption behaviour. The results regarding this research question are reported in a separate paper (29).

EsSense Profile™ Method

From the available questionnaires to measure food-evoked emotions we choose the EsSense Profile™ (7), because it is a validated questionnaire to measure food emotions that has been subjected to methodological research (7, 10, 19, 30, 31). EsSense Profile™ measures the explicit emotional response to food products by participant ratings on 39 emotional words on a 5-point intensity scale from "not at all" to "extremely" (for additional details see King and Meiselman (2)). The questionnaire was provided to the participants via a computer, using EyeQuestion software (Logic8 BV). In this paper all terms are presented in English; however, a Dutch translation of the scale was used.

Note that, purely for simplification purposes, the expressions "emotions" or "emotion response" will be used to refer to a wide range of affective phenomena/concepts mentioned throughout this paper, being aware that they may not be strictly emotions. The emerging debate about what exactly the responses elicited by emotion questionnaires do reflect (30) is necessary and deserves attention but it is beyond the scope of this work. Nevertheless, we do not assume in this manuscript that the emotion word scorings obtained with the EsSense Profile™ Method, reflect purely experienced emotions or feelings, but could be affective associations or affective product conceptualizations as well. For consistency, however, we chose to adopt the terminology used by the developers of the EsSense Profile™ questionnaire (7), which is "emotions", and to use this terminology throughout the manuscript.

Table 4.1 Description of the seven test products with the product number used throughout the paper.

Product	Picture	Brand	Flavour	Description
1		FrieslandCampina "Good morning" [a]	Strawberry, kiwi, banana	Liquid dairy based breakfast drink
2		FrieslandCampina "Good morning" [a]	Peach, apricot	Liquid dairy based breakfast drink
3		Friesche Vlag "Breaker"	Strawberry, banana	Dairy based semi-liquid (yoghurt-like) breakfast drink
4		Friesche Vlag "Breaker"	Peach	Dairy based semi-liquid (yoghurt-like) breakfast drink
5		Hero "Fruit Breakfast" [b]	Forest fruit	Liquid fruit based breakfast drink
6		Albert Heijn "Creamy yoghurt"	Raspberry, cranberry	Dairy based semi-liquid dessert; appropriate taste – inappropriate package for breakfast
7		FrieslandCampina "Vla"	Vanilla	Dairy based semi-liquid dessert; inappropriate taste – inappropriate package for breakfast

[a] Translated from the Dutch product brand name FrieslandCampina "Goede Morgen"
[b] Translated from the Dutch product brand name Hero "Fruit Ontbijt"

Procedure

The design involved a 3 x 2 within-subjects, repeated measures design, including the factors 'product presentation' (3 levels; blind taste, package, and package and taste) and 'choice' (2 levels; blind choice and package choice condition). The experiment consisted of four testing sessions, which took place in the Restaurant of the Future (RotF) in Wageningen. The RotF is a field laboratory that allows studying food choice and eating behaviour in a sensory lab as well as in settings that approximate real-life eating and drinking situations. There was an interval of one week between two sessions. In the first and third session, which took place in individual sensory testing booths, emotional responses to the tested products were measured across the three product presentation conditions; blind taste in the 1st session, package and package and taste in the 3rd session. In the second and fourth session actual food choice was monitored and these sessions took place in a dedicated room in the RotF that allows decoration and furnishing to mimic a natural out-of-home eating and drinking setting. For this specific study, the room was transformed into a place resembling a breakfast or lunch canteen with a buffet arrangement.

All testing sessions, duration 60-90 min, took place in the morning in two time slots, starting at 8.00 am or 9.30 am. Participants were scheduled at the same time slot for all sessions, and were instructed to refrain from eating for at least two hours prior to each test session.

During the *first session* (blind taste condition), emotional responses to the unbranded (no package information) products were measured. Before the test, participants were given written instructions informing them that they would receive seven samples to taste. Each sample was presented in a 60 ml transparent cup containing 30 ml of each product and a teaspoon. Participants were instructed to stir the sample with a spoon, and then to taste the product and rate the emotions they experienced. They were allowed to re-taste the product while rating the emotions. After the emotional evaluation of each product, the participants were asked to indicate how much they liked the product by means of a 9-point hedonic scale (1= "dislike extremely", 9= "like extremely"). The order by which each participant received each sample was randomized. Participants rinsed their palate with water and ate an unsalted cracker between samples.

In the *second session*, food choice was measured in a simulated cafeteria setting. Participants were asked to taste all seven products (unbranded samples) again and indicated which product they preferred to have for breakfast (blind choice condition). The selected product was presented to the participants in oblique cups containing a standard serving for one person per product. Participants were seated at two large tables joining other participants already seated.

In the *third session,* participants first evaluated the package-evoked emotions (package condition) for all seven test products. The package of each product was presented to the participants individually. Participants were instructed to view the package and rate the emotions evoked by the package only. After evaluation of all products, participants had a short break, before continuing with the package and taste condition. Here, they rated emotions evoked by the tasted food products while inspecting the package. The samples for tasting were provided in the same way as in the first session. Additionally, each sample was provided with the corresponding package. Participants were instructed to taste the product while viewing the package.

In the *fourth session,* actual food choice in a package choice condition was measured in the same simulated cafeteria setting as used in the second session. This time, all the product packages were displayed in a shelf-fridge. Participants were asked to individually come to the shelf-fridge and choose the product they would like to have for breakfast. The order of the products on the shelves was randomized across participants.

Data analysis

Analyses were performed in R (www.r-project.org, version 3.0.2, 2013-09-25), using the packages FactoMineR (32) and mlogit (version 0.2–4). Two sets of analysis were performed. First, the effect of product information (taste, package, taste and package) on food emotions was tested and second the effect of liking and food emotions on choice was tested.

Analysis on the effect of product information on food emotions

A repeated measures ANOVA was performed in SPSS (SPSS 20.0, IBM, New York USA) to test for significant differences in emotion scores (dependent variable) with Condition (3 levels; blind taste, package, package and taste) and Product (7 levels; product 1 - 7) as within-subject factors. The ANOVA was carried out for each of the 39 emotions separately. To correct for multiple comparisons we adjusted the significance level to p=0.001 by dividing an α of 0.05 by the number of comparisons, 39 (Bonferroni correction). Posthoc pairwise comparisons between conditions were performed. To visually compare the configurations of the products in the three conditions (blind taste, package and package and taste) within a two-dimensional emotion space we performed a multiple factor analysis (MFA) (33). For this analysis we generated the mean emotion scores across participants for the blind taste, the package and the package and taste condition. As a measure of correlation between the product configurations, R_V coefficients were calculated across the three conditions.

Analysis on the effect of liking and food emotions on choice

To elucidate the association with choice, product liking and emotion scores were used as predictors in Multinomial Logit Models (MLM). A detailed description of this approach can be found in Dalenberg, et al. (26). In short, two Principal Component Analyses (PCAs) were performed on the emotion scores of all participant-product combinations for the blind taste condition (B) and the package condition (P), separately. The scores on the first two PCs and the liking scores were used for further analysis.

Multinomial logit models (MLMs) were used to predict product choice. Because we were interested in the predictive value of the independent variables (liking, valence and arousal dimensions) on product choice as well as finding an optimal model per condition, we constructed a total of 6 statistical models (see Table 4.2). Model performance was assessed using likelihood ratio tests between the model fits. We will report associated χ^2 statistics for model comparisons and beta estimates for the optimal model per condition. The independence of irrelevant alternatives (IIA) hypothesis was tested with the Hausman-McFadden Test (34). The quality of fit for the MLMs was assessed by indicating the effect size (McFadden's adjusted r^2, where values between 0.2 and 0.4 represent an excellent fit (35)) and by leave-one-out cross-validation (LOOCV). Per individual, LOOCV prediction provided a choice probability for each of the 7 products. To indicate the predictive value of the optimal model, we converted these choice probabilities to a rank order per participant, running from 1 (product with the highest chance of being chosen) to 7 (product with the lowest chance being chosen). To show LOOCV performance, we will plot the frequency of final product choices per predicted rank.

Table 4.2 Constructed Multinomial logit models. **B** = Emotional responses to the blind tasted products and **P** = Emotional responses to the product's package measured with the EsSense Profile™.

Model ID	Dependent Variable	Independent variable(s)
B1	Blind choice	Liking
B2		Liking, Valence-B (PC1)
B3		Liking, Valence-B (PC1), Arousal-B (PC2)
P1	Package choice	Liking
P2		Liking, Valence-P (PC1)
P3		Liking, Valence-P (PC1), Arousal-P (PC2)

This table shows all MLMs that were constructed along with their identifier (model ID).

Results

The effect of product information on food emotions

Exploring the emotions that differentiate between the three conditions for the same product, the repeated measures ANOVA revealed significant main effects of Condition for 14 emotions (calm, quiet, secure, steady, pleasant, good-natured, tender, pleased, peaceful, friendly, eager, understanding, polite and wild), see Table 4.3. Tranquil emotions, such as calm, quiet and peaceful were rated higher in the blind taste condition, whereas the two active emotions, eager and wild, were rated higher in the package or package and taste condition.

The two-dimensional MFA plot (Figure 4.2a) shows the configurations of the products in the emotional space measured for the three conditions (blind taste, package, package and taste), by depicting three partial points, each representing one condition, and its compromise position in the middle. The first two dimensions accounted for 85.42% of the variance, with the first dimension explaining 50.52% of the total variance and the second dimension an additional 34.9% (Figure 4.2a). The MFA plot shows that for most products, with the exception of product 5, the package and taste condition is located in between the other two conditions (blind taste and package). This is confirmed by relatively high R_V coefficients between the blind taste and package and taste conditions, and between the package and package and taste conditions; R_V of 0.75 and 0.79 respectively. The R_V coefficient between the blind taste and the package condition is lower (0.46), reflecting the bigger distance between those partial points and a more dissimilar emotional space. As reflected by the coordinates, the blind taste and package conditions differ from each other along the second dimension for products 6 and 7 and along the first and second dimension for products 1, 2, 3, 4 and 5.

Figure 4.2b shows the emotion terms that describe the emotional space. The first dimension is positively associated with positive emotions, e.g. happy, good, satisfied, warm, affectionate and pleasant, and negatively associated with negative emotions, such as worried, disgusted and aggressive. The second dimension is positively associated with high arousal emotions, e.g. adventurous, wild, interested, energetic and active, and negatively associated with low arousal emotions, such as calm, bored and quiet.

Table 4.3 Mean emotional ratings per product in the three conditions (B= blind taste, P= package and PT= package and taste). Emotions were scored on a 5-point scale. Only the emotions with ratings that differed significantly between conditions are presented. Directions of significant main effects are indicated by arrows placed between the two conditions of comparison. Thus, the downward arrow (↓) in between the columns B and P for *calm* indicates that the emotion in the package condition was lower than in the blind taste condition. An upward (↑) arrow indicates that the emotion score was higher. Comparison between the blind taste and package and taste are shown in the last column B-PT.

Emotion	B		P		PT	B-PT
Product 1						
Calm	2.16^{a}	↓	1.99^{b}		1.92^{b}	↓
Steady	2.21^{a}		2.03^{ab}		1.89^{b}	↓
Quiet	1.99^{a}	↓	1.72^{b}		1.56^{b}	↓
Secure	2.39^{a}		2.18^{ab}		2.06^{b}	
Eager	1.19^{a}		1.53^{ab}		1.67^{b}	↑
Product 2						
Calm	2.24^{a}	↓	2.06^{b}		1.92^{b}	↓
Steady	2.11^{a}		2^{ab}		1.85^{b}	↓
Quiet	1.95^{a}	↓	1.71^{b}		1.65^{b}	↓
Secure	2.31^{a}	↓	2.18a^{b}		2^{b}	↓
Product 3						
Understanding	2.18^{a}	↓	1.76^{b}		1.92^{ab}	
Polite	2.34^{a}	↓	1.76^{b}		1.97^{b}	↓
Calm	2.31^{a}	↓	1.84^{b}		1.91^{b}	↓
Steady	2.23^{a}		1.81^{ab}		1.85^{b}	↓
Quiet	2.02^{a}	↓	1.47^{b}		1.5^{b}	↓
Secure	2.53^{a}		1.96^{ab}		2.07^{b}	↓
Peaceful	2.15^{a}	↓	1.77^{b}		1.85^{ab}	
Wild	0.77^{a}	↑	1.44^{b}		1.15^{b}	↑
Product 4						
Pleasant	2.47^{ab}		2.23^{a}	↑	2.59^{b}	↑
Understanding	2.14^{a}	↓	1.75^{b}	↑	2.06^{a}	
Polite	2.29^{a}	↓	1.87^{b}		2.03^{ab}	
Good-natured	2.38^{a}	↓	2.03^{b}		2.21^{ab}	
Calm	2.22^{a}	↓	1.68^{b}		1.76^{b}	↓
Steady	2.24^{a}		1.96^{ab}		1.88^{b}	↓
Quiet	1.92^{a}	↓	1.52^{b}		1.52^{b}	↓

Tender	1.76[a]	↓	1.34[b]		1.57[ab]	
Secure	2.35[a]		1.94[ab]		2.07[b]	↓
Peaceful	2.24[a]	↓	1.7[b]		1.84[b]	↓
Friendly	2.53[a]	↓	2.02[b]		2.16[b]	↓
Pleased	2.46[a]	↓	2.06[b]		2.2[ab]	
Eager	1.65[ab]		1.63[a]	↑	1.97[b]	↑
Product 5						
Calm	2.14[a]	↓	1.88[b]		1.77[b]	↓
Steady	2.06[a]		1.92[ab]		1.64[b]	↓
Quiet	1.97[a]	↓	1.73[b]		1.61[b]	↓
Secure	2.25[a]		1.96[ab]		1.75[b]	↓
Peaceful	2[a]		1.71[ab]		1.56[b]	↓
Friendly	2.24[a]		2.01[ab]		1.84[b]	↓
Product 6						
Calm	2.38[a]	↓	2.11[b]		2.22[b]	↓
Steady	2.31[a]		1.98[ab]		2.02[b]	↓
Quiet	1.99[a]	↓	1.8[b]		1.76[b]	↓
Secure	2.58[a]		2.25[ab]		2.29[b]	↓
Product 7						
Calm	2.52[a]	↓	2.16[b]		2.21[b]	↓
Steady	2.44[a]		2[ab]		2.03[b]	↓
Quiet	2.19[a]	↓	1.83[b]		1.93[b]	↓
Secure	2.6[a]		2.48[ab]		2.42[b]	↓

[ab]*Values within rows with different lowercase superscripts are significantly different across conditions according to paired comparisons test (at $p < 0.001$).*

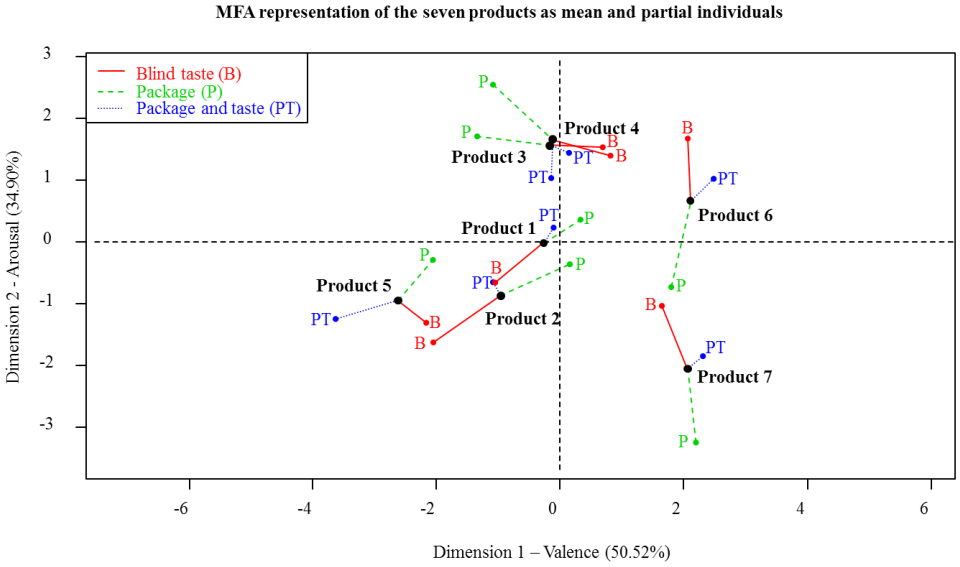

Figure 4.2a EsSense Profile™: Superimposed Representation of the first two dimensions of the MFA space showing the seven products as mean points and their partial individuals representing the emotion configurations of the emotions evoked under the three conditions: blind taste, package and package and taste, (n=103).

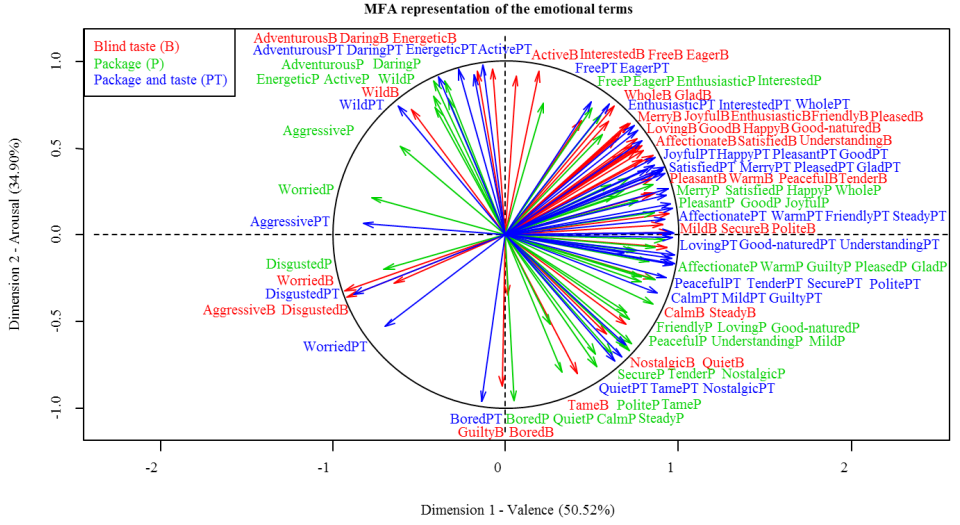

Figure 4.2b Representation of the emotions on the first two dimensions of the MFA.

The effect of liking and food emotions on food choice

Table 4.4 shows the relative popularity of all product alternatives in the experiment. As expected, well-liked products were the most frequently chosen products.

In the present study food-evoked emotions could be organized in two dimensions, i.e. valence (PC1) and arousal (PC2). For choice prediction, liking, valence and arousal were used as independent variables. Figure 4.3 shows a matrix indicating the Pearson correlation values between these variables. As expected, liking correlates highly with valence (PC1) in the blind taste condition ($r = 0.71$) and to a somewhat lesser extent with valence (PC1) in the package condition ($r = 0.43$). Furthermore, liking and arousal (PC2) show weak correlations within both conditions ($r = 0.03$, $r = 0.05$, respectively).

To test whether emotional responses to the products' taste and packaging have additive predictive value over liking for actual food choice, we compared the goodness of fit of the MLM models presented in Table 4.2. For both choice conditions, models that contain both liking and valence, significantly better predict product choice than models containing only liking (blind taste condition: $\chi^2 = 7.46$, $p<0.005$, package condition: $\chi^2 = 12.04$, $p<0.001$). Further model comparisons indicated that adding arousal only significantly improved the model fit in the package condition (blind taste condition: $\chi^2 = 0.17$, $p=0.68$; package condition: $\chi^2 = 14.08$, $p<0.001$).

For the blind taste condition, valence ($\beta = 0.30$, $p < 0.05$) and liking ($\beta = 1.04$, $p < 0.0001$) were both positively associated with product-choice (McFadden adj. $r^2 = 0.23$). For this model, IIA could not be rejected ($\chi^2(7) = -1.41$, $p = 1$). For the package condition, valence ($\beta = 0.22$, $p < 0.001$), arousal ($\beta = 31$, $p < 0.001$) and liking ($\beta = 0.76$, $p < 0.001$) were all positively associated with product-choice (McFadden adj. $r^2 = 0.17$). Also for this model, IIA could not be rejected ($\chi^2(8) = 4.62$, $p = 0.8$).

Figure 4.4 shows the outcome of the LOOCV predictions for the best fitting models separately for each condition (blind taste and package). The figure shows the percentage of empirical product choices as a function of predicted rank. As can be seen, the models perform far above chance level (dashed line). For the blind taste condition the best fitting model (Model B2, containing liking and valence as independent variables) correctly predicted 44.7% of all empirical choices as rank 1 and 29.1% as rank 2. For the package condition the best fitting model (Model P3, containing liking, valence and arousal as independent variables) correctly predicted 40.78% of all empirical choices as rank 1 and 31.1% as rank 2.

Table 4.4 Product choice (percentage of the participants that chose this product) in the blind and package condition and liking scores (mean ± SD).

Product	1	2	3	4	5	6	7
Blind choice (%)	6.8	2.9	24.3	32	1.0	26.2	6.8
Package choice (%)	16.5	6.8	21.4	22.3	6.8	24.3	1.9
Liking	5.6±1.9	5.1±2	6.5±2.1	6.5±2.1	4.9±2.3	7.2±1.5	6.6±1.9

[a] Liking ratings measured on a 9 point scale, 1= "Dislike extremely"; 9= "Like extremely"

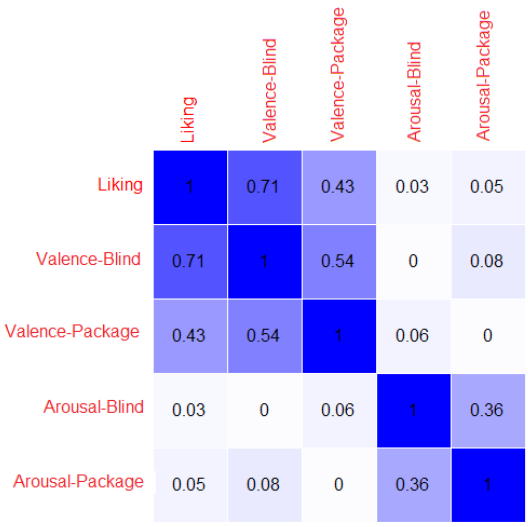

Figure 4.3 Correlations between the independent variables. The figure shows the Pearson correlations between the independent variables that were used in the analysis. The figure indicates high correlations between liking and the valence components and weak correlations between liking and the arousal components.

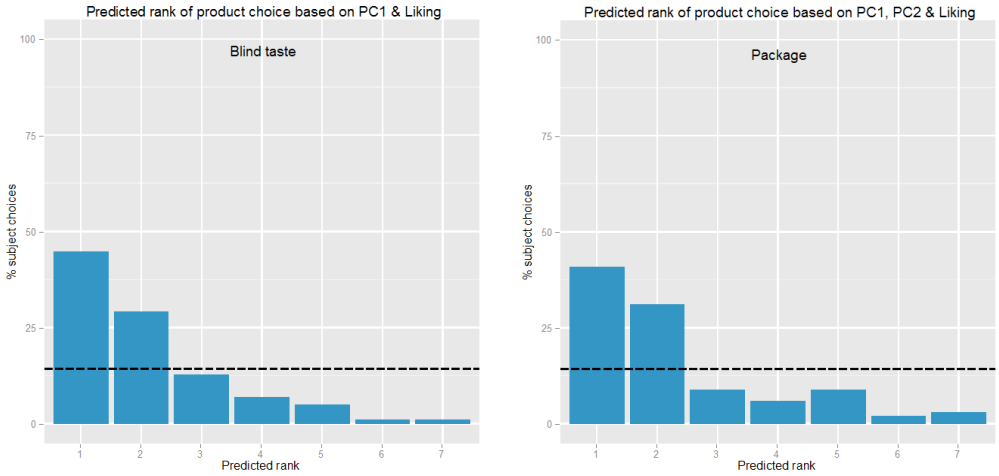

Figure 4.4 Result of the LOOCV predictions. This figure shows the prediction outcomes of the LOOCV using different subsets of the predictors liking, valence (PC1) and arousal (PC2) per condition (blind taste and package). In the figure we show the percentage of product choices per predicted rank (e.g. blind product choice for 44.7% of the participants was (correctly) predicted as rank 1 by the model when using liking & valence (PC1) as predictors). The dashed line indicates how the model would perform on chance level (14.7%).

Discussion

The present study elucidates the relationship between product liking, emotional responses induced by intrinsic and extrinsic product properties and food choice. Our study revealed three main findings. First, the EsSense Profile™ method yielded different emotional profiles for the blind taste, package and package and taste condition. Thus, the same product elicited to some extent different emotions based on either the intrinsic (sensory) or extrinsic (packaging) product properties. Second, actual food choice based on the products' sensory properties was best predicted by emotional responses (valence) and liking combined, rather than by liking scores alone. Third, in the package condition, food choice based on the products' extrinsic properties (package) was best predicted by two emotion dimensions, valence and arousal and liking ratings. These findings indicate that food-evoked emotions discriminate between product evaluations based on different elements (taste – packaging). In addition, information on food product emotional profiles adds predictive value over liking for actual food choice behaviour displayed by consumers. These findings confirm our hypothesis presented in Figure 4.1 and offer food producers new actionable strategies in food product development. To illustrate, the differential emotion profiles elicited by sensory and extrinsic product properties can be used to tailor specific product elements to emotional needs of different consumer segments in early product development stages.

Our results on the discriminative ability of food-elicited emotions replicate the findings by Ng, et al. (3), where food-evoked emotions differentiated successfully between product evaluations based on different elements (taste - packaging). Relatedly, it has been reported that emotional responses to the same food stimuli (image of a chocolate brownie) differed when evaluated under several conceived consumption contexts (e.g. a weekend breakfast or an afternoon snack) (36). Emotional responses to packaging information have been studied less frequently than intrinsic product properties. Nonetheless, packaging elements appear to have an influence on the emotional evaluation of a product (37-39). In line with our findings, packaging design elements were found to drive specific emotions. For instance, an image of a seat on the product's package (coffee) drives a feeling of relaxation (38). Thus, cues external to the sensory product attributes, such as the consumption context or package elements drive different emotional responses.

The emotional profiles in our study could be decomposed in a two dimensional emotional space, i.e. valence vs. arousal/activation, in accordance with the circumplex affect model (16, 17). This is in line with findings from previous studies (10, 17, 40, 41). Emotions elicited by the sensory (taste) cue differed from the emotions elicited by the products' extrinsic (package) cues. For the majority of the products, emotions elicited by tasting the product, with packaging information being available, generated a position in the two-dimensional emotion space in between the emotional profiles elicited by the taste only and by the package only. These differences across intrinsic and extrinsic properties in elicited emotions involved both dimensions, that is, there were differences in loadings on valence and arousal.

With regard to our second main finding we found that liking and emotional valence scores together best predicted choice based on the products' sensory properties (e.g. taste). More specifically, emotions with a positive valence and higher liking scores for a product appear to drive actual choice. This replicates our previous findings that the best prediction of choice was based on the combination of evoked emotions (valence dimension) and liking using a similar set of unbranded products in a different consumer cohort (26). Novel in this study is that we demonstrate that by adding the package element, the second emotional dimension (i.e. arousal) also becomes relevant; in the package condition all three predictors, i.e. liking, valence and arousal contributed to the best predictive value for choice, in that higher liking scores, emotions with a positive valence and emotions with positive arousal (e.g. active, energetic) drive actual choice. Higher liking ratings and positive valence are strongly related to one another, and in part represent the same underlying construct. However, it seems that when consumers are evaluating a food product's package in a common retailers setting, the arousal/activation dimension of evoked emotions starts to play a role in everyday life decision-making, and this aspect of the emotional response to food products is not

or at least incompletely captured by the general construct of 'liking'.

The relationship between emotions and food choice has been recently investigated in a study by Schifferstein, et al. (39). They reported differential emotional food experiences during different stages of product usage, including choosing a product on a supermarket shelf (buying), opening a package, cooking and eating the food. The authors propose that different sensory modalities (e.g. vision, smell, taste) may dominate during different stages and this may shape the emotional responses elicited. At the purchase stage, vision is the dominant modality, and the affective response seems to rely mainly on pre-existing attitudes and stereotypes. In the other stages (cooking, eating) participants' emotional responses stronger reflected the sensation of the intrinsic sensory properties (smell, taste, texture) of the food (39). This is not unlike our present findings, where differences in elicited emotions were found between conditions where only one sensory modality dominated product perception (i.e. taste *or* vision - viewing the package without tasting).

Previous research on non-food products and customer services showed the impact of pleasure and arousal on satisfaction (42-46). Satisfaction, an evaluative response to the perceived outcome of a consumption experience, is a key mediator of post purchase behaviour (44, 46, 47). This implies that in relation to food choice and consumption, satisfaction plays a central role when it comes to repeated choice and purchase behaviour. As such, satisfaction can be used as a likelihood estimate of food choice. Mano and Oliver (44) investigated the relationship between product-elicited emotions and product satisfaction and measured both aspects towards a purchased product. Satisfaction was positioned in the centre of an emotional cluster defined by positive affect and high arousal. In a later study, Ladhari (48) measured satisfaction, pleasure and arousal using non-food test products (movies). Pleasure as well as arousal had a significant impact on consumers' post-purchase satisfaction. Interestingly, in our study pleasure (positive valence) as well as arousal had a significant impact on consumer's actual food choice. Taken together, the research on product satisfaction and the present findings suggest that both pleasantness and arousal dimensions of food-evoked emotions are relevant for food choice.

To our knowledge, this is the first study combining emotional profiling of foods in different conditions (blind taste, package and package and taste) with actual food choice behaviour in a close to real life choice context, i.e. choosing a product from a shelf in a simulated cafeteria environment. This has additional value to knowledge about the relationship between emotional profiles in response to foods and more proxy measures of actual food choice such as intention to purchase or product satisfaction. Furthermore, the present findings could be applied in product development and product design and might aid manufacturers to manipulate the product's

intrinsic and extrinsic attributes to enhance the emotional food product experience across the different stages of product-user interaction.

A limitation in the current study is that liking ratings were assessed in the blind taste condition only. Thus, we cannot conclude that expected or informed liking (based on the package) will also be solely associated with the pleasantness dimension of emotions. It is recommended for future studies to assess liking also in a package condition to explore the relationship with choice when package information is available. In addition, participants had to evaluate a substantial number of products per session (i.e. seven). This number exceeds the number of samples in one session recommended, which is 2-3 (31). However, inclusion of actual food choice as a measure required offering a reasonable set of products to choose from. We took precautions to prevent systematic effects of presentation order and respondent fatigue by rotating the order of product presentation across subjects, and by having participants cleanse the palate and take a short break in between trials. A check (data not reported) for systematic effects of order and/or respondent fatigue, as reflected by particular patterns in the emotional responses for serving order, did not reveal any evidence for order and/ or respondent fatigue effects in the current data set. However, we cannot control out the effect of memory, where exposure to one stimulus is going to affect the response to subsequent stimuli. Ideally, a between-subjects design is required with only one sample per subject, but the number of test sessions required by such a design is hardly feasible in practice.

In conclusion, specific emotional profiles generated for products differed across the blind taste, the package and the package and taste condition, meaning that intrinsic and extrinsic product properties elicit in part different emotions. Distinct sets of emotions evoked by food products can be organized in a two dimensional space, representing a pleasantness (valence) and an activation/ arousal dimension. Liking and valence together had the strongest predictive value for product choice in a blind tasting condition. The combination of liking, valence and arousal had the strongest predictive value for choice based on extrinsic cues (packaging). Liking scores were only related to the valence dimension of emotions, not to the arousal dimension. This implies that the assessment of food-evoked emotion profiles has added value beyond hedonic evaluations in explaining and predicting actual food choice behaviour.

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Chapter 5

The contribution of conceptual profiles and liking to food choice

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Submitted for publication in revised form

Abstract

Recent studies showed that conceptual profiling provides insights into products market success. It has been claimed that key to the consumers' choice for a product is the alignment between the brand, the package and the unbranded product profile. The aim of the present study was to test this notion. In other words, does congruency between the conceptual profiles of the unbranded tasted product and of the package explain and predict actual food choice better than liking scores alone. Product profiles were assessed with a list of 30 conceptual terms developed for the product category breakfast drinks. The check-all-that-apply (CATA) method was used. Blind liking and expected liking scores (based on package) of the breakfast drinks were gathered. Then, actual food choice was observed in a simulated cafeteria breakfast session, where participants (n=101) chose one out of six products to consume for breakfast. Congruency values were calculated comparing the unbranded product profile versus the package profile. Results showed a positive relationship with actual choice for all measured variables; i.e. product-package-congruency, blind liking and expected liking scores. In particular, highest product-package-congruency values correctly predicted 34% of all individual choices, highest blind liking scores correctly predicted 43% and highest expected liking scores 59%. In conclusion, product-package-congruency appears to be a relevant driver of actual choice behaviour, but did not outperform liking ratings.

Introduction

Food choice is one of the most challenging consumer behaviours to understand and to predict. Sensory researchers as well as product developers struggle to grasp the determinants of food choice as demonstrated by the high percentages of failed products on the market that previously stood the test of consumer panels. Sensory scientists rely on traditional liking ratings to understand preference and food choice behaviour (1-6). This is reasonable because sensory appeal is known as one of the most important motives for food choice (7-9) and higher liked products are more frequently chosen than lower liked product (1). However, there is more to food choice than sensory liking per se. Consumers attach a broad set of emotions and meanings (conceptualisations) to food products, established through experience, usage and/or marketing strategies (advertisement or packaging) (10-12). All food elements (sensory, packaging or brand) communicate a set of emotions and conceptualisations. The fit-to-brand concept, introduced by Thomson, et al. (12), captures these existing associations (emotions and conceptualisations) to explain and predict food choice. More concrete, this concept states that a product is more likely to be chosen by the consumer if its' sensory properties (taste, smell, appearance) communicate the same as the products' packaging (12). These relationships are illustrated in the model (Figure 5.1) and demonstrate the focus of the current study.

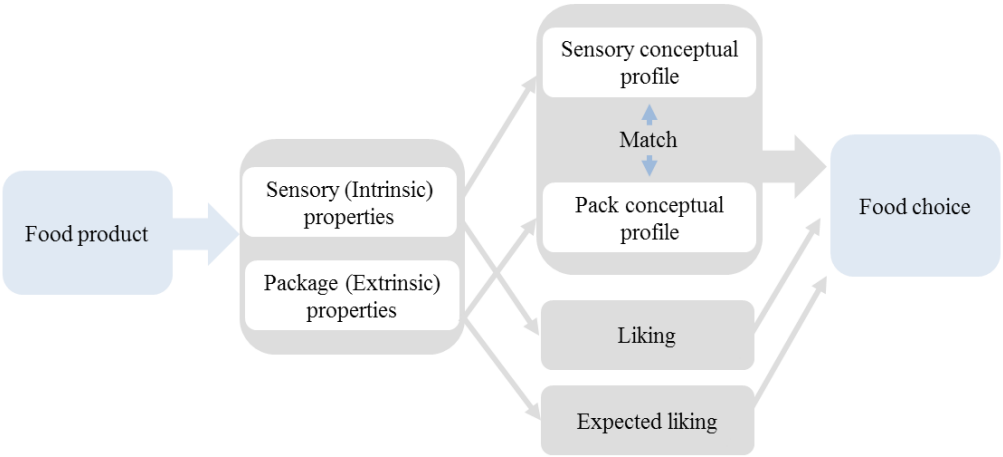

Figure 5.1 Flow chart of the proposed model to illustrate how conceptual responses and liking contribute to food choice. In this model, sensory and packaging information are antecedent to liking and conceptual responses (emotional and functional) to foods, subsequently both influence food choice.

Market success and failure of food products has been the focus of an elegant study recently conducted by Thomson and Crocker (11). In this study the fit-to-brand concept was successfully applied in explaining retrospectively actual market success (based on sales numbers) of two commercially available dark chocolates. Firstly, profiles of the chocolates' taste and the corresponding brands were established by means of conceptual profiling and secondly, the consonance between product and brand profiles was calculated, i.e. low or high correlations. The successful chocolate showed a high product-brand consonance (r= 0.78) whereas the unsuccessful chocolate showed a clear dissonance (r= 0.05) between product and brand profiles. To our best knowledge this is the only published study that shows the successful application of the fit-to-brand concept in explaining market success.

In emotional and conceptual profiling the prediction of food choice is often proposed as the ultimate goal. Nevertheless, previous studies have related emotional and conceptual profiles to choice estimates (purchase intention, satisfaction) (13-15). These are measured under controlled (lab) environments that hardly mimic naturalistic settings like retail or real life product usage situations. Actual sales numbers could serve as the optimal estimate of choice in retail settings. However, these numbers are often classified as confidential by most companies and, therefore, not publicly available. Furthermore, in real life settings it is difficult to standardize for other influential factors that might impact choice, for instance price or product availability (16-18). A good alternative might be a simulated natural environment in which no external factors, as availability or price, influence the observed choice behaviour.

A consumer typically choses one item from a small subset of comparable alternatives within a product category, rather than choosing between two dissimilar products (19). Comparable alternatives are products/brands that consumers expect to perform similarly (19, 20). Hence, a typical choice is made between products that are competitive and evoke similar expectations in functionality. It remains unclear if the fit-to-brand concept (by means of conceptual profiling) proves to be successful in predicting choice from a set of comparable alternatives. Does it outperform traditional liking scores in predicting individual choices? In the present study we test the predictive ability of the fit-to-package concept considering six comparable alternatives. Note that we use the term fit-to-package because we study the product element packaging instead of the brand.

The aim of this study was to investigate whether the congruency between the conceptual profiles of the unbranded tasted product and of the package, explains and predicts actual food choice better than liking. In the current study we applied conceptual profiling to assess emotional and cognitive associations of six unbranded breakfast drinks and, in a separate session, of their corresponding

packages. Actual food choice was measured in a simulated cafeteria breakfast sessions that mimics a real life canteen setting. Participants chose one out of the six products to actually consume for breakfast on the spot.

Methods

Participants

One hundred and one healthy adults (M/F: 50/51) were selected to participate in this study and randomly divided in two groups matched for age and gender (N_1= 52, 24 M/28 F, age 25±7 years, average BMI: 22±2; N_2= 49, 26 M/23 F, age 25±7 years, average BMI: 22±1.5). Inclusion criteria were age between 18 and 55 years, Dutch-speaking, being a consumer of breakfast drinks and having a normal weight or being slightly overweight (BMI between 18.5 and 27 kg/m^2). Exclusion criteria were pregnancy or lactation, loss or gain of 5 kg of body weight or more during last 2 months, being on a diet, allergy or sensitivity to food ingredients such as cow's milk protein, dietary fructose and other relevant allergies. Participants were unaware of the aim of the study; they were informed that we investigated differences in product evaluation between users and non-users of breakfast drinks. All participants signed informed consent and received financial compensation for participating. The Medical Ethical Committee of Wageningen University gave a positive advice for conducting this study.

Products

The participants evaluated six breakfast drinks (Table 5.1). The six breakfast drinks were selected to create a set of comparable alternatives and competitive products, including A-brand (product 1– 5) and retailer brand products (product 6). These products were commercially available in Dutch supermarkets at the time of the study. Products were stored and refrigerated at 4 °C until the moment of serving. Four breakfast drinks were dairy-based and two were fruit-juice based.

Table 5.1 Description of the six test products with the product number used throughout the paper.

Product	Picture	Brand	Flavour	Description
1		FrieslandCampina "Good morning" [a]	Strawberry, kiwi, banana	Liquid dairy based breakfast drink
2		FrieslandCampina "Good morning" [a]	Peach, apricot	Liquid dairy based breakfast drink
3		Hero "Fruit Breakfast" [b]	Orange, banana	Liquid fruit based breakfast drink
4		Hero "Fruit Breakfast" [b]	Forest fruit	Liquid fruit based breakfast drink
5		FrieslandCampina "Vifit"	Strawberry	Liquid dairy based drink
6		Albert Heijn "Morning Boost"	Tangerine, kiwi	Liquid dairy based breakfast drink

[a] Translated from the Dutch product brand name FrieslandCampina "Goede Morgen"
[b] Translated from the Dutch product brand name Hero "Fruit Ontbijt"

Conceptual lexicon

A product category specific lexicon was developed (30 items) in a pilot study to measure conceptual responses to the products' taste and packaging. First, a broad list of ca. 150 terms was gathered from a guided group discussion (breakfast drink consumers, n=6), selected terms in published conceptual lexicons (10, 12, 21), and the EsSense Profile Method™ (22). Second, a free sorting task was used to select 30 terms for the final lexicon. An additional 34 participants (breakfast drink consumers, 8 M/26 F, age 24±8 years, average BMI: 22±2) sorted overlapping terms and selected the most appropriate terms of each self-made group for the product category breakfast drinks. Thus, similar, redundant and inappropriate terms were excluded from the final list. The lexicon was divided in emotional and functional/abstract conceptualisations as proposed by Thomson, et al. (12) and contained the following ten emotional terms: *enthusiastic*, *eager*, *merry*, *quiet*, *energetic*, *energizing*, *free*, *bored*, *glad*, *worried*; and 20 functional/abstract terms: *easy*, *quick*, *filling*, *healthy*, *everyday*, *powerful*, *expensive*, *time-saving*, *handy to take away*, *fresh*, *transparent*, *natural*, *reliable*, *artificial*, *trendy*, *worried of being late*, *spontaneous*, *balance*, *individualistic*, *hurried*. Emotional terms and functional/abstract terms were treated separately within each task because the functional/abstract terms are mentally easier accessible to people and therefore might dominate responses above emotional terms (12). The check-all-that-apply (CATA) method was used to gather conceptual profiles because of its intuitive rather than reasoned nature as recommended in conceptual profiling (21). Respondents only need to decide if they associate a term with the product or not. This low level of cognitive effort for respondents is desired because conceptual associations are accessible through a more intuitive rather than analytical mind set (23). A higher level of cognitive effort and a more analytical way of thinking are expected to occur with rating scales because the respondent is probably answering two questions per item; i) whether there is a product- term association and ii) the association intensity.

Procedure

The experiment consisted of five testing sessions, which took place in the Restaurant of the Future (RotF) in Wageningen. The RotF is a field laboratory that allows studying food choice and eating behaviour in a sensory lab as well as in settings that approximate real-life eating and drinking situations. A crossover design was used to measure conceptual responses and liking of six products in two conditions (blind taste vs. package), see Figure 5.2 for an overview of the study design. Presentation order of the six products was randomized. Conceptual profiling was assessed in four testing sessions in individual sensory booths, thus three products were evaluated in one session. In a fifth session actual food choice was monitored. All testing sessions, lasting about 45-60 min, took

place in the morning in two time slots, at 8.00 am and at 9.30 am. Intervals of one week between sessions were used. Participants were scheduled at the same time slot and at the same weekday for all sessions, and they were instructed to refrain from eating for at least two hours prior to each test session. The questionnaire was provided to the participants via a computer, using EyeQuestion software (Logic8 BV). In this paper all terms are presented in English; however, we used the in Dutch developed conceptual lexicon. All participants started with an introduction to the lexicon during their first session. Participants were asked to read all 30 conceptual terms and indicate any term they felt unsure about its meaning. Unclear terms were explained verbally using synonyms and similar terms. Then, participants evaluated a warm-up sample to get familiar with the conceptual profiling task. Note that half of the participants started with the blind tasted product condition and the other half with the package condition. In the following sections we describe the experimental conditions in the order of the first group.

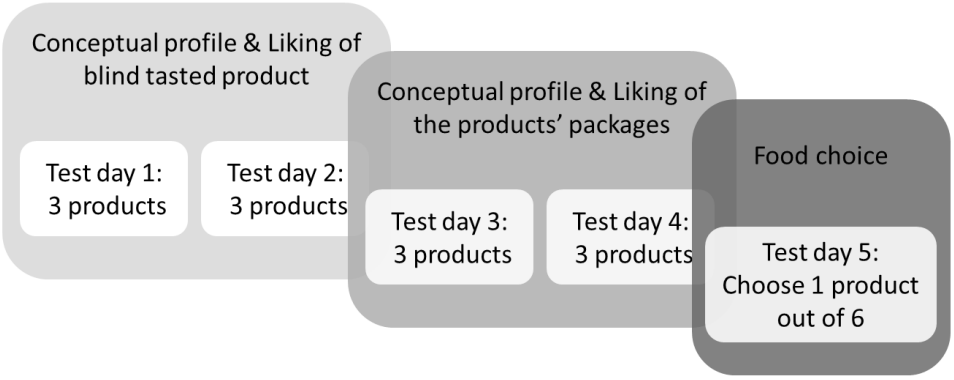

Figure 5.2 Overview of the study design. Half of the participants evaluated first the blind tasted product on test days 1 and 2 and later they evaluated the products' packages on test day 3 and 4. The other half of the participants started with the conceptualisation of the products' packages. All participants finished with choosing one product out of the six previously evaluated products.

Blind tasted product condition

In the first and second test session, conceptual responses to three unbranded (no package information) tasted products were measured. Each product sample was presented in a 150 ml transparent cup containing 100 ml of each product and a teaspoon. Participants were instructed to stir the sample with the teaspoon, and then to taste the product and indicate the conceptualisations they associated with the product by ticking the response 'yes' or 'no'. After every ten terms there was

a break of one minute while participants were allowed to re-taste the product. After the conceptual evaluation of the product samples, participants had a ten minutes break. Participants then were asked to re-taste and evaluate the samples on liking on a 9-point scale. Participants rinsed their palate with water and ate an unsalted cracker between samples.

Package condition

In the third and fourth test session, conceptual responses to three product packages (without tasting the product) were measured. The original package of each product was individually presented to the participants. Participants were instructed to view the package and indicate the conceptual terms associated with package by ticking the response 'yes' or 'no'. After evaluation of the product packages, participants had a ten minutes break. The participants then were asked to evaluate the packages on expected liking of the product on a 9-point scale.

Food choice

In the *fifth session,* food choice of the six products (in their original packages) was measured in a simulated cafeteria setting in a dedicated room in the RotF that allows decoration and furnishing to mimic a natural out-of-home eating and drinking setting. For this specific study, the room was transformed into a place resembling a breakfast or lunch cafeteria. All six test product packages were displayed in a shelf-fridge. Participants were asked to individually come to the shelf-fridge to choose the one they would like to have for breakfast. Participants consumed the breakfast drink sitting together at two large tables. The order of the products in the shelves was randomized across subjects to avoid any effect of structure.

Data analysis

The number of times a term was associated with a product was counted for all participants separately for each condition (blind taste and package), and these frequency numbers are presented in a spider plot. To assess the congruency between the conceptual profiles of the product when tasted in the blind condition vs. the package evaluation we used the global reproducibility index (RI). This index was developed to evaluate within-assessor reproducibility, i.e. whether individuals consistently evaluate a set of products across two sessions. The RI reflects the proportion of the number of descriptors used consistently by an assessor to describe the same product in two sessions and averaged for all the evaluated products (24, 25). This formula was applied to assess the within-subject congruency and will be used as a product-package-

congruency estimate, named hereafter the 'congruency index'. Note the congruency index is not averaged across all products because we were interested in the individual product-package-congruency value. The congruency index was calculated using the following formula:

$$\text{Congruency index} = \frac{\left(\begin{array}{c}\textit{number of terms}\\ \textit{consistently used across}\\ \textit{the two conditions,}\\ \textit{"yes"responses}\end{array}\right) + \left(\begin{array}{c}\textit{number of terms}\\ \textit{consistently not used across}\\ \textit{the two conditions,}\\ \textit{"no"responses}\end{array}\right)}{\textit{total number of terms}}$$

The index ranges from 0 (no congruency) to 1 (perfect congruency). This resulted in a 6×101 matrix with a congruency index for each product per participant. To test if this index can explain and predict choice it was converted into a rank-order per participant, i.e. the product with the highest congruency index received rank 1 and the second highest rank 2 and so on. To graphically show the results, the frequency of the actual product choices per predicted rank was plotted and frequency at chance level was indicated for comparison.

To test if liking (blind taste) and expected liking (package) ratings predict choice, the same rank order procedure was performed on these liking ratings (as on the congruency index). It was checked if the actual choice was the best liked product or the second best and so forth.

To test for relationships between the mean product-package congruency (congruency indices averaged across all participants per product), mean liking and mean expected liking scores (averaged across all participants per product) and choice (the number of participants that chose a particular product) the correlation coefficient Kendall's τ was calculated.

Results

Conceptual profile of the products' taste and its package

Figure 5.3 visualizes the conceptual profiles (frequency counts of the terms identified by participants as relevant for describing a product; i.e. score 1 on the CATA) of the most often chosen product (product 1) and the least often chosen product (product 6). The most popular product was chosen by 32 % of all participants and the least popular product was chosen by only 5%. The remaining

products were chosen by 20% (product 2), 16% (product 3), 15% (product 4), and 13% (product 5) of all participants (see Table 5.2). The spider plot in Figure 5.3 illustrates that many terms of the lexicon, specially developed for this study, were indeed used by participants to describe the products. For instance, the conceptual terms *easy*, *handy to take away*, and *quick* are used by more than 80% of all the participants to describe products and *fresh*, *merry*, *energetic*, and *timesaving* by more than 70%.

Table 5.2 Product choice frequency (%) and congruency, liking and expected liking scores averaged across participants. N= 101

	Choice frequency (%)	Product-package-congruency	Liking	Expected liking
Product1	32	0.74	6.66	7.23
Product2	20	0.73	6.54	6.92
Product3	16	0.67	4.86	6.43
Product4	15	0.69	5.53	6.56
Product5	13	0.66	6.05	6.73
Product6	5	0.66	5.95	5.83

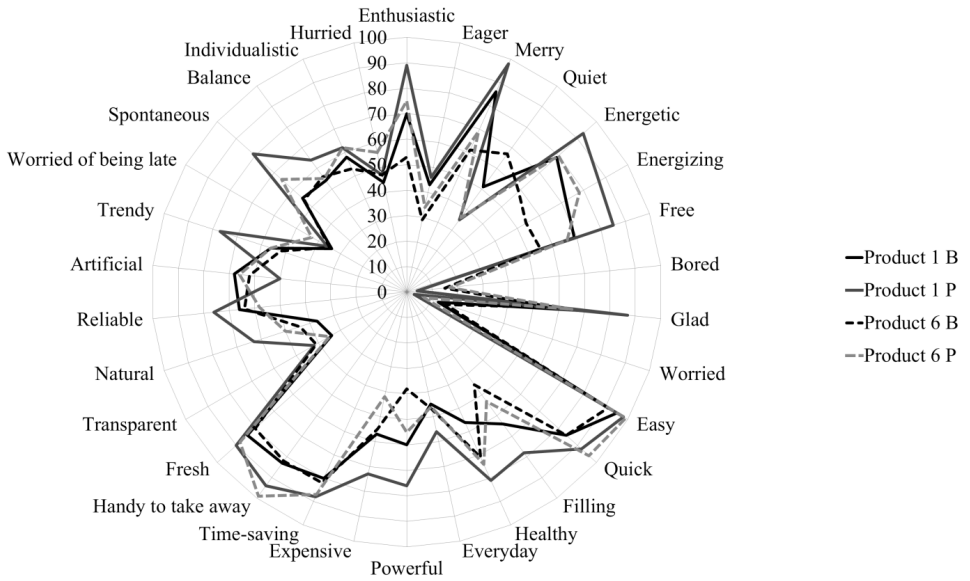

Figure 5.3 The Spider plot shows the conceptual profiles (frequency counts of the terms used by participants to describe the products) of the most often chosen product (product 1) and the least often chosen product (product 6) in the blind taste (B) and in the package (P) condition.

Prediction of actual choice based on product-package-congruency, liking and expected liking

We tested whether the congruency between the conceptual profiles of the products' taste and its package, explained and predicted subsequent food choice better than liking. Figure 5.4 shows the number of times that the actual chosen product was also the product with the highest congruency index. Rank 1 represents the number of times the actual choice of a participant corresponded to the product with the highest congruency index. Rank 2 represents the number of times actual choice corresponds to the second highest congruency index and so forth.

For many participants the highest and second highest congruency index had identical values. In this case, we counted them separately but included these counts in rank 1 as well as rank 2. Figure 5.4 shows that the congruency index correctly predicted one third (34%) of all actual choices (n=101) as rank 1 and approx. half (55%) as rank 2.

Liking in the taste-only condition and expected liking in the package condition correctly predicted 43% and 59% subsequent individual choices, i.e. actual choice corresponded with highest liking scores (rank 1). Note for 70% and 65% of the cases the highest liking scores equals the second highest (rank 2) (see in Figure 5.5 and 5.6). The top 2 candidates for actual liking and expected liking predict 63% and 79% choices correct, respectively (including identical values for rank 2 and rank 3).

The relationship between choice and the congruency index shows the expected gradually decline towards rank 6. Hence, the lowest product-package-congruency and the least liked products are also the least frequently chosen products.

Table 5.2 shows the average scores per product across all participants for the congruency indices, liking and expected liking scores and choice frequencies (percentages with which a particular product was chosen). The correlation between product-package congruency and product choice was significant (Kendall's $\tau = 0.73$, $p<0.05$). Products with higher congruency between conceptual profiles of the tasted product and its package were chosen more often. It can be observed that the averaged congruency values showed limited variation across the six products and relatively high congruency indices were found for all products.

The correlation between blind liking and product choice, and expected liking and product choice lacked significance (Kendall's $\tau = 0.33$, $p=0.35$ and Kendall's $\tau = 0.6$, $p=0.09$, respectively). Note all correlations are based on six observations only and therefore must be interpreted with caution.

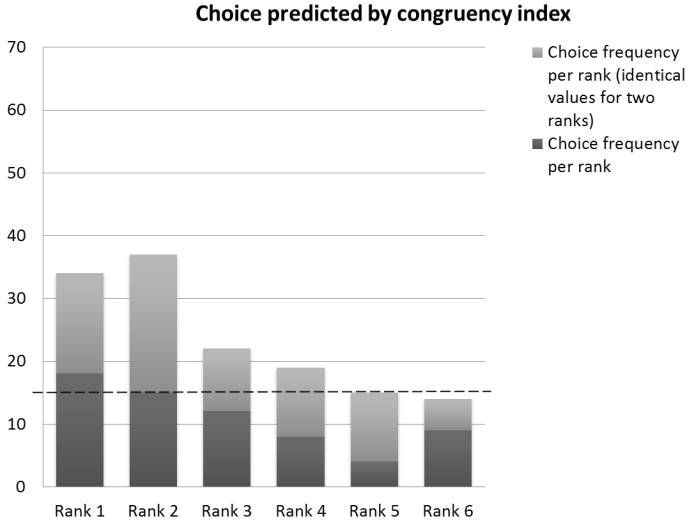

Figure 5.4 The figure shows the frequency of the actual product choices per rank which were based on the product-package-congruency index (e.g. product choice for 34 of the participants was correctly predicted as rank 1). Dark grey fraction: predicted choice frequencies per rank. Light grey fraction: the congruency index had the same value for rank 1 and 2 (or rank 2 and 3 etc.) and predictions were counted for both ranks. The dashed line indicates predicted choices on chance level.

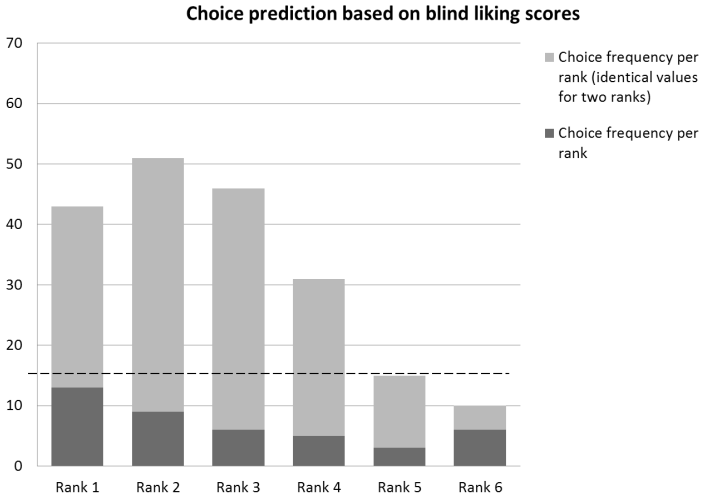

Figure 5.5 The figure shows the frequency of actual product choices per rank which were based on blind liking scores (e.g. product choice for 43 participants was correctly predicted as rank 1 by blind liking scores). Dark grey fraction: predicted choice frequencies per rank. Light grey fraction: liking scores had the same value for rank 1 and 2 (or rank 2 and 3 etc.) and predictions were counted for both ranks. The dashed line indicates predicted choices on chance level.

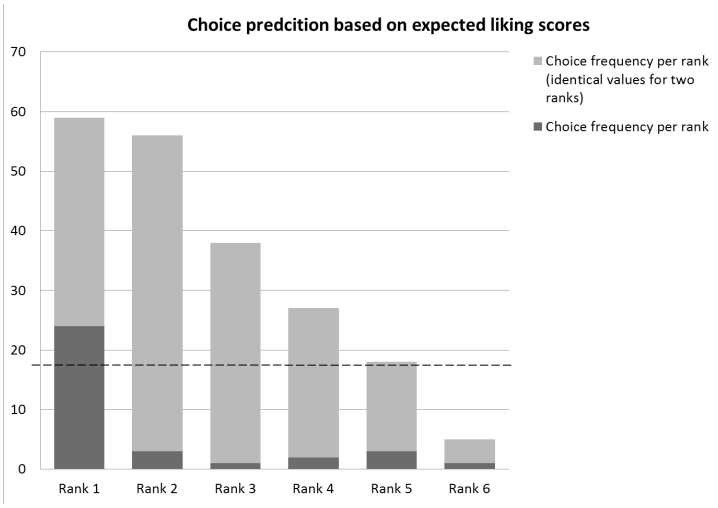

Figure 5.6 The figure shows the frequency of actual product choices per rank which were based on expected liking scores (e.g. product choice for 43 participants was correctly predicted as rank 1 by expected liking scores). Dark grey fraction: predicted choice frequencies per rank. Light grey fraction: liking scores had the same value for rank 1 and 2 (or rank 2 and 3 etc.) and predictions were counted for both ranks. The dashed line indicates predicted choices on chance level.

Discussion

The present study tested the impact of the fit-to-package concept and liking on food choice. Our study revealed two main findings. First, the fit-to-package concept (product-package-congruency in conceptual profiling) helped to explain and predict individual product choice in a simulated cafeteria context. Thus, the more congruent the conceptual profile of the blind tasted product was to the profile based on the corresponding packaging the more frequently it was chosen. Second, liking ratings and especially expected liking ratings (liking based on the product's package) outperformed the product-package-congruency in the predictive ability of individual product choice. In particular, expected liking predicted 25% more individual choices correct than the product-package-congruency. Thus, expected liking is the best predictor of individual choice followed by blind liking scores and product-package-congruency.

We demonstrated that a product was more likely to be chosen if, for instance, consumers associate a products' package with *energizing* or *handy to take away* and these expectations were fulfilled. Similarly, a match between expectations evoked by a product (brand, packaging) and its fulfilment corroborates product and brand satisfaction (26-28). Previously, (dis)confirmation of product related

expectations as well as experienced purchase motive fulfilment were found to be main drivers of purchase decisions (29, 30).

Nevertheless, the product-package-congruency values showed relatively lower predictive power relatively to liking. Where Thomson and Crocker (11) proved the fit-to-brand concept to be effective in explaining market success, i.e. the successful product showed a strong match between the brand and the unbranded product profile whereas the unsuccessful product did not warrant product-brand-fit, the present findings are less convincing. The current study is built on the fit-to-brand concept as proposed by Thomson and Crocker (11), but the studies differ in the measurement technique (Best-Worst-Scaling (BWS) vs. CATA), set of test products (two vs. six products), and outcome measure (sales numbers vs. actual choice numbers). These differences may explain the inconsistent findings. The BWS is known to be more sensitive in product discrimination. The CATA approach in the current study might not be sensitive enough to capture subtle product differences. Also, the fit-to-brand concept was used to explain the success/failure of two products with clearly different market performance (one successful, the other not) based on sales numbers in the study by Thomson and Crocker (11). However, in a typical choice moment consumers select amongst a set of competitive and comparable alternatives of ca. 5 products (19). In the current study, the food choice measure is more challenging for the prediction because the congruency values were all relatively high, meaning that none of the products showed a clear product-package dissonance. Hence, the product-package congruence in this study may have less predictive ability with regard to choice, due to a lack of variation across the series of products.

Our second main finding revealed that liking scores, both actual and expected liking were the best predictors of actual food choice. This finding is in line with previous literature that better liked products are chosen more often (1-6). Furthermore, it has been found that expected liking ratings are found to be strongly correlated with purchase intention and product satisfaction (31, 32) and repurchase (33).

The present study has some strength and limitations. A strength of the current study is the measure of actual choice. In a simulated cafeteria setting participants had to make a choice between several alternatives. Hence, their selection behaviour was observed instead of relying on self-report judgements of purchase intention or willingness to buy a product. Our observational measure is a better indication of real life choice behaviour than a measure of intention because there is a well-known discrepancy between intentions and actual behaviour (34, 35). Furthermore, to measure conceptual associations we used a variant of the check-all-that-apply method which differs from the classical CATA approach where all items are presented at the same time. This approach is often

criticized because participants tend to be biased by the order of items and/or do not evaluate all items equally and/or do not read the whole list of terms. To prevent these response biases in the current study the terms were presented one by one. Participants were asked to check yes if they associated a term with a product or not by absence of an association. This approach reduces the response bias (36, 37).

The outcome measures, conceptual profiles and actual choice were assessed in different contexts, i.e. sensory booth and simulated cafeteria setting. It has been shown that emotional responses or associations to foods are context dependent, e.g. a product evokes different emotions under a dessert or breakfast context (38). Conceptual associations are likely to be context dependent as well and different associations might be apparent at the moment of choice in the simulated cafeteria setting compared to the sensory booth environment. These context effects may decrease the predictive ability of conceptual profiling. For future studies we recommend to investigate the role of context in product evaluation and to assess conceptual profiling under more realistic choice and consumption circumstances.

In conclusion, the present study showed a positive relationship between product-package-congruency, liking scores, and food choice. The more congruent the unbranded product profile was to the package conceptual profile and the more a product was liked or expected to be liked, the more often the product was actually chosen. Liking ratings, however, still outperformed product-package-congruency in its predictive ability regarding actual choice behaviour.

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Chapter 6

Food choice: The battle between package, taste and consumption situation

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Abstract

The present study compared how intrinsic (sensory) and extrinsic (packaging) product properties influence actual food choice in combination with the concept of product appropriateness in a specific consumption context. Food choice of seven test products was measured in three breakfast sessions within a simulated cafeteria setting with subsequent product consumption. Test products were five breakfast drinks and two dessert products considered as inappropriate for breakfast. One hundred and three participants took part in a blind taste session, after which they chose one out of the seven foods to consume for breakfast. In a second session (familiar package session), the same participants based their choice on the package of the seven foods they tasted in the first session. An additional group of 65 participants took part in a third naïve package session, where they chose just on the basis of package without being previously exposed to the foods. Results showed that food choices in the naïve package session were guided by the package that labelled the products as "breakfast product". Food choices in the blind session were strongly correlated ($r = 0.8$) with the liking of the products. Food choice in the "familiar package session" lay between the blind and naïve package session. It is concluded that food choice in a simulated cafeteria setting is guided by extrinsic (package) as well as intrinsic (sensory) properties and both can act as a cue for product appropriateness given a specific consumption context. Depending on the salience of either intrinsic or extrinsic properties during the choice moment their impact on choice is stronger.

Introduction

Food choice is influenced by both intrinsic (sensory properties) and extrinsic (packaging and label) product properties. In various laboratory (1, 2) and real life (3) studies, liking ratings have been shown to relate to food choice and food intake. The effect of packaging information on food choice has recently been assessed in an elegant study by Hoppert, et al. (4), who showed that packaging information (e.g. fat content label) influenced food choice in a laboratory setting. This study used multiple repeated choices from a fixed set of products, but without consuming the product afterwards. It has been argued that in sensory consumer research more emphasis is needed on research that shows real behavioural or physiological effects in more natural situations than the laboratory (5, 6). To the best of our knowledge the effect of packaging has not been studied in a real life choice situation, where participants consume the chosen product afterwards.

In addition to product-related food properties, situational cues as for instance appropriateness (i.e. whether a food product matches the consumption context) seem to be relevant in food choice (7, 8). For example, it has been shown that breakfast items were preferred in the morning compared with dinner items (9). However, this could not be replicated by Kramer, et al. (10) thus the robustness of an effect of consumption context appropriateness in food choice is still unclear. Extrinsic properties of a food such as the package can be used to communicate appropriateness for a certain consumption context, e.g. labelled as 'breakfast drink'. We do not know how appropriateness of the test products will interact with the intrinsic and extrinsic product properties on food choice in a real life choice situation.

The objective of the present study was to assess the effect of sensory properties, package and appropriateness on food choice in a simulated cafeteria setting and with participants consuming the chosen product afterwards. The study thereby adds ecological validity to food choice studies performed within a traditional laboratory space, as the cafeteria setting does better approximate food choice behaviour in a real-world setting. We examined choice from a set of seven products (five commercially available breakfast drinks and two dessert products) in three breakfast sessions: one blind product session and two package sessions. In the blind session participants chose their preferred product based just on tasting the products. In the familiar package session, the same participant group chose one product to consume out of the same set of products; however, this time their choice was based on the package. To explore the sole effect of packaging on choice, a different group of participants took part in a package session without previous consumption of the test products, i.e. the naïve package session.

Methods

Participants

One hundred and sixty-eight healthy Dutch-speaking adults from Wageningen and its environs were included in this study. Inclusion criteria were regular (one to nine times per year) or frequent (>10 times/year) use of breakfast drinks, age between 18 and 55 years and a BMI between 18.5 and 27kg/m^2. From the 168 participants, 103 (M/F: 51/52, age: 25.6±8.5 years, BMI: 22±1.9 kg/m^2) took part in the blind session and in the familiar package session, and 65 participants (M/F: 16/49, age: 26±9.7 years, BMI: 21.7±2 kg/m^2) took part only in the naïve package session. The two groups were similar in mean age and BMI. Sixty-seven per cent of the first participant group were regular users of breakfast drinks and 33% were frequent users. From the second group, participating only in the naïve package session, 57% were regular users and 25% were frequent users.

Test products

The test products were all commercially available products in supermarkets and consisted of five breakfast drinks and two dairy dessert products (see Table 6.1). Four breakfast drinks were yoghurt-based (two liquid and two more viscous) and one was fruit based. Desserts were chosen for their (in)congruency in terms of intrinsic and extrinsic properties compared with the breakfast drinks. More specifically, one of the desserts had an appropriate taste and texture but an inappropriate package for breakfast. This product was creamy cranberry flavoured yoghurt (more indulgent product compared with plain yoghurt), it was labelled as "creamy yoghurt" and in supermarkets it was placed in the shelf with dessert products. The other dessert product (vla) had both an inappropriate package and taste for breakfast. Vla is a vanilla custard which is a typical dessert product for everyday dinner meals in The Netherlands, something that is solidly grounded in cultural food tradition. The desserts differed from the breakfast drinks in e.g. creaminess and sweetness. To verify our assumptions on the appropriateness of the products we measured perceived product appropriateness by a group of volunteers (n = 26, different ones than those who participated in the study) after the study was conducted. The appropriateness of the test products was evaluated for eight different food use situations (for breakfast, when tired, when eating alone, for a snack, have little time to eat, for lunch, for dinner, for dessert). To measure appropriateness we used an adopted version of the appropriateness measurement tool published by Cardello and Schutz (8). The appropriateness of the products for eight different food use situations was evaluated on a 7-point scale anchored on the left side by "not appropriate at all" and on the right side by "very appropriate," the scores were translated from 0 to 6. The package of each test product

was presented as an image. Figure 6.1 shows the appropriateness evaluation of all seven test products for the two consumption situations of interest, i.e. breakfast and dessert. Products 6 and 7 were evaluated as the most appropriate dessert products *($M_{product6}$= 5.9 (0.4), $M_{product7}$=5.8 (0.4))*. In comparison with products 6 and 7, we observed that products 1–5 had an average lower than 2 when their appropriateness as desserts products were evaluated. Similarly, we observed that products 6 and 7 were evaluated as being less appropriate for the consumption situation 'breakfast' *($M_{product6}$= 2.8 (1.5), $M_{product7}$=1.8 (1.6))* as compared with products 1-5. Before participants took part in the blind session, they scored liking of the test product in a test session not described in this report. To assess liking, each sample was presented in a 60 ml transparent cup containing 30 ml of each product and a teaspoon. Participants were instructed to stir the sample with the spoon, then take a spoonful to taste the product and indicate how much they liked the product by means of a 9-point hedonic scale (1= "dislike extremely", 9= "like extremely"). The order by which each participant received each sample was randomized. Participants rinsed their palate with water and consumed an unsalted cracker between each sample.

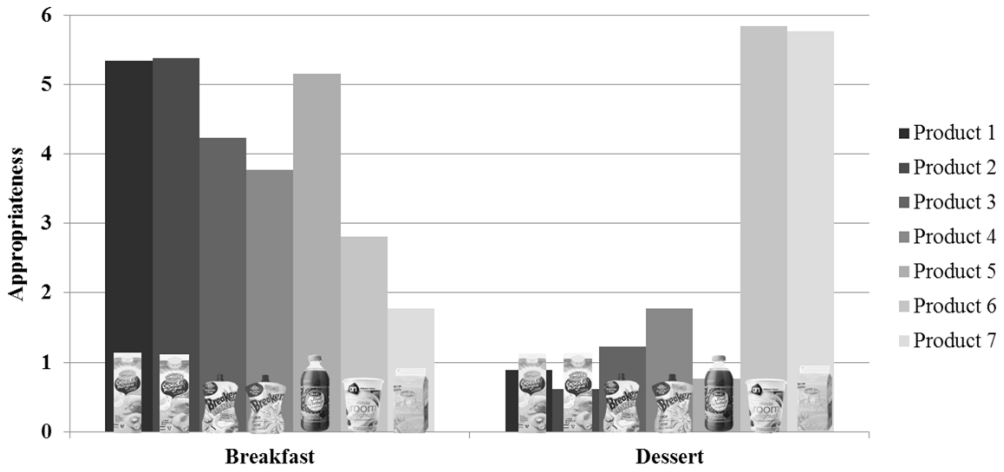

Figure 6.1 Appropriateness ratings of test products for breakfast and dessert, 7-point scale, 0= "not appropriate at all" and 6= "very appropriate", N=26.

Procedure

Actual food choice was measured in three breakfast sessions, one blind session and two package sessions, in the Restaurant of the Future (RotF) in Wageningen. The RotF is a field laboratory that allows studying food choice behaviour in settings that approximate real-world situations. The test was run in a test room converted to a cafeteria at a university campus. The breakfast session differed

from real life in that only the seven test products were available and participants did not have to purchase the chosen products. Participants were not allowed to eat 2 hours before the start of each test session. All testing sessions lasted 45 - 60 min and were conducted between 8:00 and 10:30 a.m. to ensure that the "breakfast context" would be salient. All participants were informed that they could consume the selected product after choosing.

During the first session participants were instructed to taste all seven test products and to select one to consume for breakfast. The test products were presented without any packaging information (blind session). Subsequently, the selected product was provided for consumption to the participants in oblique cups containing a standard serving for one person.

In the second session, after an interval of 1 week, actual food choice was measured based on packaging (familiar package session). In this session participants viewed just the packaging. Packaging contained labels, brand and product information and likely evoked existing associations during previous experience with the products. Participants were asked to individually come to a shelf-fridge with all the test products and choose the one they would like to have for breakfast. The order of the products in the shelves was randomized across participants to avoid any effect of structure.

In the third session (the naïve package session), an additional group of participants took part in a package session with the same procedure as in the familiar package session. In contrast to the previous group, these participants had not tasted the test products before as part of the experiment.

Data analysis

SPSS 20.0 (IBM, New York, USA) was used for statistical analyses. Chi square goodness of fit was used to test if the distribution of food choice differed between the three sessions (blind session, familiar package session, naïve package session) based on frequencies, i.e. the number of participants who chose a particular product. A mixed model ANOVA together with Tukey's test was performed to investigate differences in liking between products. To examine the relationship between liking scores and food choice, correlation analysis was applied.

Table 6.1 Description and nutritional composition (energy content and macronutrient) of the seven test products with the product number used throughout the paper.

Product	Picture	Brand	Flavour	Description	Composition – per 100 g serving[c]				
					Energy content KJ (kcal)	Protein gram (% energy)	Carbohydrate gram (% energy)	Fat gram (% energy)	Fibre gram
1		Friesland Campina "Good morning"[a]	Strawberry, kiwi, banana	Liquid dairy based breakfast drink	280 (65)	2.9 (18)	11.4 (71)	0.8 (11)	1.1
2		Friesland Campina "Good morning"[a]	Peach, apricot	Liquid dairy based breakfast drink	260 (60)	2.9 (20)	9.7 (67)	0.8 (13)	1
3		Friesche Vlag "Breaker"	Strawberry, banana	Dairy based semi-liquid (yoghurt-like) breakfast drink	459 (109)	3.5 (13)	15 (57)	3.5 (30)	1.6
4		Friesche Vlag "Breaker"	Peach	Dairy based semi-liquid (yoghurt-like) breakfast drink	473 (112)	3.5 (13)	14 (53)	4 (34)	0.3

5		Hero "Fruit Breakfast"[b]	Forest fruit	Liquid fruit based breakfast drink	213 (50)	0.4 (3)	11.2 (95)	0.1 (2)	0.6
6		Albert Heijn "Creamy yoghurt"	Raspberry, cranberry	Dairy based semi-liquid dessert; appropriate taste – inappropriate package for breakfast	544 (130)	2.5 (8)	11 (35)	8 (57)	0
7		Friesland Campina "Vla"	Vanilla	Dairy based semi-liquid dessert; inappropriate taste – inappropriate package for breakfast	365 (87)	2.4 (11)	12.9 (60)	2.8 (29)	0

[a] Translated from the Dutch product brand name Friesland Campina "Goede Morgen."
[b] Translated from the Dutch product brand name Hero "Fruit Ontbijt."
[c] Values based on nutritional information per 100 g serving as provided by the product label.

Results

Food choice in the blind session, the familiar package session and the naïve package session

Separate analysis of choice distribution for men and women in the blind and the familiar package session did not yield gender differences (data not reported). Therefore, further analyses are reported for all participants in each session.

Choice frequencies across products differed significantly (X^2 =47.3, $p<0.05$) between the blind session and the naïve package session (see Table 6.1 and 6.2). Participants in the naïve package session chose most frequently products 1 and 2, which were two of the least chosen products in the blind session. Comparing these two sessions with the familiar package session we observed that choice distribution in the familiar package session lay between that of the other two sessions (blind session and naïve package session).

The results further indicate that food choices in the blind session and the familiar package session differed significantly (X^2 =15.1, $p<0.05$). In the blind session, participants strongly preferred product 4, followed by products 3 and 6 (see Table 6.1 and 6.2). Notably, these products were the more viscous (semi-liquid) products in the series. In the familiar package session, participants' choice reflects a shift showing that the percentage of choice for products whose packaging information signalled appropriateness for a breakfast consumption context (products 1, 2 and 5) increased, whereas the percentage of choice for the dessert products (products 6 and 7) was slightly reduced, although the majority of participants still chose product 6, closely followed by products 3 and 4.

Food choice between the two package sessions (familiar vs. naïve) also differed significantly (X^2= 17.1, $p<0.05$). Product choice in the naïve session, where participants did not taste the products before they chose a product for breakfast, was dominated by two context appropriate products that had strong labelling as a breakfast product (products 1 and 2). First choice of the participants in the familiar package session was product 6, a dessert product that partly matched the breakfast drink products in intrinsic (sensory) properties, followed by products 3 and 4.

Table 6.2 Distribution of product choice as percentage of participants who chose a particular product in the blind session N=103, the familiar package session N=103, and the naïve package session N=65.

Product	Liking[a] (SD)	Food choice in blind product session(%)	Food choice in familiar package session(%)	Food choice in naïve package session(%)
1	5.6[b] (1.9)	6.8	16.5	24.6
2	5.1[b] (2.0)	2.9	6.8	24.6
3	6.5[c] (2.1)	24.3	21.4	13.8
4	6.5[c] (2.1)	32.0	22.3	9.2
5	4.9[b] (2.3)	1.0	6.8	9.2
6	7.2[c] (1.5)	26.2	24.3	16.9
7	6.6[c] (1.9)	6.8	1.9	1.5

[a] Liking ratings measured on a 9–point scale, 1= "Dislike extremely"; 9= "Like extremely."
[b,c] Tukey's test differentiates between relatively lower liked products (b) and higher liked products (c).

Liking and product choice

Test products differed significantly in liking ($F(6,612) = 19.918$, $p<0.001$). A mixed model ANOVA with post hoc Tukey's test revealed two distinguishable groups of relatively lower liked products (products 1, 2 and 5) and relatively higher liked products (products 3, 4, 6 and 7; see Table 6.2). The relatively higher liked products were the more viscous and creamier products in this series (data not shown) and had the highest energy content (see Table 6.1). In the blind session, liking and choice percentages were significantly correlated ($r = 0.79$, $p=0.03$). Better liked products were chosen more often. However, this relationship lost significance for the familiar package sessions ($r = 0.59$, $p=0.17$).

Discussion

Our results show that package plays a key role in consumers' food choice in a simulated cafeteria setting. In addition, the situational cue "appropriateness" (if a food matches the consumption context) guided food choice. As expected, package and product appropriateness had the strongest influence on choice when consumers were naïve (no recent exposure to the foods) to the sensory characteristics of the products. When consumers had recent experience with the sensory properties, their choice, even when based on package information only, was influenced by both extrinsic and expected intrinsic (sensory) product properties. Hence, we found an assimilation effect, where choice pattern was in between choice patterns based on solely intrinsic properties and solely extrinsic properties.

Liking, the hedonic response to the products, was found to have a strong impact on choice when consumers' choice was based on sensory characteristics only. When package was presented the influence of liking was diminished, suggesting that the importance of intrinsic properties and their hedonic evaluation for actual choice behaviour might be overestimated in situations where an individual is confronted with a combination of intrinsic and extrinsic product characteristics. This is in line with findings of Hoppert, et al. (4) who also demonstrated the potentially conflicting influence of combined evaluation of intrinsic and extrinsic product properties on choice behaviour in a laboratory setting. In this study it was shown that evaluation of a particular attribute (fat content in dairy products) could diverge for the processing of sensory and packaging information when subjects were presented with combinations of intrinsic/extrinsic properties. For example, the acceptance of yoghurt increased with an increasing actual fat content (intrinsic) but diminished when high fat content was labelled on the product, indicating contrasting effects of intrinsic and extrinsic product properties in relation to choice. The authors concluded that depending on the setting and the attributes consumers are exposed to, there is the possibility of over- or underestimating the impact of intrinsic and extrinsic properties on food choice.

We showed the influence of package and appropriateness on food choice in a simulated consumption situation. A strong influence of package on purchase intention and product evaluation has been shown in previous studies within laboratory settings (11, 12). In line with our findings about the concept of appropriateness, previous studies found that appropriateness ratings of foods differ across consumption situations and were found to predict food satisfaction which is closely related to consumers' repeated purchase behaviour (7, 8, 13). Furthermore, it is well known that external cues influence product performance. When there is a discrepancy between blind liking and liking based on expectancy arising from extrinsic properties, the hedonic evaluation of a product shifts towards expected liking (assimilation effect) (12, 14, 15). We found a similar assimilation effect as has been observed for liking, but now for actual food choice. Food choice influenced by intrinsic as well as extrinsic properties lay in between choice patterns based on solely intrinsic properties and solely extrinsic properties.

Notably, the three most frequently chosen products in our study were the more viscous, semi-liquid products. Previous studies showed that a more viscous product leads to higher expected satiation and facilitates learned satiation (16, 17). In addition, findings from Markman, et al. (18) suggest that products serving the goal of satiating best may result in higher liking ratings. This is in line with the higher liking ratings for the more viscous products in our product sample. It remains speculative but expected satiation (cued by viscosity) might have been an additional driver of choice in our study, as the chosen product was indeed consumed as breakfast. Hence, participants knew they had to make their breakfast meal with the chosen product.
In the current study equal numbers of men and women participated in the blind and packaging

sessions, whereas the naïve packaging group consisted of more women than men. This raises the issue whether gender differences may have influenced the present results. In previous studies gender differences have been found in food choices, mainly when food choice was related to diet and health benefits, such as fruits and vegetables or low fat/low sugar products (19, 20). Women were found to make healthier choices than men and were more likely driven in their choice behaviour by health or dieting benefits of foods. In our study, however, we found no support for gender differences. This can be explained by type of products used. The breakfast drinks and dessert products used in the current study included no light variants, and do not include health claims or dieting benefit information. Nevertheless, gender effects may warrant further consideration as they could not completely be ruled out given the unbalanced design.

In conclusion, food choice in a simulated cafeteria setting is guided by extrinsic (package) as well as intrinsic (sensory) properties that both can act as a cue for product appropriateness given a specific consumption context. For instance, in a supermarket or other vending place of breakfast drinks, choice may be mainly driven by the extrinsic properties if a consumer, despite being familiar with the sensory properties, is confronted with only the products' packaging, which is then the salient attribute at the choice moment. Depending on the salience of either intrinsic or extrinsic properties during the choice moment their impact on choice is stronger.

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Chapter 7

Sensory driven emotions

Relationship between sensory and emotional profiles of foods

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Abstract

Sensory attributes are important drivers of food-evoked emotions. The present study established the relationship between sensory attributes and emotional responses to food products (breakfast drinks and desserts). We combined data collected for seven products by two different panels. First, a large consumer panel (n=103) reported on 39 emotions perceived while tasting the seven products using the EsSense Profile™. Second, all seven products were evaluated by a trained panel (n=10) on 31 sensory characteristics using descriptive analysis. The results show that texture-related attributes such as *creamy, fatty, thick* and *mouth filling* were strongly related to positive emotions, e.g. *happy*, *joyful* and *satisfied*. Second, sensory attributes such as *yoghurt-like* and *coarse particles* were strongly associated with active emotions, i.e. *energetic* and *adventurous*. Third, a *fresh* and *sour* taste was associated with the emotion *wild*, a *sweet* taste with *calm* and *astringent* with *aggressive*. In conclusion, texture-related attributes were drivers of positive emotions and specific taste-related attributes were drivers of specific arousal emotions. Thus, specific sensory drivers of emotional responses to food products were identified. These relationships may be of value in product development to be able to tailor a food product's sensory characteristics to consumers' emotional associations with the product.

Introduction

Emotional responses evoked by foods have become an important study area in sensory and consumer science. It has been proposed that the foods' sensory attributes are one of the drivers of food-evoked emotions (1, 2). Sensory attributes are often used to describe and differentiate food products (3), and they are strongly associated with emotions and liking (4). Food-evoked emotions have a similar function as sensory attributes in research in that they are also used to differentiate between products and provide a profile of the product which adds to product conceptualization that goes beyond traditional liking ratings.

In the past years a few studies have investigated the relationship between sensory and emotional attributes for different food products e.g. chocolate (5, 6) and odours of dairy products (7). Examples of sensory attributes that have been found to evoke specific emotional responses are *cacao* that was associated with the emotional response *energetic* (6) and *natural sweetness* in blackcurrant juices that was associated with the positive emotions *happy* and *satisfied* (unpublished data: personal communication with Ng and colleagues). Can we expand these relationships between sensory and emotional attributes to other product categories? It would be interesting to see if general patterns exist between the sensory and emotional attributes across product categories in addition to product category specific relationships. Relevance of this type of information is that food manufacturers could use it to adapt sensory characteristics to an emotional profile evoked by the product that matches the consumer's wishes or expectations. To be able to put this application into practise knowledge is needed on which sensory attributes evoke a specific emotion.

The objective of the present study was to investigate the relationship between sensory attributes and emotional responses of breakfast drinks and desserts. For that purpose we combined data collected by two different panels but on the same seven products. First, a large consumer panel (N=103) reported on the emotions perceived after tasting the seven products, using the EsSense profile™. This existing data set was combined with new gathered data whereby all seven products were evaluated by a trained panel on sensory characteristics, using descriptive analysis.

Methods

Test products

The test products were five breakfast drinks and two dessert products (Table 7.1). All of them were commercially available products in Dutch supermarkets at the time of the study. Products were stored and refrigerated at 4 °C until the moment of serving. Four breakfast drinks were dairy based (two liquid and two more viscous) and one was fruit juice based. The desserts were both dairy products (a creamy fruit yoghurt and vla (vanilla custard)). Emotional profiling was the first measure of a broader study investigating the impact of food-evoked emotions and context appropriateness (whether a food product and its labelling match the consumption context like breakfast or dinner) on food choice. The results regarding these research questions are reported in separate papers (8, 9).

Emotional profiling study

Participants

One hundred and three healthy Dutch speaking adults (M/F: 51/52, age: 25.6±8.5 years, BMI: 22±1.9 kg/m^2) from Wageningen and its environs were included and completed this study. Inclusion criteria were being a consumer of breakfast drinks and age between 18 and 55 years. Exclusion criteria were pregnancy or lactation, loss or gain of 5 kg of body weight or more during last 2 months, being on a diet, allergy or sensitivity to food ingredients such as cow's milk protein, dietary fructose and other relevant allergies. All participants signed informed consent and received financial compensation for participating. The study was approved by the Medical Ethical Committee of Wageningen University.

EsSense™ Profile Method

EsSense profile™ is a questionnaire that measures the explicit emotional response to food products by participant ratings on 39 emotional words on a 5-point intensity scale from "not at all" to "extremely" (for additional details see King and Meiselman (10). The questionnaire was provided to the participants via a computer, using EyeQuestion software (Logic8 BV, Elst, The Netherlands). In this paper all terms are presented in English; however, we used a Dutch version of the scale.

Procedure

The testing session, duration 60-90 min, took place in the morning in two time slots, starting at 8.00 am or 9.30 am, in the sensory testing booths of the Restaurant of the Future in Wageningen, the Netherlands. Participants were instructed to refrain from eating for at least two hours prior to each test session. Emotional responses to the unbranded (no package information) products were measured. Before the test, participants were given written instructions that they would receive seven samples to taste, starting with a warm-up sample. Each sample was presented in a 60 ml transparent cup containing 30 ml of each product covered with a lid, and labelled with a 3-digit code. Participants were instructed to stir the sample with a teaspoon, and then to taste the product and rate the emotions they experienced. They were allowed to re-taste the product while rating the emotions. The order by which each participant received each sample was randomized. Participants rinsed their palate with water and ate an unsalted cracker between samples.

Sensory profiling study

Participants

The panel consisted of 10 assessors, all females, with an average age of 56.0±10.7 years. The panellists were recruited and screened using standardized tests with regard to their sensory abilities, basic taste and odour detection, and ability to communicate sensory descriptions of products. The assessors were trained over four 2-hr sessions during which they familiarized themselves with the test products and generated an initial set of 55 relevant sensory attributes. The panel used once the initial set of attributes to evaluate the products and then discussed these evaluations to reduce the list through consensus on either the most relevant attributes or by combining several attributes in a single attribute (e.g. red fruit for strawberry and raspberry flavours). The final test set consists of 14 mouth feel, 2 odour, and 15 taste attributes that could be used consistently by the assessors and that describe the test products (see Table 7.2 for the attributes and their definitions).

Table 7.2 Attributes per attribute group and their definitions.

Main group	Attribute group	Attribute	Attribute Description
Flavour	Odour	FL-intensity odour	total amount of odour
		FL-cream	smell of whipped cream
	Taste	FL-intensity taste	total amount of taste
		FL-sweet taste	basic taste and of artificial sweetener
		FL-sour	basic taste
		FL-fresh	light taste, not heavy or stale
		FL-citrus	such as lime and lemon
		FL-red fruit	such as strawberries, raspberries and currants
		FL-banana	taste of banana
		FL-peach	taste of peach
		FL-raisin	taste of raisins
		FL-artificial fruity	as of sweets
		FL-nutty	taste of nuts
		FL-yoghurt-like	taste of yoghurt or cottage cheese
		FL-vanilla	natural vanilla flavour or artificial
		FL-almond	almond essence
	Aftertaste	FL-sweet aftertaste	basic taste and of artificial sweetener
Mouth feel	Mouth feel	MF-thick	not thick (liquid) to thickened
		MF-rough	hairy teeth, as in spinach
		MF-astringent	astringent feeling in the jaws
		MF-creamy	full, soft, velvety
		MF-fatty	oil like
		MF-mouth filling	a small bite gives the feeling the mouth is filled
		MF-coarse particles	product contains large pieces
		MF-hard particles product	contains large pieces that are hard
		MF-soft particles	product contains large pieces that are soft
		MF-fine particles	product contains small pieces
		MF-prickle	tingling in the mouth
	After feel	MF-astringent after feel	astringent feeling in the jaws
		MF-rough after feel	hairy teeth and/or a dry feeling
		MF-residue	particles remain behind

Procedure

The sensory profile of the seven test products was characterized with the final test set using descriptive analysis (DA). Profiling took place during two 2-hr sessions in the same sensory testing booths used for the emotional profiling study. In each session, each of the seven test products was profiled once using EyeQuestion software (Logic8 BV, Elst, The Netherlands). The intensity of each attribute was rated with an unstructured line scale anchored with 'very low' at 10% and 'very high' at 90% of the line scale. First the odour of a drink was assessed, followed by the taste and mouth feel attributes. Participants were not restricted in their number of sips. The after taste and after feel attributes were evaluated after swallowing the sample. Each assessor received the samples in a different random order so that context effects were levelled out. The drinks were presented in 60 ml portion cups again without packaging and brand information, with 40 ml of test product, covered with a lid, and labelled with a 3-digit code. An eighth drink served as a warm-up sample, being the first sample to be evaluated in both sessions. The data of this eighth product was excluded from the analyses.

Data analysis

A multiple factor analysis (11) was performed to illustrate and compare the configurations between the sensory and the emotional data sets gathered for the same seven products. The data for each set were averaged across participants and resulted in a 7 x 31 sensory data matrix and a 7 x 39 emotional data matrix which were used for MFA. To strengthen the illustrations made in the MFA plots we used Pearson correlations, based on 7 observations, between the sensory attribute and the emotion mean scores across participants.

Table 7.1 Description and nutritional composition (energy content and macronutrient) of the seven test products with the product number used throughout the paper.

Product	Picture	Brand	Flavour	Description	Composition – per 100 g serving[c]				
					Energy content KJ (kcal)	Protein gram (% energy)	Carbohydrate gram (% energy)	Fat gram (% energy)	Fibre gram
1		Friesland Campina "Good morning"[a]	Strawberry, kiwi, banana	Liquid dairy based breakfast drink	280 (65)	2.9 (18)	11.4 (71)	0.8 (11)	1.1
2		Friesland Campina "Good morning"[a]	Peach, apricot	Liquid dairy based breakfast drink	260 (60)	2.9 (20)	9.7 (67)	0.8 (13)	1
3		Friesche Vlag "Breaker"	Strawberry, banana	Dairy based semi-liquid (yoghurt-like) breakfast drink	459 (109)	3.5 (13)	15 (57)	3.5 (30)	1.6
4		Friesche Vlag "Breaker"	Peach	Dairy based semi-liquid (yoghurt-like) breakfast drink	473 (112)	3.5 (13)	14 (53)	4 (34)	0.3

5		Hero "Fruit Breakfast" [b]	Forest fruit	Liquid fruit based breakfast drink	213 (50)	0.4 (3)	11.2 (95)	0.1 (2)	0.6
6		Albert Heijn "Creamy yoghurt"	Raspberry, cranberry	Dairy based semi-liquid dessert	544 (130)	2.5 (8)	11 (35)	8 (57)	0
7		Friesland Campina "Vla"	Vanilla	Dairy based semi-liquid dessert	365 (87)	2.4 (11)	12.9 (60)	2.8 (29)	0

[a] Translated from the Dutch product brand name FrieslandCampina "Goede Morgen"
[b] Translated from the Dutch product brand name Hero "Fruit Ontbijt"
[c] Values based on nutritional information per 100 g serving as provided by the product label

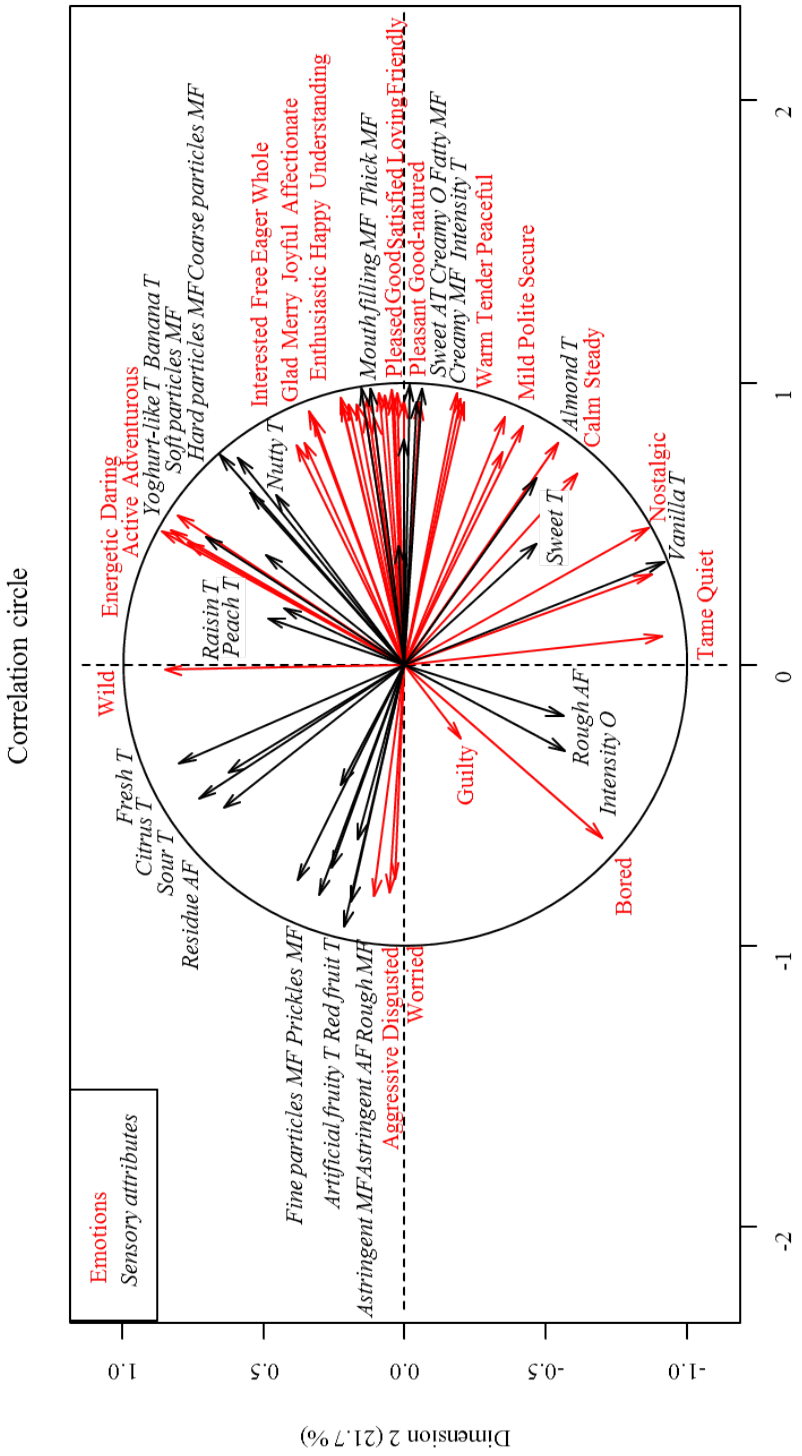

Figure 7.1 Representation of the first two dimensions of the MFA space showing the emotional terms (in the colour red) and the sensory attributes (in the colour black). Abbreviations used for the sensory attributes: Odour (O), Taste (T), Aftertaste (AT), Mouth feel (MF).

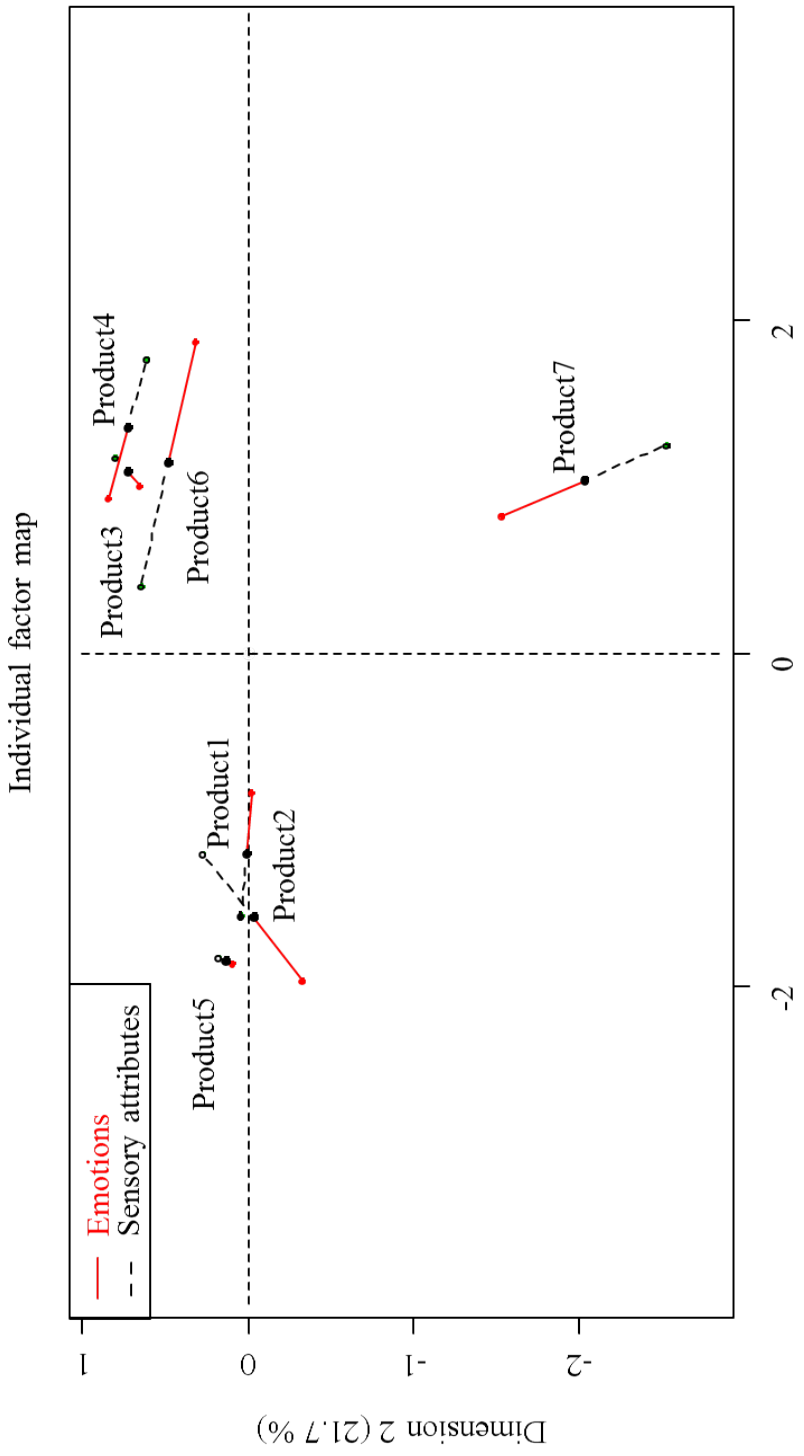

Figure 7.2 Representation of the first two dimensions of the MFA space showing the seven products as mean points and their partial individuals representing the emotion configurations of the emotions and sensory attributes associated with the seven products.

Results

Figure 7.1 depicts representations of the 31 sensory attributes (see Appendix 1 for means and standard deviations) and the 39 emotional responses towards the test products (breakfast drinks and desserts) in the MFA two-dimensional space.

The first two dimensions account for 72.9% of the variance. The first dimension (51.2%) is positively associated with sensory attributes as *creamy*, *fatty*, *thick*, and *a sweet* aftertaste and negatively associated with the sensory attributes *(artificial) fruity* taste, *astringent* and *fine particles*. Inspecting the emotions in the plot, the first dimension is positively associated with positive emotions e.g. *happy*, *good*, *joy*, *satisfied*, and *affectionate* and negatively associated with *aggressive*, *disgusted*, and *worried*. The second dimension (21.7%) ranged from *sour* and *fresh* to *sweet* taste and *vanilla* sensory attributes. For the emotional terms the second dimension ranged from *wild*, *energetic*, and *active* to *bored*, *tame*, and *nostalgic*. The configurations of the sensory and emotional attributes already illustrates the link between them as we find *fresh* (sensory) and *wild* (emotion) at the top of the MFA plot and *creamy* (sensory) and positive emotions along the first dimension. These observations were supported by the Pearson correlations (higher than 0.7 and greater than 0.9, respectively). More specifically, correlations greater than 0.9 were found between the sensory attributes *creamy*, *fatty*, *mouth filling*, and *thick* and the emotional responses *pleasant*, *understanding*, *polite*, *happy*, *glad*, *good*, *good-natured*, *tender*, *pleased*, *satisfied*, *peaceful*, *joyful*, *friendly*, *merry*, and *warm*. Furthermore, Figure 7.1 highlights that the sensory attributes *yoghurt-like* (taste), *coarse* and *hard particles* (mouth feel) loading along the second dimension were associated ($r > 0.7$) with *adventurous*, *active*, *energetic* and *daring* (high arousal emotions). Other sensory and emotional associations are *sweet* (aftertaste) and *warm*, *good* and *friendly*; *astringent* and *aggressive*; and *vanilla* and *nostalgic*/*quiet*.

Figure 7.2 shows the partial individuals plot of the MFA. Inspecting the position of the products' coordinates, two clusters of products spread across the MFA two-dimensional space can be identified, and one product (product 7) being relatively distant from the two clusters. Both sensory profiling and emotional profiling organises the products in a similar way. Focusing now on the representation of the emotional and sensory terms on the space depicted in Figure 7.1, it can be observed that compared to the 2nd cluster, the first cluster of products (product 1, product 2, and product 5) was relatively stronger associated with negative emotions, namely *disgusted* and *aggressive*, and with the sensory attributes *fine particles*, *red fruit* and *artificial sweetness*. The second cluster of products (product 3, product 4, and product 6) was strongly associated with *energetic/active* (high arousal emotions) and *yoghurt-like* and *soft/hard particles* (sensory). Product 7 was associated with *nostalgic* (emotion) and *sweet/vanilla* taste (sensory).

Discussion

The present study established the relationship between the sensory descriptive profile (gathered with a trained sensory panel) and the emotional profile (gathered with a consumer panel) of the same seven products (breakfast drinks and desserts). Texture-related attributes such as *creamy* and *fatty, thick* and *mouth filling* were strongly related to the majority of positive emotions, namely *happy*, *joyful* and *satisfied*. Second, the sensory attributes *yoghurt-like* and *coarse particles* were strongly associated with high arousal emotions, i.e. *energetic* and *adventurous*. Third, a *fresh* taste was also related to the high arousal emotion *wild*, a *sweet* taste with calming emotions and *astringent* was related to the negative emotion *aggressive*. These findings could be applied in food-related emotion research and have potential for product development. It is thought that a better consonance between different product characteristics and elements that together form the food products' identity increases consumer's satisfaction with a product. (4, 6, 12, 13). In order to create consonance the sensory characteristics should be aligned to the emotional profile the product elicits. The current findings yield some implications as on how to put this into practice. For example, a product developer may want to adapt the sensory characteristics of a liquid dairy based breakfast drink (e.g. product 1) to a more energetic and active perceived product to align with the brand image. Based on our present findings, one option would be to change it into a semi-liquid (yoghurt-like) product and/or adding some coarse particles to the product as this is stronger associated with emotions as energetic and active.

Texture-related attributes such as creaminess, a fatty mouth feel, thickness and mouth filling have been identified in numerous other studies as enhancers of product appreciations (14-18), and improved mood/positive emotions (2). The present study also found close associations between texture-related sensory attributes and positive emotions such as *happy*, *joyful* and *satisfied*. Regarding findings on arousal related emotions, previous research shows diverse findings. Jager, et al. (5) found that a *mint* flavoured chocolate (which has a cooling sensation) was associated with *energetic*. Liem, et al. (19) showed that a preference for *sour* taste in children was related to willingness to try novel food products and they speculated that a personality trait like sensation seeking may moderate this relationship. Similarly, in this study high arousal and active emotions were associated with *fresh*, *sour* and *citric* flavoured attributes. However, high arousal emotions (*energetic* and *active*) were even stronger associated with texture related attributes (*yoghurt-like*) and *coarse particles*. This finding seems to be product specific, because Thomson, et al. (6) on the other hand found *cacao* (sensory specific attribute of chocolate) to be associated with *powerful* and *energetic*. It can be concluded that the active/arousal emotions are as relevant as pleasant emotions in product evaluation since several studies show their strong associations with disparate sensory attributes; however a general

pattern could not be identified yet. Furthermore, undesired sensory attributes as *astringent* in the current study and *watery* (in blackcurrant juices, unpublished data: personal communication with Ng and colleagues) seem to relate to negative emotions, e.g. *aggressive* and *worried*. *Sweetness* was found to be a key driver of positive emotions (7) and has been associated with *fun* and *comforting* (6) and *loving* and *happy* (5) in chocolate. Gibson (2) reported a calming und stress reducing effect of *sweet* taste in his review on the emotional influences on food choice. In line with these findings the present study showed that *sweetness* was associated with pleasant emotions in addition to calming and tranquil emotions. The current study and numerous food emotion studies, which showed that emotions differ across various food products, demonstrate that human senses (e.g. taste and smell) are powerful drivers of emotions (4, 8, 12, 20, 21) or emotional associations (6, 13). Eating a particular food as such changes the emotional state via sensory effects, the consumption context, expectations and previous experiences (2).

Some strengths and limitations of the present study should be discussed. A strength of the current study is that a wide variety of emotional responses and sensory attributes was covered. It has been observed previously that consumers need and use many different emotional terms to describe the complex emotional experience during food consumption (10). In the current study we employed two types of test panels, a trained panel and an untrained consumer panel, to assess the emotional and sensory product profiles. Combining the data of two different panels has its pros and cons. On the one hand, the two distinct approaches seek for two separate panels because the most efficient and appropriate way to perform analytical measurements (e.g. descriptive analysis) is a trained panel and an affective measure (e.g. food-evoked emotions) is best performed by a consumer panel (22). On the other hand, results between two panels which use distinct approaches to evaluate food products (analytical vs. affective) were compared. The outputs might be less straightforward to relate to each other, one being of instrumental/technical nature and the other a subjective and intuitive judgement. Nevertheless, to prevent other factors biasing product evaluation we applied and recommend to keep the experimental settings like research facilities, time of the day and other protocol details (sample temperature, lightening, and materials) consistent across both panels. Furthermore, the comparisons between the emotional and sensory attributes in the current study are limited to a specific product category. Therefore, some sensory attributes that were found to be associated with negative emotions might elicit even positive emotions in other product categories as for instance for the product wine *astringent* might be preferred and elicit positive emotions. However, we were able to point out sensory attributes as *sweetness* and texture-related attributes that might evoke calming and positive/arousal emotions across product categories. Furthermore it seems a product containing similar sensory attributes (e.g. *fresh* or *sour* taste) elicits active emotions across different products. For future studies we recommend to include descriptive

analysis in emotion research throughout several foods. This would enable stronger conclusions on the relationship between the products sensory attributes and emotional responses and facilitate integrating the role of emotions in early product development stages.

In conclusion, in the present study we explored which specific sensory attributes are related to specific emotional responses to foods. Texture-related sensory attributes were found to drive numerous positive emotions (pleasantness). *Refreshing* and *sour* tastes were associated with high arousal emotions (activation). Furthermore, product category specific attributes were identified as drivers of specific emotional responses. Our findings suggest that for instance in product development it may be beneficial to identify drivers of emotional responses to be able to tailor a product to consumers' emotional requirements.

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Appendix 7.1

Table. Means and standard deviations for the 31 sensory attributes.

		Product1 Mean (SD)	Product2 Mean (SD)	Product3 Mean (SD)	Product4 Mean (SD)	Product5 Mean (SD)	Product6 Mean (SD)	Product7 Mean (SD)
Odour	*Intensity*	70.5 (9.7)	53.5 (18.4)	55.7 (17.8)	50.9 (17.7)	57.5 (14.3)	51 (13)	64.9 (19.7)
	Cream	14.6 (8)	15 (9)	29 (11.5)	37.6 (19.4)	9.5 (3.8)	46.9 (23.9)	36.9 (18.7)
Taste	Intensity	68.5 (9.6)	57.2 (12.8)	64.8 (13.2)	59.9 (14.7)	53.6 (16.7)	64.4 (13.6)	62 (17.6)
	Sweet	57.6 (16.2)	49.2 (10.2)	56.6 (17.4)	52.9 (18.2)	41.7 (12.4)	46.2 (18.5)	61 (16.5)
	Sour	42.5 (17.3)	36.9 (16.6)	31 (15.7)	27.4 (15.2)	43 (22.5)	53.1 (20.1)	12.7 (5.7)
	Fresh	47.3 (22.4)	43.6 (19.2)	35.8 (19.4)	44.7 (20.4)	46 (23.9)	51 (14.2)	18.6 (10.8)
	Citrus	28.2 (16.1)	36.1 (18.3)	27.9 (18.1)	24.4 (11.3)	24.7 (18.8)	26 (19.6)	9.5 (4.1)
	Red-fruit	52 (26)	11.6 (7)	11.3 (5.3)	9.5 (3.6)	73.5 (13.1)	64.1 (20.6)	8.7 (3.3)
	Banana	14.6 (10.1)	14.6 (4.5)	44.8 (28.6)	20.9 (16.1)	10.2 (2.6)	12.3 (3.1)	9.7 (4)
	Peach	12.8 (6.3)	42.6 (27.5)	19.7 (13.4)	66.6 (18.5)	10 (2.6)	16.1 (11.3)	8.6 (3.5)
	Raisin	15.4 (12.9)	12.6 (6.7)	54.4 (19.9)	14.5 (11.7)	25 (16.9)	16.5 (11.2)	8.7 (3.6)
	Artificial-fruity	58.6 (21.1)	26.6 (17.7)	23.4 (17.8)	15.7 (8.9)	39.5 (24.3)	21.8 (10.9)	9.4 (4.1)
	Nutty	11.3 (3.9)	16.7 (10.5)	36.5 (20.6)	43.1 (20.8)	9.4 (3.6)	13 (4.1)	14.6 (9.5)
	Yoghurt-like	43.6 (16.3)	43.5 (17.5)	53.5 (14.9)	61.4 (20)	8.9 (3.8)	65 (14.6)	11.3 (4.8)
	Vanilla	9.7 (5.1)	9.4 (4.3)	14.2 (14.3)	12 (10.4)	9 (3.7)	10.4 (6.3)	81.5 (11.7)
	Almond	9.5 (4)	12.8 (8.9)	18.3 (12.4)	22.1 (19.9)	8.6 (3.6)	9.4 (3.1)	26.1 (12.4)

	Thick	32.4 (8.5)	25.1 (9.6)	71.3 (11.8)	74.1 (12.2)	12.5 (3.6)	82.8 (6.8)	62.5 (12.2)
	Rough	34.8 (16.2)	34.8 (13.7)	26.6 (13.2)	17.1 (7.7)	23.3 (14.9)	26 (18.7)	19.5 (13.6)
	Astringent	30 (14)	26.5 (12.2)	15.7 (5.3)	12.9 (4.7)	32.3 (14.9)	19.6 (9.7)	11.5 (4.6)
	Creamy	14 (8.6)	13.7 (6.5)	56.1 (17.3)	67.7 (16)	9.3 (3.8)	61.7 (18.9)	60.3 (14.9)
	Fatty	12.6 (5.6)	13.5 (6.8)	33.9 (18.8)	40.5 (19.8)	9.3 (4.7)	31.8 (17.3)	36.7 (17.4)
	Mouth-filling	25.9 (9.4)	21.7 (9.8)	71.2 (11)	74.6 (11.3)	13.7 (7.5)	81.3 (7.3)	59.5 (14.9)
	Coarse-particles	9.7 (3.6)	10.1 (3.6)	62.5 (11.5)	70.1 (16)	8.8 (3.5)	34.8 (21.4)	11.7 (14.4)
	Hard-particles	9.5 (3.5)	9.6 (3.6)	53.3 (21.3)	64.9 (15.8)	8.7 (3.4)	14.2 (7.7)	8.7 (3.4)
	Soft-Particles	10.2 (5.1)	10.6 (4.7)	46.2 (15)	52.8 (20.1)	9.5 (5.4)	41.2 (23.4)	8.3 (3.6)
Mouth feel	Fine-Particles	60.2 (23.2)	68 (19.2)	48.9 (19.1)	14.4 (8.3)	50 (23.6)	34.2 (20.6)	9 (3.4)
Mouth feel	Prickle	24.8 (17.1)	18.9 (8.4)	12.9 (5.6)	12.7 (6.7)	23.9 (16.5)	18.3 (11.6)	9.9 (4.1)
Aftertaste	Sweet	40.3 (11.1)	41.8 (14.5)	54.9 (14.8)	51.8 (16.8)	33.7 (11.7)	41.5 (18.4)	49.3 (19.3)
Aftertaste	Astrin-gent	28 (14.3)	22.4 (10)	16.5 (7.5)	14.1 (6.9)	26.8 (16.1)	21.3 (11.9)	14.4 (12.5)
Aftertaste	Rough	41.7 (17.9)	40.2 (18.4)	30.9 (14.2)	26.4 (15.8)	22 (10.6)	26 (17.5)	40.3 (27.2)
Aftertaste	Residue	45.1 (22.1)	47.8 (21.4)	48.5 (21.4)	32.2 (18.3)	36.6 (24.8)	22.5 (9.9)	9.5 (4)

Chapter 8

General discussion

The studies described in this thesis focused on the role of emotions, conceptual associations and liking in food choice. We tested if food-evoked emotional and conceptual associations explain and predict food choice better than sensory liking per se, with a focus on both intrinsic and extrinsic product properties. In addition, we investigated the ability of food-evoked emotions to differentiate between products and the influence of user context appropriateness on choice.

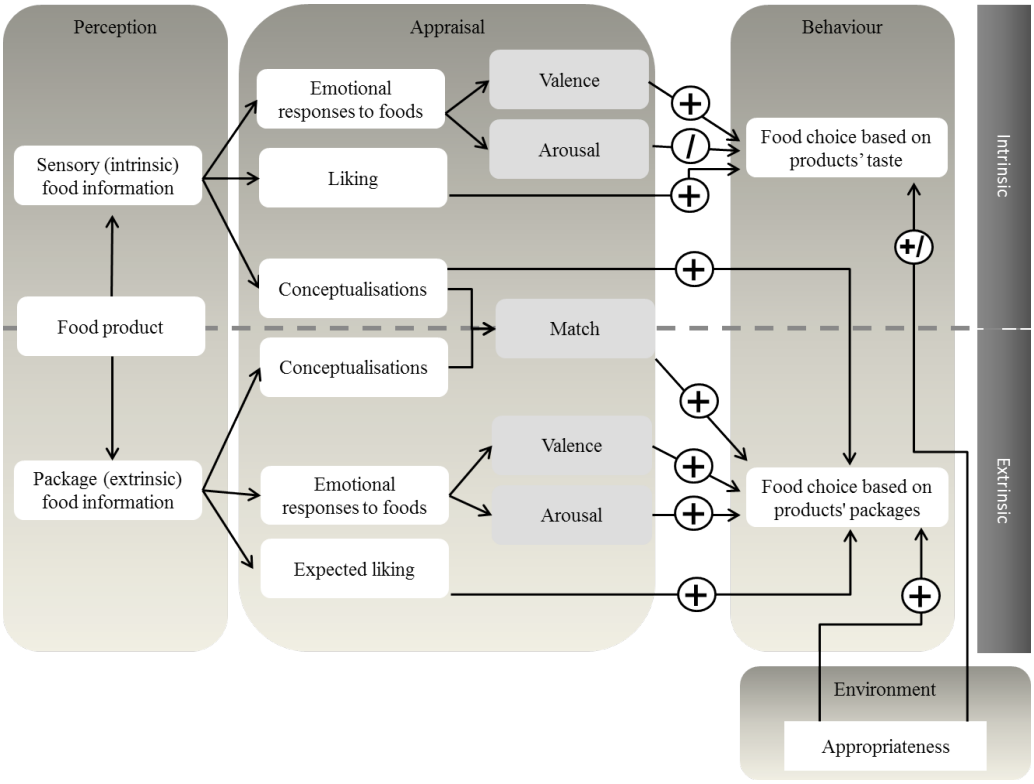

Figure 8.1 Model that shows the main findings of this thesis, namely the impact of emotional responses, liking, conceptualisations and appropriateness on food choice. Intrinsic and extrinsic properties were studied. Positive relationships are illustrated with + and no relationship with /. Emotional responses to foods can be decomposed in two dimensions (valence and arousal). Positive valence emotions, but not arousal emotions, guide food choice when evoked by intrinsic properties (taste, mouthfeel) (chapter 2, 3, 4). Food choice based on extrinsic information (package) was driven by positive valence emotions and high arousal emotions elicited by the products' package (chapter 4). Blind liking and expected liking scores are positive drivers of choice based on taste as well as package (chapter 3, 4). Further, the match between conceptual responses to the products' taste and its' package was positively related to choice based on packaging (chapter 5). Eating occasion appropriateness communicated through packaging was positively related to choice based on the package but to a lower extent with blind tasted product choice (chapter 6). A possible application of the presented model is provided in chapter 7.

Main findings

Before investigating the relation between emotions and choice, we first demonstrated that two different emotion measurement tools, PrEmo® and EsSense Profile™, differentiated successfully between unbranded tasted products from the same product category (chapter 2). The resulting food-evoked emotions could be organized in two dimensions (valence vs. arousal). The combination of emotion valence and liking scores predicted individual choice for over 50% of all participants and outperformed the predictive ability of liking scores alone (chapter 3). These findings were replicated in the next study using only the EsSense Profile™ but now we also looked into the impact of packaging on emotions and choice. This time the combination of liking, valence and also arousal had the strongest predictive value for package-based choice with correct predicted individual choices for 41% of all participants (chapter 4).

Investigating the consumers' appraisal of a food product, we measured the emotional and functional associations with foods (conceptual profiling) in addition to liking. We demonstrated that the congruency (match) between the conceptual profiles based on the products' sensory and packaging properties was positively related to food choice. The more congruent the sensory product profile was to the package conceptual profile the more frequently the product was chosen. However, liking ratings and especially expected liking ratings (anticipated liking of the product based on viewing its package) outperformed the product-package-match in the predictive ability of individual product choice. In particular, expected liking correctly predicted 25% more individual choices than the product-package-match. A closer look into the consumption context and packaging showed that appropriateness also guided package-based choice, but was less influential on choices based on the products' taste (chapter 6).

Lastly, we combined emotional and sensory profiling data and found that texture-related attributes were drivers of positive emotions and that specific taste-related attributes were drivers of specific arousal emotions. These sensory drivers of emotions could be of value in product development (chapter 7).

Methodological considerations

The aim of this thesis was to test the predictive ability of food-evoked emotions and conceptualisations on choice in addition to liking scores. Before discussing and interpreting the results it is important to take a number of methodological issues into account.

Study design

Food choice. When interpreting the contribution of emotion profiles or conceptualisations to choice prediction, one needs to bear in mind that the assessment of choice in this thesis goes beyond the appraisal assessment in consumers mind (see Figure 8.1). Most studies rely on a measure of consumers' intention or product appraisal (1-3). These measures are a proxy to choice behaviour and they are easier to implement in a study design than actual choice behaviour. There is, however, a well-known and difficult to ignore discrepancy between intentions and actual behaviour (4). Therefore, in this thesis we applied an observational measure of choice behaviour in a simulated cafeteria setting because we believe it represents the real life behaviour better than a questionnaire on intention or willingness to choose or buy.

Measuring choice behaviour in a simulated cafeteria setting did have some consequences. For one, it resulted in a trade-off between internal (strictly controlled environment) and external validity (real life consumer context). Classical sensory science measures, like Descriptive Analysis and Temporal Dominance of Sensation, are typically conducted in a laboratory setting to control for outside influences (5). But there is a debate if results obtained will be applicable to a real life context (6, 7), as it is clear that a measure of product choice in a laboratory setting will differ from a real life choice decision at the supermarket (8-10). Meiselman (7) emphasized that sensory and consumer research should be done in a real life context and noted that several studies already moved outside the lab setting (7, 11, 12). Our studies followed that trend because we agree on the notion that external validity is fundamental in predicting food choice and market success and it should receive more attention in food choice research.

Some researchers propose sales numbers as an external valid measure of choice (13-15). However, a measure of choice at the supermarket like sales numbers is most likely influenced by price and availability (16, 17). We believe that the simulated cafeteria setting which we used in all studies balanced optimally the need for internal and external validity. The test products were presented in a refrigerated shelf in a typical cafeteria setting; however, participant's choice was not influenced by price (no price) or availability, i.e. the same number of each product were available for every individual choice.

We consider the inclusion of choice as an output parameter as a strength of the studies in this thesis. A potential drawback, however, was that offering participants a realistic choice, required the presentation of a larger number of samples to the participants than recommended in sensory and emotional profiling (18, 19). King, et al. (19) reported an effect of number of samples on emotion scores across serving positions, indicating that liking and emotional ratings may decrease slightly for those samples presented at the end of a series. Our emotion data did not confirm this finding as no effect of sample order on emotion ratings was found (chapter 2, 4). Nevertheless, response fatigue might bias emotional as well as conceptual profiling. These effects can be minimized by limiting the number of products per test (19). As a consequence we optimised the number of products used in a single testing session in the last study. More research is needed to clarify this issue to be better able to combine food-evoked emotion research with food choice experiments in a real life setting.

Measurement tools. To identify new potential drivers of choice we focused on affective (emotional) and conceptual associations individuals experience during food consumption. To measure these associations elicited by foods we used explicit self-report tools, namely the EsSense Profile™ method, the conceptual profiling approach and PrEmo®. Each tool had its strengths and limitations. The EsSense Profile™ contains a broad range of emotion terms and as a generic tool it can be applied to various food products (18). Most studies on food-evoked emotions applied the validated EsSense Profile™ method and showed that this method successfully differentiates between products (18, 20-22). We replicated these findings and contributed to the validation of the EsSense Profile™, e.g. we provided additional insights into the optimal number of samples to be presented in a single session (chapter 3, 4). Similarly, the conceptual profiling approach gauges a broad list of terms (emotional and functional associations); however, a product specific list has to be developed for every specific product category (15, 23-25). Both tools require verbalisation of the emotional and conceptual terms, whereas, these can be difficult to express with words (26-28).

PrEmo®, on the other hand , is a non-verbal questionnaire and measures emotions which are expressed by animations of a cartoon character instead of words (26). Hence, it is not language dependent, but this instrument is limited to a small number of emotional terms to measure food emotions. PrEmo® was not specifically developed to measure emotional responses to foods (26), nevertheless, the findings presented in this thesis demonstrated that PrEmo® was suitable to differentiate between food products (chapter 3).

All tools mentioned above are explicit measures of emotional and conceptual responses to foods and assess only a single moment of the consumption episode, i.e. the first tasted bite or sip.

However, part of the emotional and conceptual associations elicited by foods occurs below the level of consciousness (29). Hence, individuals are not aware of these associations and cannot report them in explicit questionnaires. Moreover, a realistic food consumption occasion involves an eating episode of a meal. It follows that the research tools applied in this thesis did not capture emotional or conceptual associations that occur below the level of consciousness or evolve during a consumption episode. Other techniques are needed to capture these associations, e.g. the Implicit Association Task (IAT), physiological measures of the autonomic nervous system (ANS), or the Temporal Dominance of Emotions (TDE) technique (30-32). These tools might be interesting for future research.

Test foods. To test the predictive ability of emotional and conceptual responses to foods, breakfast drinks were chosen as test products in all studies. The product category breakfast drink was chosen because it was relevant to the project sponsors. In addition, the product category was convenient for the study design because breakfast drinks are typically consumed as a single product for breakfast and there is no bias of other foods consumed prior or during the breakfast. The choice to always measure emotional and conceptual responses to breakfast drinks was optimal for this project because we were able to replicate findings and to compare findings on food-evoked emotions across studies (chapter 3, 4). However, using products from the same category might decrease the generalizability or external validity of our findings. Previous research showed that emotional profiles differ across products from different product categories, for instance, some products (chocolate) elicit more intense emotions than other products (oatmeal and carrots) (18, 20, 22, 33). Hence, it is possible that our results demonstrating that the positive and high arousal emotions related to packaged food product choice could be product category dependent. It is conceivable, albeit speculative, that a more 'calming product' (e.g. tea) would result in different outcomes. In this case the low arousal emotions might play a role in product choice, however, this has not yet been investigated and future research should investigate other product categories.

Subjects

In emotional and conceptual profiling it is recommended to include only users of the test products as participants (15, 18). None-users tend to associate more negative emotions and less positive emotions to the product of interest (18). This is in line with marketing research, where target segmentation is common practice. With respect to food products, target segmentation means to identify a subset of consumers who are aware of, and regularly use, a product category. This focus on a so called 'meaningful subset' of participants (34) is not typically applied in sensory science where the aim is to generalize study results to the entire population (8). Nonetheless, due to the

individual differences in emotional profiles reported by King and Meiselman (18) we recommend to incorporate target segmentation in emotional profiling as we did in the studies described in this thesis.

Discussion and interpretation of the results

Emotions predict choice

The findings described in this thesis provide new insights into the link between food-evoked emotions and food choice (chapter 2, 3, 4). Food-evoked emotions add predictive value to solely liking ratings, for choice based on taste as well as on packaging (see Figure 8.1). Hence, emotions are involved in food-related decision making. This notion fits into the somatic marker hypothesis, introduced by Damasio (35), which states that emotions play a key role in decision making processes (35, 36).

The most important finding regarding the effect of packaging on emotions and choice was the significant contribution of the arousal dimension (active, energetic emotions) on packaged food choice (see also Figure 8.1). This dimension is of special interest because it shows a much lower correlation with liking than the valence dimension (positive-negative, pleasantness-unpleasantness) (chapter 4). In early consumer studies researchers investigated consumers' usage experience of non-food products (37, 38). Based on this earlier work it was shown that it is essential to include hedonic (pleasure) evaluations of the product experience in combination with existing measures of a product's utilitarian value. Similar to our findings these product-related emotions could be also organized in a two dimensional space, i.e. valence vs. arousal, and a relationship was shown between valence, arousal and post-purchase product satisfaction, i.e. a choice estimate measured on a Likert scale (37-39). The research on product satisfaction and the findings presented in this thesis (chapter 4) suggest that both pleasantness and arousal emotions guide consumers' product selection. More specifically, emotions guided choices towards products associated with positive emotions and high arousal although this pattern could be (partly) product category specific. A possible underlying mechanism is that individuals seek for these emotions in a product because positive emotions are a source of pleasure and they have a rewarding effect (40, 41). The arousal dimension in our research findings contains emotions like active and energetic, which may be associated with approach behaviour and action tendencies (42, 43). Therefore, this dimension could predominantly represent a source of motivation and desire to obtain reward, which represents another distinct source of reward, i.e. wanting, as described by Berridge and Kringelbach (40).

Emotions and Liking

The combination of emotions and liking resulted consistently in the best fitting model to predict choice (chapter 3, 4). More specifically, adding emotional profiles to the model with liking resulted in a 10% increase of correctly predicted individual choices based on package. For unbranded food choices, emotions improved the prediction based on liking only by 5%. The significance of these improved models depends on the research aims, and has to be weighed in terms of expected costs and benefits. One could question if the added 'effort' of measuring product-evoked emotions is worthwhile when the prediction of choice improves only by 5-10%, and still leaves us with approx. 50% unexplained variance in choice behaviour. After all, predicting product performance based on classical liking evaluations requires only a simple single hedonic evaluation. However, based on the outcomes of this thesis, we do believe that emotion profiling is valuable in characterizing product 'identity' and in actionable endpoints for product development. As described in the previous chapter (7) food-evoked emotions can be used to adapt a product to consumers' needs and expectations. Liking ratings provide limited information because a single score does not tell a product developer how to change a products profile. For example, two products may have similar liking scores, yet distinct emotional profiles (18, 21). The more detailed emotional profiles may guide product development in the way that enables tailoring of a food product's sensory characteristics to consumers' emotional associations with the product (15, 21, 25).

Liking ratings as drivers of food choice

As expected, liking was still a strong predictor of individual choice in all three studies described in this thesis, confirming that (expected) liking is an important determinant of food choice (13, 44-51). We showed high correlations between higher liking ratings and many positive emotions (valence) in our studies (chapter 2). Other researchers also reported a strong relationship between liking and emotion measures in foods (18, 21). Based on this, one may argue that liking and positive valence emotions in part represent the same underlying construct.

Liking is the actual experienced pleasure component of a reward, and is defined as an affective response to a stimulus (40, 52). When consumers evaluate the hedonic impact (pleasure and palatability), liking refers to the conscious experience of pleasure (hedonic feelings) when tasting a product (40, 53). Thus, liking may be used by consumers as an umbrella term for positive emotions they experience during food consumption. Therefore, to better understand the hedonic impact of food consumption, the measure of various emotions in response to foods may also serve as a tool to further explore and understand the nature of liking. The measure of emotions (especially valence)

might offer a more detailed, more specific and more accurate profile of the hedonic evaluation of foods compared to a mono-dimensional construct such as liking. This may explain our findings that emotions combined with liking provide a better prediction of food choice than a single liking score (chapter 3, 4).

Conceptualisations as drivers of food choice

In this thesis we correctly predict individual food choices for approximately half of the participants based on liking and emotional responses to foods. Hence, the remaining half of the individual choices could not be explained by liking and emotion measures. We assumed that choice is not only driven by liking and emotion-related associations but also by broader conceptualisations (meanings and cognitive associations consumers attach to a product).

Conceptualisations can be used to gauge the match between the conceptual profiles elicited by the products sensory and packaging cues (15). We hypothesized that the product-package-match would result in a better prediction of choice compared to liking ratings. However, our findings did not confirm this hypothesis. The match between conceptual responses to the products' taste and its' package was positively related to choice based on packaging (see Figure 8.1), but liking ratings outperformed the product-package-match in the predictive ability of individual product choice (chapter 5). A recent study by Thomson and Crocker (15) demonstrated that the product-brand-match gives insights into why a product is successful on the market or not. A strong product-brand-match was found for a successful product whereas an unsuccessful product showed a strong mismatch. Despite the fact that our study did not show evidence for a strong additional value for conceptualisations in predicting actual choice compared to liking, we do believe that the product-brand-match concept is valuable. It offers an indirect measure of product expectations fulfilment, which is achieved if a product delivers the expected emotional and functional benefits to the consumer. Expectation fulfilment has been linked to product satisfaction, a key mediator of post-purchase behaviour (38, 54-57). Moreover, the fit-to-package concept gauged with conceptual profiling can provide detailed information on which specific expectations elicited by packaging cues are not fulfilled by the sensory properties, for example taste. Thus, this information can be applied in product development.

Context appropriateness influences choice

In chapter 6 we provided more evidence that package plays a key role in consumers' food choice via contextual cues signalled by the package. We showed that the contextual cue 'appropriateness'

(if a food matches the consumption context) influenced food choice in a simulated cafeteria setting (see Figure 8.1) (chapter 6). In line with these observations, food product evaluations were found to be affected by an appropriate context. More specifically, consumers associated more frequently positive emotions with a product in an appropriate evoked consumption context as compared to an inappropriate context (22, 33). A more positive emotional profile evoked by the consumption context might in turn lead to an increase in choice (chapter 3, 4). These findings demonstrate the importance of the consumption context and packaging on consumer behaviour and choice.

Implications and future research

From the perspective of increased numbers of health problems caused by an unhealthy diet it is important to understand the determinants involved in food choice. Understanding why a product will be chosen and why a product may or may not succeed in the market could help to promote healthy choices. In this thesis we studied the emotional and conceptual drivers of food choice and showed that both are relevant drivers of choice.

In the previous chapter (7) an application of emotion research in product development is offered. Emotional responses and sensory attributes of food products were measured. Then, specific sensory drivers of emotional responses were identified (chapter 7). These findings have relevance for product development in two ways. First, the identified links could be used to create consonance between the emotional profiles of different product elements, e.g. the brand, the package and the actual product taste by modifying the sensory product properties (15, 25, 56). This might result in a stronger congruency between different product elements which was positively related to product choice (chapter 5) (15, 56). Second, a product developer might tailor the sensory attributes in a way that they elicit (stronger) positive emotions. This could be used to promote a healthy product choice because we demonstrated in this thesis that food choice is guided by positive emotional responses to foods. Hence, emotions can guide the product development of new or existing healthy products on the market.

In addition to an application in product development, the present thesis findings also raised some suggestions for future research. In the context of the current trend in food-evoked emotion research to develop word lists specific for a product category, the question arises if future research should focus on specific or generic tools (applicable to all foods and beverages) to measure emotions. On the one hand, in emotional profiling the specific word lists are found to be more sensitive to detect subtle differences between products then generic word lists (21, 58, 59). On the other hand, results obtained with a generic word list are better comparable across studies than specific lists because

the latter will contain different emotional terms across studies.

Ideally, the product specific as well as the generic tools should be applied in future research. An emotion questionnaire specifically developed for a product category may result in richer (more differential) emotional profiles that can explain more variance in food choice behaviour. A generic tool will contribute to understand the impact of food-evoked emotions on food choice across various product categories. Taken together, this information will help to make inferential conclusions on the role of emotions in the decision making process.

In the studies described in this thesis we applied exclusively explicit self-report instruments, i.e. the EsSense Profile™, the conceptual profiling approach and PrEmo®. All these instruments measure emotions and associations participants can become aware of and they measure emotions elicited only by a static event of a consumption episode (the first sip or bite). Nevertheless, emotional and associative experiences in a real life consumption situation also occur below the level of consciousness and emotions are not static events, but they are dynamic, i.e. changing over time (29, 31, 60). In future research it would be therefore interesting to apply tools which measure these emotional and conceptual associations to foods.

It would be worthwhile to assess emotional responses to foods using implicit physiological measures of the autonomic nervous system (ANS) or brain imaging techniques such as functional MRI (32, 61, 62). Previous research showed that measures of the ANS, e.g. heart rates and skin conductance responses, vary across different food odours or different sensory attributes (taste, sight)(32, 63, 64). It would be interesting to investigate, for instance, how implicitly assessed arousal responses to foods are related to actual choice behaviour. In addition, to increase our understanding of implicit conceptual responses associated with foods, techniques like the Implicit Association Task (IAT) or the Affective Misattribution Task (30, 65-68) should be implemented in future research.

Furthermore, the Temporal Dominance of Emotions (TDE) has been shown to provide a fuller emotional profile of a consumption episode than a static measure of emotional responses to a single bite or sip (31). A dynamic measurement tool will help to explain the impact of emotions elicited during a consumption episode on actual food choice behaviour. Taken together, these methods offer the possibility to also capture the implicit and dynamic emotional and conceptual responses to foods, which might improve our understanding of the consumption experience in a realistic setting.

Lastly, it may be also of great interest to investigate how emotions influence product selection

behaviour in the long term. In this thesis we focused on a single measure of choice; however, food choice is often habitual behaviour, thus choices are repeated over time (69, 70). It would be worthwhile to understand the role of emotions in repeated choice behaviour in the long term.

Conclusions

Affective (emotional) and cognitive responses to foods as potential drivers of choice were studied. Emotional responses to foods predicted choice consistently better than liking scores alone. However, the combination of emotions and liking scores for foods resulted consistently in the best possible prediction of choice. Hence, emotions guide consumers' choice behaviour in a way that is in part not captured by liking ratings and provide valuable additional insights for product development.

Furthermore, conceptual product profiles, i.e. a set of emotional and functional terms consumers associate with the product, seem to be related to choice behaviour; but it is still unclear what their contribution is in predicting choice based on liking per se.

Overall, both the affective and the cognitive associations to foods were found to be relevant drivers of choice and provide deeper insights into individuals' dietary choice behaviour.

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Summary

Asking consumers how much they like a product is often used to tell which product they will choose and consume in the future. And indeed, a consumer is more likely to choose a product which she/he likes than a less liked product. However, consumers do not choose a product based on liking alone, as many highly liked products are failing on the market. How we select a brand or product in a supermarket is not completely known but there are certainly more factors involved than liking. Food choice is also influenced by previous consumption, emotions (e.g. happy, energetic or enthusiast) and all kind of associations (e.g. fresh or trendy) consumers attach to a certain product. Identification of specific emotions or associations that consumers link with products will help to understand what influences them in the moment they put a product in their shopping trolley. In the research studies described in this thesis, we measured emotions and associations consumers felt or linked with a food product.

The aim of research described in this thesis was to test if emotions and associations evoked by a food product explain and predict food choice better than liking per se. We focused on the sensory properties (e.g. taste, texture) and on the product packages. In addition, we explored the link between sensory properties and emotional responses to foods; and the influence of the context appropriateness (e.g. a cheese sandwich for lunch (appropriate) or ice cream for breakfast (not appropriate)) on choice.

In the first study (chapter 2) we used two different tools to measure emotions evoked by the sensory properties of seven breakfast drinks (without any packaging information). We used a questionnaire, the EsSense ProfileTM Method, and asked participants to taste a product and to indicate how much they felt specific emotions, which were presented as written words. And, we used a non-verbal tool, PrEmo®, to measure emotions which were represented by an animated cartoon figure (a 'puppet that acted out' certain emotions) without using actual words. The tools were compared and we assessed their ability to distinguish products from the same product category (breakfast drinks). In this first study we also measured actual food choice behaviour, i.e. participants choose one product out of seven, and we asked participants how much they liked the products. The results showed that participants felt different emotions when tasting the seven products. Both tools, EsSense ProfileTM and PrEmo®, were able to detect these differences. To test if we can use emotions to predict what a consumer will choose (chapter 3), we summarised several specific emotions in two broad dimensions (units). The first dimension covers positive and negative emotions and the second dimension calm and energetic/active emotions. We found that positive emotions and higher liking ratings together predicted participants' actual food choice better than predicting choice based on liking ratings alone. We were able to predict choice based on the sensory properties for over 50% of all participants.

In the second study we repeated the measures of study 1 but now we also introduced the product packages. So, we asked participants to rate the emotions evoked by the product packages and to choose a product based also on the package (like it usually happens in the supermarket). This time the combination of positive emotions, active emotions and higher liking ratings resulted in the best possible prediction of choice. We were able to predict choice for 41% of all participants.

In the last study (chapter 5) we measured liking and associations (e.g. fresh or trendy) participants linked with products (six breakfast drinks). We asked participants how much they liked the products or how much they expected to like them based on the packages. Furthermore, participants had to taste the products or view the packages and then to indicate if they associate a term with the product or not. Later we checked if participants associated the same terms with the product's taste and the corresponding package. We found that the better the product-pack fit (same terms associations) was, the more often a product was likely to be chosen. However, we also found that liking ratings predict participants' choice better than the product-pack fit.

In the studies described above we took some additional measures to understand better consumer's food choice behaviour and the emotional responses to foods. In chapter 6 we describe the influence of context appropriateness on choice behaviour. We showed that consumers were more likely to select a product when the package provided some information on the context appropriateness (e.g. breakfast context for breakfast drinks). In addition to the measurements we took during the three studies, a trained sensory panel (a group of testers trained to describe sensory properties) tasted and evaluated the sensory properties of the test products (chapter 7). We were able to describe the link between specific sensory properties and the emotional responses. We found that texture-related properties (e.g. creamy, fatty and mouth filling) were related to positive emotions (e.g. happy and joyful) and that specific taste-related properties (e.g. yoghurt-like, fresh) were related to some arousal emotions (e.g. adventurous or wild).

The general discussion (chapter 8) describes the main findings and conclusions of this PhD thesis. We showed that using emotions together with liking improves the prediction of choice based on liking scores alone. Hence, emotions may help to predict which product a consumer is going to select at the supermarket. Furthermore, associations consumers link with a food product also help to understand food choice, but it is still unclear if they advance the predictions of choice based on liking scores.

In addition, we showed that consumers' choice based on the product packages is influenced by appropriateness. Lastly, we identified which sensory properties evoke specific emotional responses,

to offer a way to apply our findings in product development.

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Swetlana

About the author

Curriculum vitae

Swetlana Gutjar was born on March, 30th, 1986 in Nekrasowa/Altai, Russia. She obtained her high school diploma (Cusanus-Gymnasium Erkelenz, Germany) in 2006 and then started to study Psychology at Maastricht University, the Netherlands. During her Bachelor curriculum, she also followed several elective courses at the University of Bangor in the United Kingdom. She received her Bachelor degree in 2009 and enrolled in the Master's program in Social and Health Psychology at Maastricht University thereafter. She completed her Master's thesis in the department Sensation, Perception and Behaviour at Unilever R&D Vlaardingen, the Netherlands. She investigated the role of expected satiety on portion size selection behaviour, which resulted in a publication in the journal Appetite. She obtained her Master's degree in 2010.

She was appointed as a PhD candidate at the Top Institute Food and Nutrition (TIFN) and the Division of Human Nutrition of Wageningen University in the project 'Sensory and Liking' in 2011. Her research focused on the influence of affective and cognitive responses to foods on consumers' choice behaviour, as described in this thesis.

During her PhD project, Swetlana joined the educational program of the graduate school VLAG, she attended several international conferences and was involved in teaching. Furthermore, she was member of the VLAG PhD-council, the Wageningen PhD council and the organising committee of the PhD study tour to Sydney and Melbourne, Australia. In 2015, she was awarded with the Young Scientist Award by the organising committee of the 11th Pangborn Sensory Science Symposium in Gothenburg, Sweden.

Publications in peer-reviewed journals

Gutjar, S., de Graaf, C., Palascha, A., & Jager, G. (2014): Food choice: The battle between package, taste and consumption situation. Appetite, 80(0), 109–113.

Gutjar, S., de Graaf, C., Kooijman, V., de Wijk, R.A., Nys, A., Ter Horst, G.J., & Jager, G. (in press): The role of emotions in food choice and liking. Food Research International, accepted for publication.

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Gutjar, S., Dalenberg, J.R., de Graaf, C., de Wijk, R.A., Palascha, A., Renken, R.J., & Jager, G. (in press): What reported food-evoked emotions may add: A model to predict consumer food choice. Food Quality and Preference, accepted for publication.

Bulsing, P.J., **Gutjar, S.**, Zijlstra, N., & Zandstra, E. H. (2015): High satiety expectations of a first course promote selection of less energy in a main course picture task. Appetite, 87(0), 236-243.

Gutjar, S., de Graaf, C., & Jager, G. (submitted): The contribution of conceptual profiles and liking to food choice.

Gutjar, S., de Graaf, C., de Wijk, R.A. & Jager, G. (submitted): Sensory driven emotions - Relationship between sensory and emotional profiles of foods.

Abstracts and presentations

Gutjar, S., Jager, G., Nys, A., Kooijman, V., de Wijk, R.A., de Graaf, C. Emotional appraisal in response to food products. 36th British Feeding and Drinking Group Annual Meeting, 29-30 March 2012, Brighton, UK. *Oral presentation*.

Gutjar, S., Jager, G., Nys, A., Mensink, M.G.J., de Wijk, R.A., & de Graaf, C. The congruency between food and context evoked emotions predicts food choice. 5th European Conference on Sensory and Consumer Research, 9-12 September 2012, Bern, Switzerland. *Poster presentation*.

Gutjar, S., de Graaf, C., Kooijman, V., Mensink, M.G.J., de Wijk, R.A., & Jager, G. (2013): Emotional responses to unlabelled and labelled food products. Appetite 71, p. 476. 37th British Feeding and Drinking Group Annual Meeting, 4-5 April 2013, Loughborough, UK. *Oral presentation*.

Gutjar, S., de Graaf, C., Kooijman, V., Mensink, M.G.J., de Wijk, R.A., & Jager, G. Emotional responses to unlabelled and labelled food products and their influence on food choice. 10th Pangborn Sensory Science Symposium, 11-15 August 2013, Rio de Janeiro, Brazil. *Poster presentation*.

Gutjar, S., de Graaf, C., & Jager, G. (2014): Food choice: the battle between package, taste and consumption situation. Appetite 83, p. 358. 38th British Feeding and Drinking Group Annual Meeting, 3-4 April 2014, Portsmouth, UK. *Poster presentation*.

Gutjar, S., de Graaf, C., de Wijk, R.A., & Jager, G. Emotional responses to taste and package and their impact on food choice. 6th European Conference on Sensory and Consumer Research, 7-10 September 2014, Copenhagen, Denmark. *Poster presentation*.

Gutjar, S., de Graaf, C., de Wijk, R.A., & Jager, G. Sensory drivers of food-evoked emotions. 39th British Feeding and Drinking Group Annual Meeting, 9-10 April 2015, Wageningen, The Netherlands. *Poster presentation*.

Gutjar, S., Dalenberg, J.R., de Graaf, C., de Wijk, R.A., Palascha, A., Renken, R.J. & Jager, G. What measuring food-evoked emotions can bring us? An extended model to predict consumers' choice. 11th Pangborn Sensory Science Symposium, 23-27 August 2015, Gothenburg, Sweden. *Poster presentation Young Scientist Award*.

Gutjar, S. The congruency between food and context evoked emotions predicts food choice. Top Institute Food and Nutrition Annual Conference, 30 May 2013, Amsterdam, The Netherlands. *Poster presentation & poster pitch presentation winner*.

Overview of completed training activities

Discipline specific courses and activities	Organizer and location	
Course 'Sensory Perception & Food Preference'	Graduate school VLAG, Wageningen, The Netherlands	2011
Course 'Research Methods in Human Appetite'	University of Sussex, UK	2011
Course 'NutriScience, A multifaceted approach to nutrition research'	Graduate school VLAG, Wageningen, The Netherlands	2013
Course 'Sensory evaluation and Food preferences'	Copenhagen University, Denmark	2014
Symposium "Sensory Specific Satiety: the role of product properties in obesity prevention"	Graduate school VLAG, Wageningen, The Netherlands	2012
MOAabout meeting, Measuring emotions in relation to products & consumers	MOA, Amsterdam, The Netherlands	2012
European Conference on Sensory and Consumer Research	Elsevier	
5th European Conference	Bern, Switzerland	2012
6th European Conference	Copenhagen, Denmark	2014
British Feeding and Drinking Group (BFDG)	BFDG	
36th Annual Meeting	Brighton, UK	2012
37th Annual Meeting	Loughborough, UK	2013
38th Annual Meeting	Portsmouth, UK	2014
39th Annual Meeting	Wageningen, The Netherlands	2015
10th Pangborn Sensory Science Symposium	Elsevier, Rio de Janeiro, Brazil	2013
Symposium 'Positive Design Day'	TU Delft, The Netherlands	2013

General courses and activities		
Teaching and supervising thesis students	Educational Staff Development Wageningen UR, The Netherlands	2011
PhD introduction week	Graduate school VLAG, Baarlo, The Netherlands	2012
Master class: Analysis in R	Graduate school VLAG, Wageningen, The Netherlands	2012
Scientific writing	Wageningen Graduate School (WGS), Wageningen, The Netherlands	2013
Master class: Longitudinal data analysis	Graduate school VLAG, Wageningen, The Netherlands	2013
1st PhD Workshop Carousel, Stress identification and management, Writing propositions, Scientific publishing	WGS, Wageningen, The Netherlands	2014
Course 'Career Perspectives'	WGS, Wageningen, The Netherlands	2014
Several PhD workshops	Top Institute Food and Nutrition (TIFN), Wageningen, The Netherlands	2011-2015
Optional courses and activities		
Preparing PhD research proposal and research presentations	Division of Human Nutrition, Wageningen, The Netherlands	2011-2014
Organizing and participating in PhD study tour to Sydney and Melbourne, Australia		2013
Committee Member VLAG PhD Council	Graduate school VLAG, Wageningen, The Netherlands	2012-2014
Committee Member Wageningen PhD Council (WPC)	WGS, Wageningen, The Netherlands	2012-2014
Organizing and participating in the 1st Wageningen PhD Symposium	WGS, Wageningen, The Netherlands	2013

Colophon

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