Food Quality and Preference 126 (2025) 105381

Contents lists available at ScienceDirect

Food Quality and Preference

journal homepage: www.elsevier.com/locate/foodqual

The consumer journey: A new methodology to study the effects of store and product information on consumers' responses to sustainable foods and clothing fabrics

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ARTICLE INFO

Keywords:
Store
Food
Clothing fabric
Product information
Consumer-product interactions
Heart rate
Skin conductance
Facial expressions

ABSTRACT

Background: Consumer experiences are not only based on how a food tastes or clothing fabric feels but also on factors such as the store of purchase and product information.
Method: Participants were taken on virtual consumer journeys to monitor their reactions to sustainable foods or clothing fabrics. After a virtual 'purchase', an ingredient/material information phase followed, whereafter foods were tasted or T-shirt sleeves were felt.
Results: Heart rate and skin conductance were significantly affected by the type of food ($p < 0.001$), while the type of fabric and information significantly influenced facial expressions ($p < 0.05$). Sustainable supermarket assortment foods triggered higher skin conductance and more negatively valenced facial expressions than those from the regular assortment ($p < 0.05$). Reformulated muffin, yoghurt drink, and Bolognese sauce triggered higher skin conductance, while this was lower for reformulated cookies and lentil burgers. Facial expressions were more positive for reformulated cookies and more negative for reformulated lentil burgers ($p < 0.05$). Fabric from reused clothing triggered negative facial expressions and increased heart rate and skin conductance ($p < 0.01$), especially in combination with an upscale store. Fabrics from nettles and polylactic acid were similar to reactions to the familiar benchmark (organic cotton), namely lowered heart rate and skin conductance, and positive facial expressions.
Conclusion: This methodology identified opportunities for the development of sustainable foods and fabrics that are acceptable to consumers and could therefore be a valuable tool in the development of sustainable products that are successful in the marketplace.

1. Introduction

Sustainability is key in many new developments of foods as well as apparel. In the case of foods, there has been a growing interest in developing food products with valuable ingredients from previously underutilized side streams. Examples of such ingredients include those recovered through biorefinery processes that contribute to the sustainability of food products (Aschemann-Witzel & Peschel, 2019; Garcia-Garcia, Stone, & Rahimifard, 2019). Valorization of side stream -or upcycling- is central to both the European and Dutch ambitions to grow towards a circular economy based on the conversion of waste, side streams, and renewable biological sources by 2050 (Dijksma & Kamp, 2016; European Commission, 2015). A similar interest in sustainability can be seen for apparel, a category of consumer goods that is identified as a major contributor to greenhouse emissions. In an effort to lower the ecological footprint of clothing, producers shift from traditional fabric origins such as cotton to alternative materials such as nettles or polylactic acid. Also, alternatives such as recycled fabric and reused clothing become increasingly available to consumers.

The market success of these promising developments ultimately depends on the acceptance of these alternative ingredients and materials by consumers. Some consumers have been shown to lack interest or awareness related to alternatives or associate it with waste, which may cause feelings of disgust or belief that a food product is contaminated (Baxter, Aurisicchio, & Childs, 2017; Kirchherr et al., 2018; Rozin, Haddad, Nemeroff, & Slovic, 2015). Similarly, sustainability may not

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https://doi.org/10.1016/j.foodqual.2024.105381
Received 7 November 2023; Received in revised form 20 November 2024; Accepted 22 November 2024
Available online 27 November 2024

(yet) be an important driver of consumer acceptance of clothing materials, in contrast to for example fit and comfort (Rausch, Baier, & Wening, 2021). For consumers, navigating the complex food and non-food environment with its virtual endless number of choice options, types of labels, ingredient specifications, and brands can be a challenging task, particularly when dealing with intangible product attributes. This process occurs both consciously and unconsciously. Therefore, understanding the thoughts, associations, and emotions that are related to the moment of consuming – or touching- a product that contains alternatives is imperative to its market success (De Wijk & Noldus, 2021; Meiselman, 2016; Siegrist & Hartmann, 2020). Other moments, such as the selection and purchase of the product in the store are probably important as well. Perception of consumer goods, irrespective of whether these goods are foods or non-foods, does not start at the moment that the food is tasted, or that a non-food product such as clothing fabric is touched, but is typically affected by prior interactions with these products. In the case of food products, perception typically starts before the food is placed in the mouth. Before the food is consumed, consumers have purchased the food in a supermarket, may have seen the packaging and label, may have read the information on the packaging, have prepared the food, and have put the prepared food on a plate. Consequently, prior to tasting, consumers will already have expectations regarding the food's taste and flavor based on visual, smell, tactile, and sometimes even auditory cues. These expectations affect the decision of consumers whether the food is accepted and consumed. Similarly, for non-food products such as clothing prior to touching a new piece of clothing, consumers' expectations are already shaped by factors such as the type of store where the clothing was purchased, or information provided by the label, logos and material specification. These expectations may be confirmed or disconfirmed when the food is consumed or when the clothing is worn, which may determine the repeat purchase of the product.

The importance of these events for consumer acceptance is generally acknowledged, but primarily by marketeers who have coined the phrase 'customer's journey' for this series of events whereby certain events seem to be more important for consumer acceptance than others. In sensory and consumer food science the effects of the full range of events between purchase and consumption on consumer acceptance is rarely investigated. Instead, most studies are limited to the consumption event itself, or to the events that immediately precede consumption, such as visual inspection of the food product and/or its package. These studies typically find that branding, product names and sensory descriptors, and health and ingredient labels affect consumers' acceptance and taste experiences (see Piqueras-Fiszman and Spence, 2015 and Skaczkowski, Durkin, Kashima, & Wakefield, 2016 for excellent reviews of these effects). Models such as the assimilation and contrast model (Piqueras Fiszman & Spence, 2015; Schifferstein, Kole, & Mojet, 1999) describe various ways of how expectations based on for example packages and labels interact with actual experiences. These models predict the effects of expectations on actual experiences depending on how closely the expectations align with the experiences. In sensory and consumer science of non-foods this type of research is even less developed.

One of the reasons for this lack of development is that tests in realistic contexts such as stores and homes are costly, as these tests are rather time consuming and burdensome to conduct compared to traditional central location tests (Holthuysen, Vrijhof, De Wijk, & Kremer, 2017). Also, the downside is that there is very little control on how the product is being tested (e.g., Boutrolle, Delarue, Arranz, Rogeaux, & Köster, 2007; Delarue & Lageat, 2019). A solution is to simulate these contexts in the laboratory, which would not only be cost-effective but would also combine the increased experimental control of the laboratory with the increased realism of the simulated context (Galiñanes Plaza, Delarue, & Saulais, 2019; Holthuysen et al., 2017). Recently, the incorporation of context into food sensory and consumer testing has received more and more attention (Galiñanes Plaza et al., 2019). A new and promising development is the use of immersive technologies to create an immersive simulated context to improve the predictive validity and reliability of sensory and consumer testing, i.e., re-creating the physical context of a store or home in a laboratory with visual, auditory and olfactory cues. Immersive technologies are technologies that blur the line between the physical world and a digital or simulated world, creating a full sense of immersion (Delarue & Lageat, 2019; Hehn, Lutsch, & Pessel, 2019).

Initial studies in the area of immersive technologies indicate that they indeed seem to improve the predictive validity and reliability of liking scores in food consumer testing (Andersen, Kraus, Ritz, & Bredie, 2018. Bangcuyo, Smith, Zumach, Pierce, and Guttman (2015) were the first to apply immersive technologies and found that liking data collected in a virtual coffee house were more discriminating and a more reliable predictor of future coffee liking than those collected in traditional sensory booths. Moreover, using similar immersive settings to evaluate liking for cookies in a virtual home kitchen, Hathaway and Simons (2017) found that the immersive setting not only generated more reliable liking data over time but also had people more engaged compared to the traditional sensory booth testing context. The latter most likely also contributed to improved data quality (Bangcuyo et al., 2015). So far, immersive technologies have been applied primarily to foods, and the context was typically limited to the consumption situation.

For the present two studies, the use of immersive technologies was explored 1) for broader contexts that included phases of the typical consumer journey, namely store and information about the food ingredients and fabric material, and 2) with explicit (or declarative) (questionnaires) as well as physiological responses (heart rate and skin conductance responses of the autonomic nervous system (ANS)), and facial expressions. In contrast to declarative measures, physiological measures do not rely on introspection and may therefore be well-suited to measure relatively subtle effects that consumers are not aware of, but which may play an important role in product acceptance. In food science, these measures have been primarily used to complement declarative measures during tasting (De Wijk, He, Mensink, Verhoeven, & de Graaf, 2014, De Wijk, Ushiama, Ummels, Zimmerman, & Kaneko, 2021, Samant, Chapko, & Seo, 2017, Mojet et al., 2015, Danner et al., 2014, Kaneko et al., 2019). Skin conductance is seen as a reliable marker for arousal (e.g., Boucsein, 1992). Novelty is often also associated with increased skin conductance/arousal, combined with a short deceleration in heart rate (also referred to as orienting response, see Verastegui Tena, Van Trijp, & Piqueras Fiszman, 2019 & Verastegui-Tena, van Trijp, & Piqueras-Fiszman, 2019; Bradley, 2009). Attention and anticipation are associated with a more prolonged deceleration in heart rate (Poli, Sarlo, Bortoletto, Buodo, & Palomba, 2007). Facial expressions, the expressive component of emotions, relates to factors such as arousal, novelty, and valence (e.g., Ekman, 1999). Studies have demonstrated that high arousal is typically associated with emotions of anger, disgust, fear, and happiness. Novelty is associated with emotions of surprise and interest, familiarity with neutral, or even boredom (e.g., Coppin & Sanders, 2016). Valence may be seen as a combination of emotions of (lack of) happiness and (lack of) negative emotions such as disgust, anger, and fear. Combined, ANS responses and facial expressions may be well suited to explore the roles of factors such as arousal, novelty/familiarity, and emotions during consumer journeys. Finally, 3) immersive technologies were explored for responses to foods and non-foods (T-shirts from different clothing fabrics). Despite their obvious differences, foods and clothing share many commonalities, such as their sensory properties are important drivers of consumer acceptance and purchases of foods and clothing are both driven by a combination of rational and irrational factors. For example, even though consumers may rationally know that certain foods or fabrics may be better for themselves and/or for the environment, irrational reactions such as disgust may prevent the adoption of these products.

The present studies will 'guide' participants along virtual journeys that start when a food or T-shirt product is seen in a store and is 'purchased', followed by information about the foods' ingredients and T-shirts' fabric material. This virtual journey becomes a real journey when the food is then actually consumed – or when the T-shirt fabric is actually felt during evaluation. Each phase of a journey will be systematically varied and possible effects on product evaluations will be measured using a combination of declarative (questionnaires), physiological measures (heart rate, skin conductance) and facial expressions.

For these studies it is hypothesized that:

- Information about store assortment (food study) or store type (clothing fabric study) will affect responses during product evaluations.
- Compared to the regular ingredients/materials, information about sustainable alternatives will affect product evaluations negatively.

2. Methods

2.1. Participants

For the food study cross-sectional data were collected from 33 participants. For the clothing fabric study, cross-sectional data were collected from 31 participants. Participants were recruited from a voluntary consumer panel of Wageningen Food and Biobased Research. Potential participants were screened on selection criteria using a recruitment survey (EyeQuestion Software). Inclusion criteria for both studies were 1) having good general health and 2) being between 20 and 70 years old. An additional criterium for the food study was 1) buying pasta sauce, muffins, biscuits, vegetable burgers and milk drinks at least once a year. Exclusion criteria were suffering from cardiac arrhythmia, having food allergies, following a vegetarian or vegan diet (food study) or having allergies for clothing fabrics (fabric study). The age of participants of the food study ranged from 20 to 67, with a median sample age of 40. Gender was distributed across the sample as 34 % males and 66 % females. The age of participants of the fabric study ranged from 20 to 64, with a median sample age of 51. Gender was distributed across the sample as 42 % males and 58 % females. All participants gave informed consent for the use of their data in this study. After completion of the study they received a small financial compensation. Approval for both studies was granted by the Social Ethics Committee of Wageningen University and Research.

2.2. Materials

2.2.1. Foods.

Five commercially available test foods were included in the study. These foods were selected based on their availability in (Dutch) supermarkets and the possibilities for reformulation to produce more sustainable versions. The food products were purchased at a local supermarket (Albert Heijn) and included vegetarian lentil burgers, vanilla muffins and oat cookies (all Albert Heijn private label), strawberry yoghurt drink (Optimel) and Bolognese sauce (Grand'Italia). During the experiment, lentil burgers and Bolognese sauce with cooked pasta were warmed using a microwave to their normal consumption temperature. All test foods were presented either on a spoon in a small bowl or in a cup to facilitate simple tasting and minimize arm movement. The participants always tasted the five products with the regular ingredients and

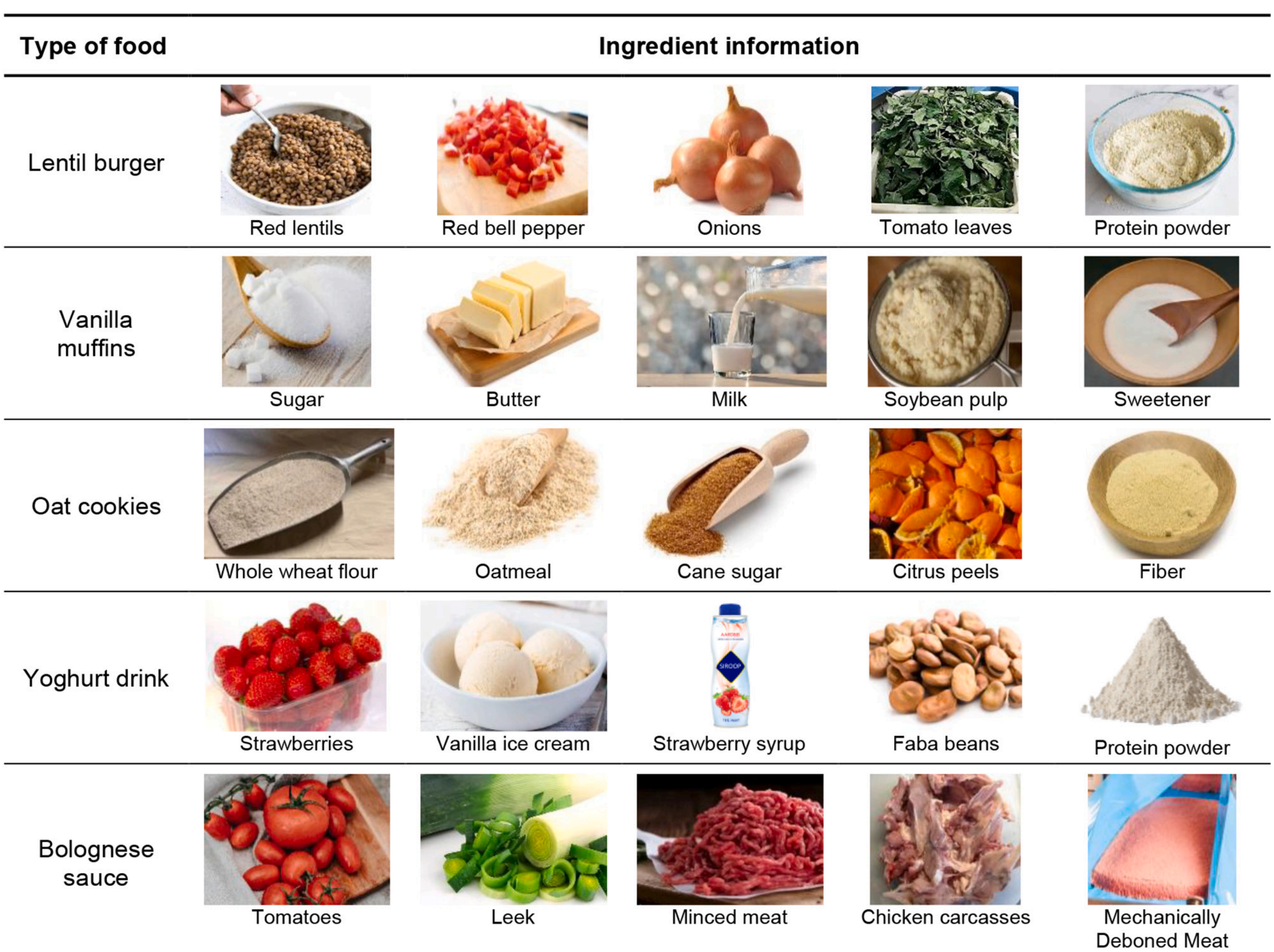


Diagram 1. Overview of type of ingredient information per food product used in the food study.

were led to believe in the reformulated conditions that the foods contained an alternative ingredient. This ingredient was protein from tomato leaves for the lentil burger, fiber from citrus fruits for the oat cookie, sweetener from soybean pulp for the muffin, Mechanically Deboned Meat (MDM) from chicken carcasses for the Bolognese sauce, and protein from fava bean for the yoghurt drink as a new protein source (see Diagram 1). These ingredients were selected from previous Wageningen University and Research studies that indicated that these reformulations were technically and economically viable, for example valorization of side-streams (e.g., Pyett et al., 2023). Consumers were probably familiar with the concept of added protein, sweeteners or fiber to food products. Though, the selected reformulated ingredients mostly are either novel or future-oriented and were thus unfamiliar applications. MDM was specifically included as it might trigger stronger emotional responses (e.g., disgust, neophobia) when showing its source, namely chicken carcasses.

2.2.2. Fabrics.

The fabric samples that were touched with the fingers were all manufactured from cotton. To introduce sensory variations between T-shirts, black T-shirts (long sleeves, size XL for men) from four manufacturers were included in the study: Fruit of the Loom, Hema, Zeeman and WE fashion. Four sleeves of Fruit of the Loom T-shirts were used and two sleeves from each of the other T-shirts resulting in a total of ten test samples. Each test sample was fixated on a wooden base (size 25 × 18 cm). The opening of one side of the sleeve was held open by a metal wire, whereas the other opening was closed. This set-up allowed the participants to easily insert one hand inside the sleeve without using the other hand and to evaluate the sleeve's fabric with the fingers. The participants were led to believe via the ingredient information that the fabric sample was either manufactured from organic cotton (the benchmark material for familiar and popular T-shirts), reused materials (used clothing that is cleaned), recycled materials (a fabric that is remanufactured from used clothing) fibers from polylactic acid (PLA), or nettles (see Diagram 2). These types of materials were selected because 1) they represent clothing materials that are already commercially available, and 2) they vary in the degree to which they are familiar to the average consumer. For example, clothing of organic cotton, and recycled and reused clothing is already fairly mainstream, whereas clothing from materials such as PLA and nettles are currently niche products but become increasingly popular (Fattahi, Khoddami, & Avinc, 2020; Vived Adhia et al., 2021).

2.3. Procedure

The two studies were conducted at the experimental facility of Noldus Information Technology located in Wageningen, The Netherlands. Participants in the food study participated in two 1-h sessions separated by a one-week interval (April 2022), whereas participants in the clothing fabric study participated in a single 1-h session (October 2022). At the start of a session, participants were seated comfortably behind a PC equipped with webcam and keyboard and a short verbal instruction was given. Sensors for heart rate and skin conductance were attached to the fingers and palm of the non-dominant hand, after which this hand was loosely fixated to the table with Velcro tape to avoid unnecessary movement artefacts. During a session, participants were presented with multiple consumer food or textile journeys, using series of photographs and videos shown on the monitor in front of them. Each type of journey will be described below.

Consumer food journeys: Food journeys always started with

Diagram 2. Overview of type of fabric material information used in the clothing fabric study.

images on a computer monitor of a supermarket entrance and instructions to imagine a situation where the participant enters a supermarket to buy a specific product. Next, participants in the regular assortment condition were 'led' via a series of images to an aisle with regular products, where a specific test food was brought into focus (see upper row of diagram 3). In the sustainable assortment condition, the same test food was located in an aisle with sustainable products (see second row of diagram 3). After the regular or sustainable product was 'purchased', participants were informed with texts and images about the food's ingredients. In the sustainable condition, one of the food's ingredients was replaced with a more sustainable ingredient. In the example shown in Diagram 3 onions in the regular product (third row) were replaced in the reformulated product by proteins extracted from tomato leaves (fourth row). In half of the food journeys, participants were subsequently presented with a video about the preparation of the product (e.g., video of the mixing of the ingredients of the lentil burger and subsequent frying in a pan). The results of the preparation phase will not be reported here. The supermarket and ingredient phases lasted 35 and 30 s, respectively. Finally, each food journey ended with an evaluation phase where the product believed to be shown in the previous phases was actually tasted and evaluated. Participants rated declarative sensory properties, credence attributes and financial aspects. Each of the

Diagram 3. Examples of two types of consumer food journeys: Upper images: a journey starting with the regular or sustainable assortment of a supermarket, via the ingredient information images for both store types and ending with the tasting of the regular lentil burger or the lentil burger containing an alternative ingredient. Duration of the phases in the videos: Store: 35 s; Ingredient information: 30s; Preparation 90s or 0 s. The preparation phase is not indicated in the diagram.

five test products was presented twice to each participant: once in the regular condition and once in the sustainable condition, resulting in a total of ten journeys presented during two sessions. Per session, each product was presented once, either in the regular or in the sustainable condition. The order of product/condition combinations was randomized across participants. Across participants every product was presented equally often in every condition. The average duration of one food journey, including evaluations, was 10 min.

Consumer textile journeys: Textile journeys always started with images on a computer monitor either showing a discount clothing store (upper row of diagram 4) or an upscale clothing store (second row of diagram 4) and an instruction to imagine a situation where the participant enters a clothing store to 'buy' a T-shirt. Next, participants were 'led' via a series of images to an aisle with T-shirts, where a specific T-shirt was brought into focus. Labels attached to the T-shirt indicated the material of T-shirt (for example reused, see also diagram 2). Next, specific details about the manufacturing process of the T-shirt materials were provided in a series of images. At the end of each textile journey a virtual dressing room was 'entered 'and a T-shirt sleeve from one of the fabric samples was placed in front of the participant's dominant hand. The store and ingredient material information phases lasted 65 and 50 s, respectively. Next, participants probed the sleeve fabric with their fingers, after which they evaluated the textile on several declarative sensory properties, quality & style and credence attributes and financial aspects before the next journey started (see Diagram 4). Each participant was presented in a random order with 10 textile journeys (2 types of store x 5 types of materials). Across participants, each T-shirt brand was presented equally often in every combination of store and type of material. The average duration of a textile journey, including evaluations, was 5 min.

At the end of each session, sensors were removed, and the participant used another computer to fill in other questions regarding demographics and specific attitudes and interests. For the sake of clarity, only the results from measurements during tasting of the food and probing of the T-shirt will be reported here.

Declarative sensory food evaluations. After tasting the food in each consumer journey, participants used the keys numbered 1–7 and a seven-point scale anchored from 1 (Not at all) to 7 (Very much), to evaluate the food on a number of attributes related to sensory properties (liking, sweetness or saltiness resp. for a sweet or savory type of food), credence attributes (sustainable, safe, healthy, natural), and financial aspects (price that the participant would be willing to pay relative to an average price for similar products, willingness to buy).

Declarative clothing fabric evaluations. After feeling each T-shirt fabric sample, participants were instructed to use the keys numbered 1–7 and a seven-point scale anchored from 1 (Not at all) to 7 (Very

Diagram 4. Examples of two types of consumer clothing fabric journeys: Store phase: Upper images: a journey starting in a discount store; lower images: a journey starting in an upscale store. Both store types ended with the selection of a reused T-shirt whereafter material information regarding (in this case) reused clothing was shown in the video. Duration of the phases in the videos: Store: 65 s, material information: 50s.

much), to evaluate the T-shirt on attributes related to sensory properties (thick, rough soft, supple, selected from Philippe et al. 2004), quality & style (expensive, attractive, fashionable, trendy, quality, pleasant), credence attributes (pure, sustainable, safe, natural, harmful, clean), and financial aspects (price that the participant would be willing to pay relative to an average price for similar products, willingness to buy).

Heart rate and skin conductance measurements. The heart rate and skin conductance of the participants were recorded with the BIOPAC MP150 system and AcqKnowledge 5.0.4 data software. Skin conductance was measured with two gelled, isotonic Ag/AgCl electrodes attached to the thenar and hypothenar muscles of the participant's non-dominant hand. To receive the signal from the electrodes, a wireless photoplethysmogram (PPG)/skin conductance sensor sent the signal to a Bionomadix PPGED-R receiver. Skin conductance response was measured in μSiemens units. Heart rate was measured with a TSD200 PPG transducer fixed to the index finger of participant's non-dominant hand. Heart rate was measured in beats per minute.

Facial expression measurements**.** Videos of participants were collected during all phases of the journeys. Facial expression data was generated at a time frame of 0.04 s using FaceReader 8.0 software (Noldus Information Technology, Wageningen, The Netherlands). Detection of the presence of a face is analyzed using a Viola-Jones algorithm (Viola & Jones, 2001). Face modelling was done using the algorithmic approach called Active Appearance method, which utilizes 10,000 facial expression images that were classified by experts to optimize the model fit (Cootes, Edwards, & Taylor, 1978). Classification of the algorithm is done using an artificial neural network. Seven emotional facial expressions were extracted from FaceReader: disgust, surprise, happiness, anger, sadness, and scared, and neutral, as well as three affective attitudes: interest, boredom, and confusion. Emotions were also summarized by valence (degree of emotional positive or negative) and arousal (emotional intensity). All FaceReader scores, except for valence, are expressed as scores from 0 (absent) to 1 (fully shown). Valence scores are expressed from −1 to 1. For this study only expressions related to valence will be used.

2.4. Data analysis

Data from two participants from the food study and one participant from the clothing fabric study were omitted from the data analysis because of equipment failure resulting in incomplete data. Tobii studio 2.2 software was used to present the stimuli, collect the webcam images, and extract descriptive statistics. The facial expressions shown in the video images during product evaluations were analyzed with the FaceReader software, and all measures were combined in Observer XT 10.5 software (Noldus information Technology, Wageningen, The Netherlands), and exported to Excel with 25 samples per second. The results of the first 5 s during food or fabric evaluations, averaged per second, were further analyzed with Mixed Model Anovas (IBM® SPSS® statistics, version 25, Armonk, New York, USA) with participant as random factor. For the food study, test food (5 types), store assortment (2 types, regular & sustainable), ingredients (2 types, regular & reformulated) and time (5 s for tasting) were used as fixed factors. For the fabric study, T-shirt brand (4 brands, WE fashion, Fruit of the Loom, Hema, & Zeeman), store type (2 types, discount & upscale), material type (5 types, organic cotton, recycled, reused, nettles & PLA)) and time (5 s for feeling) were used as fixed factors. The analyses were limited to main effects and 2-way interactions.

3. Results

Results will be shown separately for the food and fabric studies and will be limited to the periods during which the products were evaluated during tasting (foods) and feeling (fabric).

3.1. Foods

Effect of test food. Attribute scores varied significantly with type of test food (all $p < 0.001$). The variation between test foods was especially large with regard to their (perceived) healthiness and naturalness (see Fig. 1A). Heart rate and skin conductance varied with test food (heart rate: ($F(4,1663) = 5.4$, $p < 0.001$, skin conductance: ($F(4,1663) = 9.2$, $p < 0.001$) (not shown).

Effect of store assortment. Test foods from the sustainable store assortment were rated after tasting as more sustainable than the same foods from the regular assortment ($F(3,244) = 2.7$, $p = 0.05$). No significant interactions were found between store assortment and test food (see Fig. 1B).

Figs. 2 present results from physiological measurements and facial expressions. Skin conductance during tasting of test foods from the sustainable assortment was significantly higher compared to test foods from the regular assortment (6.5 versus 6.0 μSiemens, $F(1,966) = 6.1$, $p = 0.01$). These effects varied with test food (food*assortment interaction: $F(4\ 962) = 4.0$, $p = 0.003$). Muffin, cookies and Bolognese sauce from the sustainable assortment triggered higher skin conductance than the same foods from the regular assortment. In contrast, no effect was found for yoghurt drink, and lower skin conductance was found for the sustainable lentil burger (Fig. 2A, left). Heart rates during tasting were not affected by the type of store assortment (Fig. 2B, left). The valence of facial expressions during tasting was significantly lower for the test foods from the sustainable store assortment compared to the regular assortment (−0.147 versus −0.179, respectively $F(1,960) = 9.8$, $p = 0.002$). These valence effects of assortment did not vary with test food (food*assortment interaction: $F(4,959) = 0.8$, n.s.) (Fig. 2C, left).

Effects of ingredient specification. Reformulated test foods were rated as more sustainable, and less sweet and salty, than the same test foods with regular ingredients. No significant interactions between ingredient specification and test food were found (Fig. 1C).

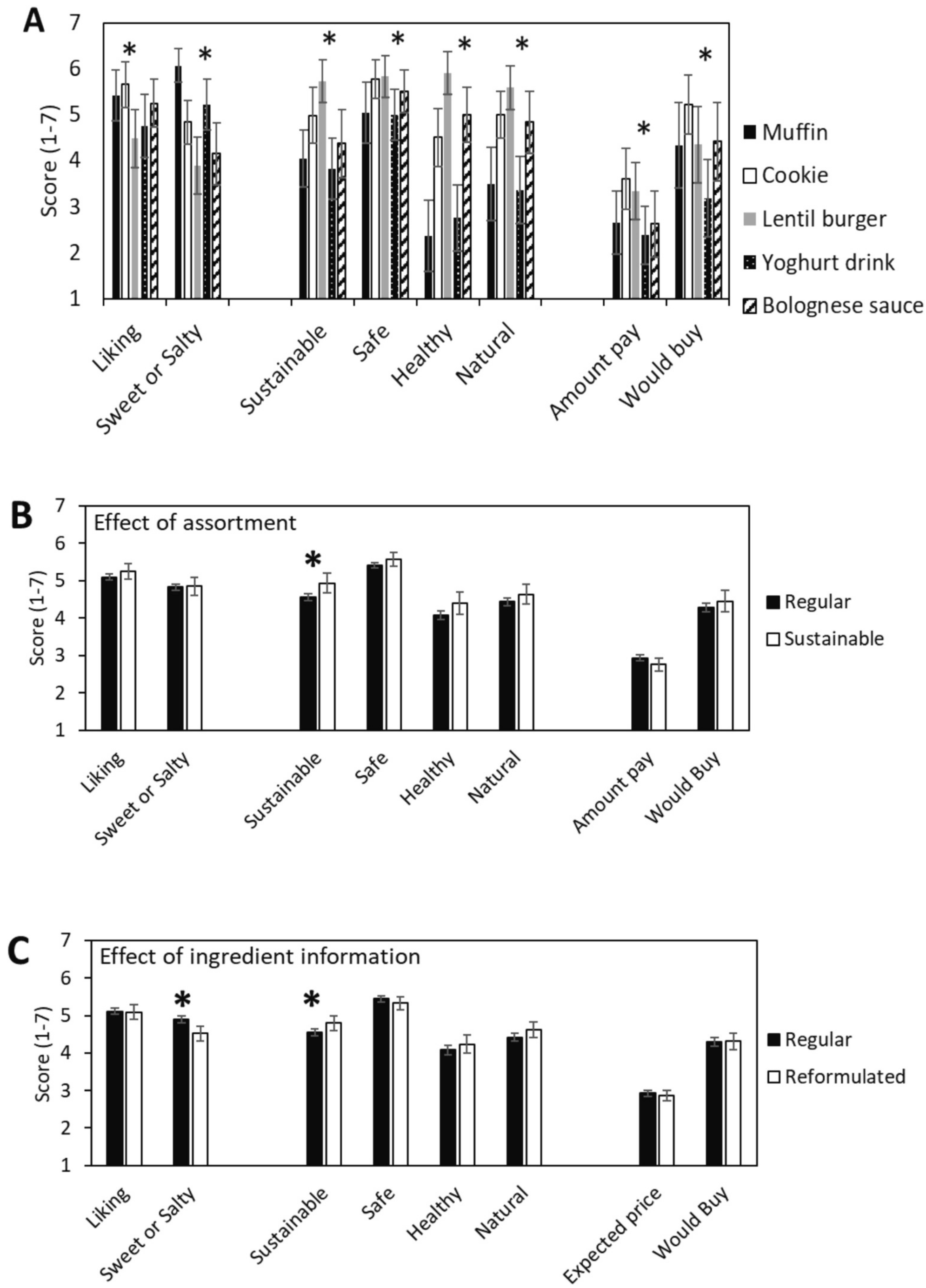
The effects of type of ingredient specification on skin conductance during tasting varied with test food (food*ingredient interaction: $F(4,1137) = 6.9$, $p < 0.001$). Skin conductance for reformulated muffin, yoghurt drink and Bolognese sauce with alternative ingredients was higher compared to the same foods with regular ingredients ($p < 0.05$). Reformulation lowered skin conductance in cookies and lentil burger ($p < 0.05$, respectively, Fig. 2A, right). Heart rates during tasting were not affected by ingredient specification (Fig. 2B, right). Valence of facial expressions during tasting varied with ingredient specification and were food-specific (food*ingredient interaction: $F(4,1124) = 3.6$, $p = 0.007$). Reformulation resulted in more positive facial expressions for reformulated cookies and more negative facial expressions for lentil burgers compared to their regular counterparts (all $p < 0.05$). Valence for the other foods was unaffected by ingredient specification (Fig. 2C, right).

3.2. Clothing fabrics

Effect of test fabric. The brand of T-shirt especially affected the sensory and quality & style attributes ($p < 0.001$) (Fig. 3A). Skin conductance and heart rate varied with fabric sample (heart rate: $F(3,662) = 14.1$, $p < 0.001$; skin conductance: $F(3,574) = 9.2$, $p < 0.001$) (not shown).

Effect of store type. The type of store primarily affected the amount of money that participants expected to pay ($p < 0.001$), and to a lesser degree some of the quality & style attributes ($p < 0.05$) (Fig. 3B). Heart rate also varied with store type ($F(1,662) = 14.9$, $p < 0.001$) with higher heart rate for the discount store (Fig. 4B, left). The interactions between store type and T-shirt brand, were significant for heart rate and skin conductance (heart rate: $F(3,663) = 7.0$, $p < 0.001$, respectively, skin conductance: $F(3,475) = 5.2$, $p < 0.001$, respectively) (Fig. 4A, left). Store type did not affect the valence of facial expressions.

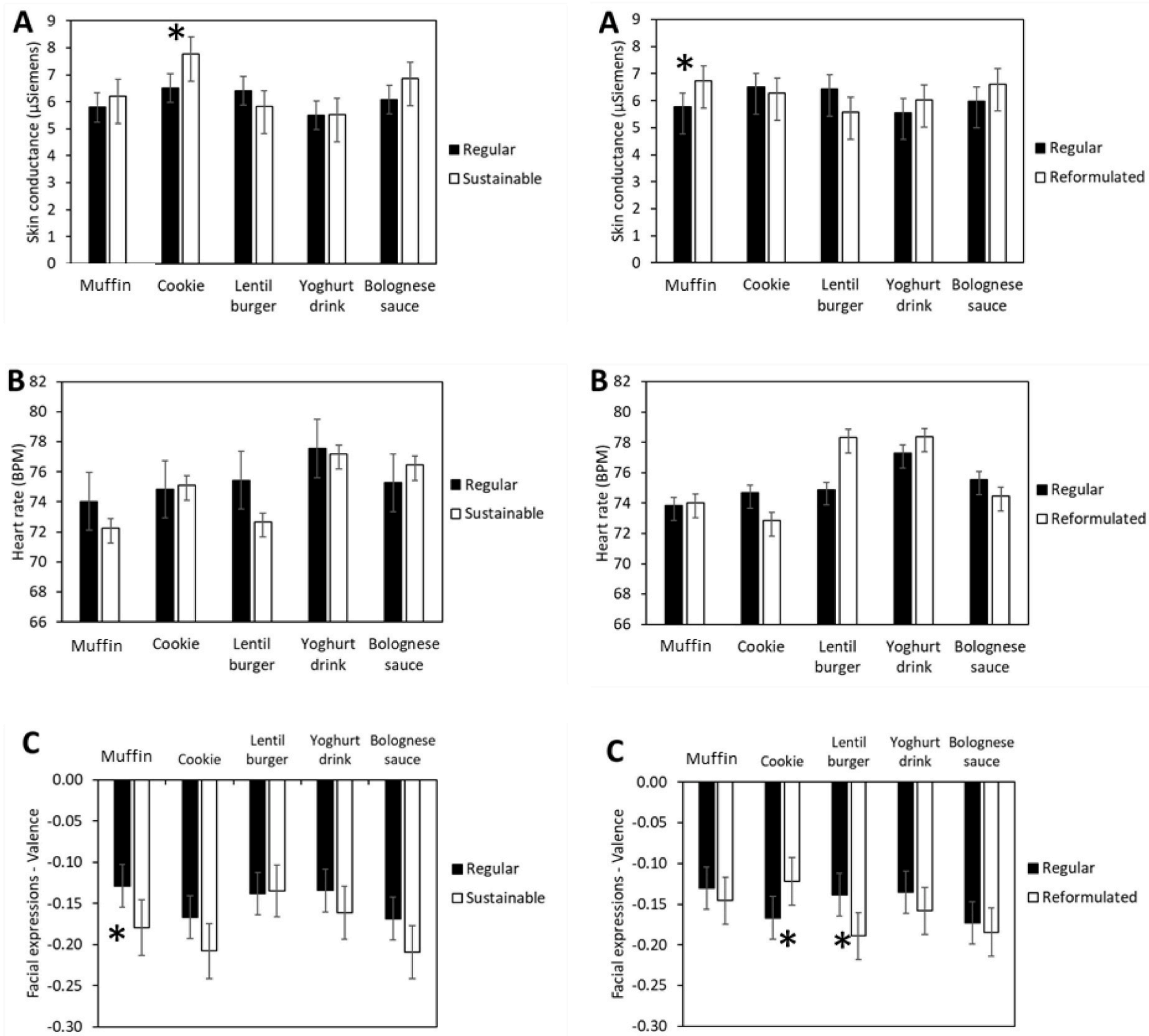
Effects of material information. The material type primarily affected the quality & style and credence attributes ($p < 0.001$) and to a lesser



Figs. 1. Attribute scores A) per test food, B) averaged across test foods per regular/sustainable store assortment, and C) averaged per regular/reformulated ingredient information. Error bars represent standard errors. * Indicates significance at $p < 0.05$.

degree the sensory attributes ($p < 0.05$) (Fig. 3C). The interactions between material information and T-shirt brand were significant for heart rate, skin conductance and valence of facial expressions ($F(12, 663) = 5.5$, $p < 0.001$, $F(12, 574) = 12.7$, $p < 0.001$, and $F(12, 664) = 2.0$, $p = 0.02$, respectively) (Figs. 4A, B and C, right). T-shirts that were believed to be manufactured from nettles and PLA were associated with lower heart rate and skin conductance, and more positive facial expressions. T-shirts believed to be from recycled material were associated with more negative facial expressions, whereas reused (second-hand) samples were associated with higher heart rate and skin conductance, and more negative facial expressions.

Interaction effects of store type and material information. The interactions between store type and material information were significant for heart rate and skin conductance (heart rate: $F(4,662) = 2.8$, $p = 0.03$, skin conductance: $F(4,574) = 14.7$, $p < 0.001$). The largest differences were found for the upscale store. Evaluation of T-shirts from the upscale store believed to contain organic cotton was associated with relatively low heart rate and skin conductance, whereas T-shirts from the same store believed to be reused was associated with relatively high heart rate and skin conductance (not shown).



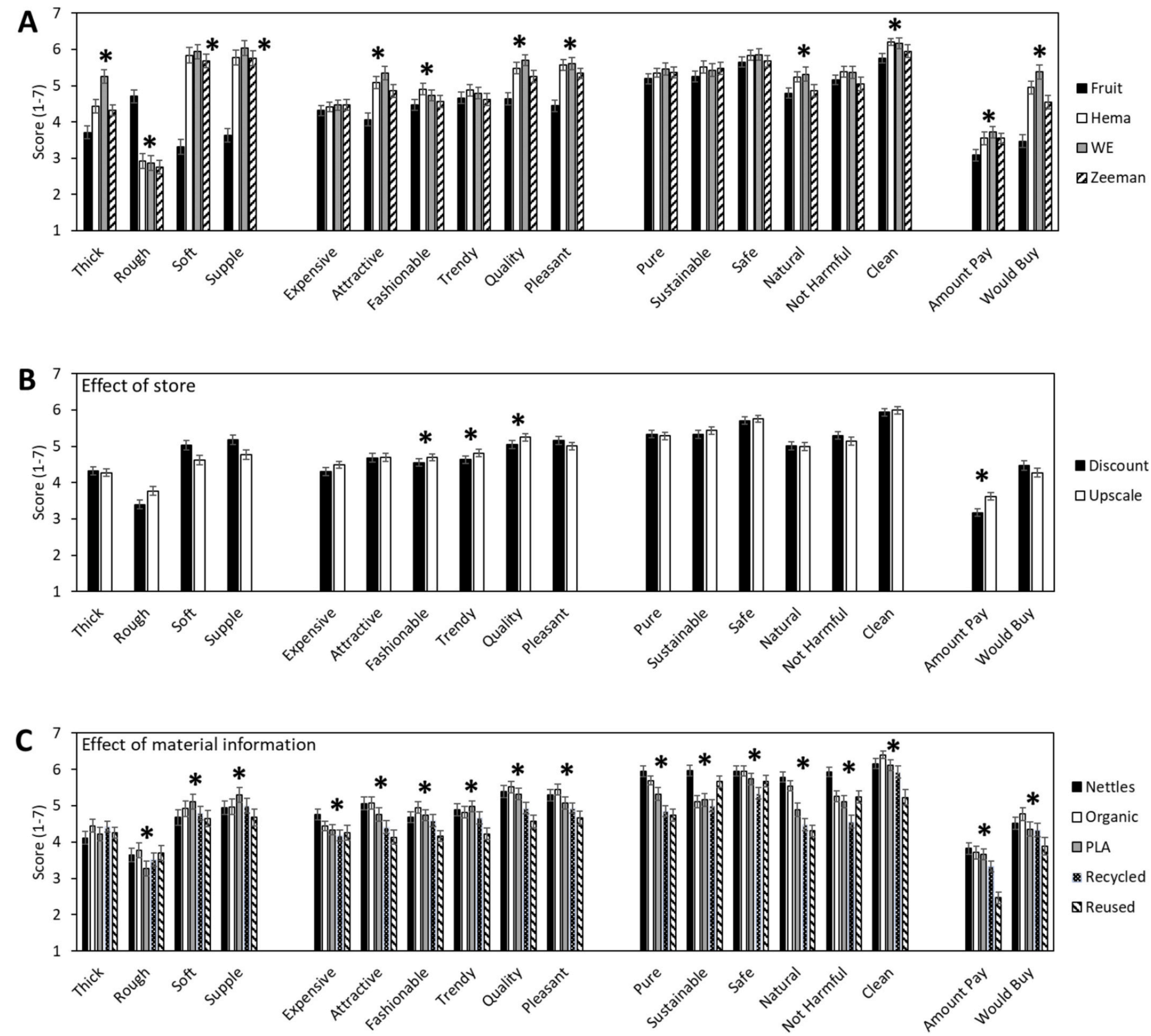
Figs. 2. Effects of store assortment (left) and ingredient specification (right) on skin conductance (A), heart rate (B) and facial expression (valence) (C) during tasting of five test foods. Error bars represent standard errors. * Indicates significance at $p < 0.05$.

4. Discussion

4.1. General

In the present studies, participants were taken on a virtual food or clothing fabric journey that started in store followed by an ingredient or origin material information phase. Finally, participants evaluated the product – either a test food that was tasted or a T-shirt fabric sample that was felt – that they believed to be the product shown in the preceding virtual journey. Responses during evaluations were tested with questionnaires, physiological measures (heart rate and skin conductance) and facial expressions. Evaluative physiological and declarative responses varied systematically with the type of food or clothing fabric sample which is not surprizing given the large differences between samples, especially in the case of the foods. More interestingly, evaluative responses were also affected by the prior virtual store context, which confirms the first hypothesis. For example, the belief that a food came from a shelf with sustainable products triggered more negative facial expressions and increased skin conductance during subsequent tasting compared to exactly the same food believed to come from a shelf with regular products. Evaluative responses were also affected by the ingredient/material information, which confirms the second hypothesis. For example, the belief that the touched fabric was from reused clothing produced more negative facial expressions and increased skin conductance compared to exactly the same material believed to be made from organic cotton. These results demonstrate that 1) product experiences during evaluations are not only determined by intrinsic product properties, such as the texture of a food or a clothing fabric but also by product properties that can typically not be tasted or felt, such as knowledge about the store assortment/store type and the product's ingredients/materials and 2) these effects were not limited to foods but were also found for clothing fabrics.

The fact that the phases of a so-called consumer journey affect subsequent experiences when consumers physically interact with products is itself not new. Supermarkets, restaurants, food commercials and TV-chefs all have ways to improve specific phases of the journey to enhance (food) experiences. Yet, systematic studies of the effects of phases of consumer journeys on product experiences are lacking. As a result, possible effects rarely play a role in the development and marketing of new products. One obvious reason is that these studies are difficult to carry out in real-life because they require systematic variations at for example a store and in packaging and ingredient/material specifications. In addition, such studies would require monitoring individual consumers' behaviors as well as their responses in situations such as supermarkets and their own kitchens. The present studies suggest that the effects of factors such as product placement and ingredient



Figs. 3. Attribute scores A) per T-shirt brand, B) averaged across T-shirt brands per discount/upscale store, and C) averaged per material information. Error bars represent standard errors. * Indicates significance at $p < 0.05$.

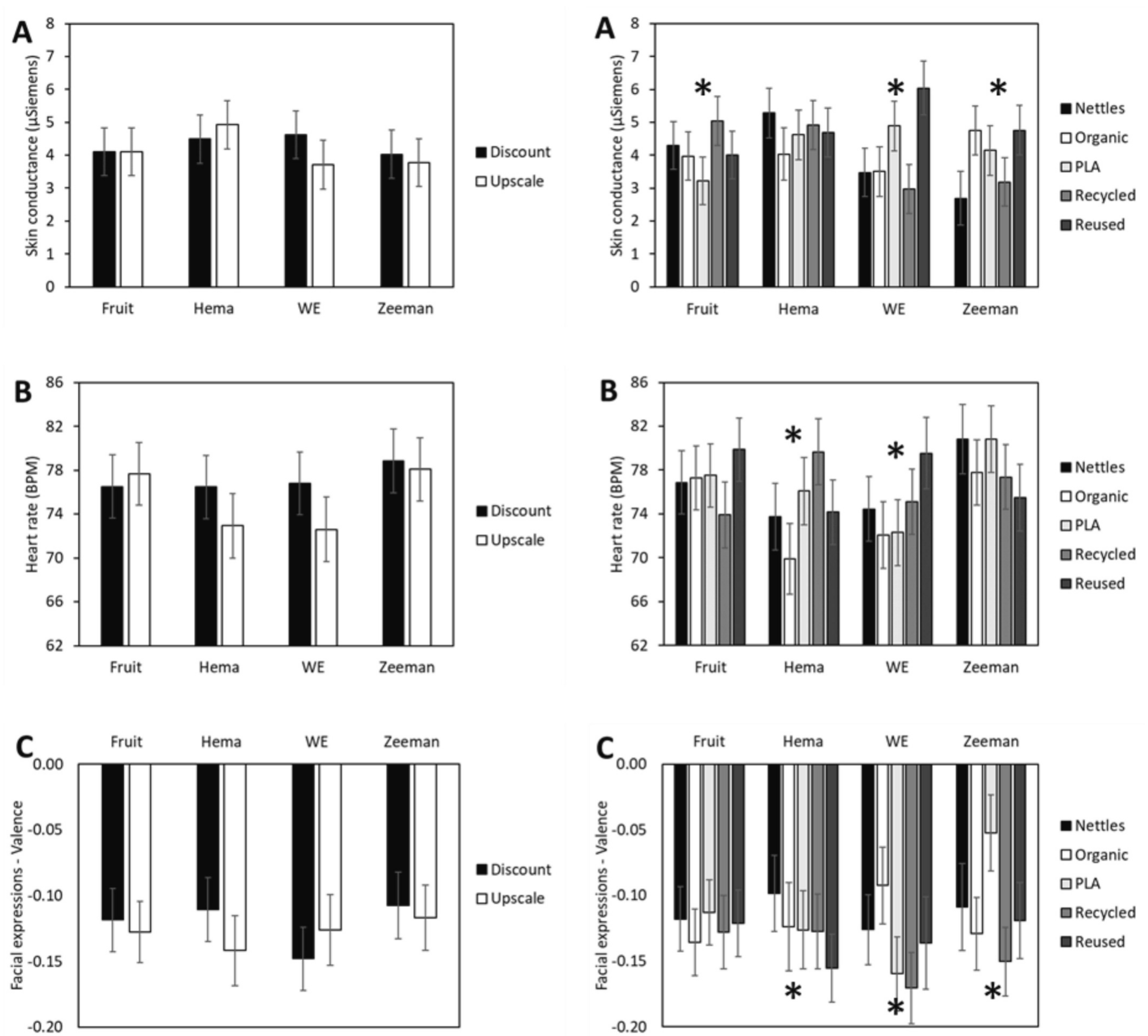
specifications on product experiences can also be studied in the laboratory which could offer an economical and efficient alternative to real-life studies. This fits well with the current trend in sensory and consumer science where parts of the consumer journey are recreated in the laboratory. Typically, the recreated parts concern the consumption ambience and its effects on (food) experiences. The present study suggests that these studies can successfully be expanded with other parts of the journey, such as the type of store and store assortment. The use of multiple consumer journeys in the same experimental session may seem to lack ecological validity at first sight. However, in real-life multiple consumer journeys may also be active, either consecutive during preparations of breakfast, lunch and dinner meals, or simultaneously when a meal is being prepared with ingredients from various stores and with different ingredient specifications. Moreover, presenting multiple consumer journeys to participants did not result in increasing numbers of negative reactions.

Next, results from the present food and fabric studies will be discussed in detail below together with possible practical implications.

4.2. Foods

Different test foods triggered different declarative and physiological responses during tasting. Obviously, the fact that widely different test foods result in different scores on sensory, affective and other aspects is not surprising. Neither surprising is that these test foods also trigger different physiological responses and facial expressions, which is consistent with the results of previous studies (e.g., De Wijk et al., 2014, De Wijk et al., 2021; Danner et al., 2014; Kaneko et al., 2019). More interesting is that responses during tasting were not only affected by the taste of the test food but also by prior information about the test food's sustainability and ingredient specification. Each of these effects will be discussed here.

Test foods that participants believed to be from the sustainable assortment of a supermarket did not affect the sensory properties but



Figs. 4. Effects of store type (left) and ingredient specification (right) on skin conductance (A), heart rate (B) and facial expression (valence) (C) during feeling of four types of T-shirt fabrics. Error bars represent standard errors. * Indicates significance at $p < 0.05$.

triggered higher skin conductance, i.e., more arousal, and more negatively valenced facial expressions during tasting than exactly the same test foods believed to be from the regular assortment. The higher arousal of the foods from the sustainable assortment suggests that these foods are still not viewed as mainstream food products. That this high arousal was accompanied by more negative facial expressions suggests furthermore that consumers may expect less desirable sensory properties from foods labelled as 'sustainable'. Other studies on the effect of sustainable positioning of food, such as with labels, generally find a positive effect on consumer perceptions, though the effect varies (Majer, Henscher, Reuber, Fischer-Kreer, & Fischer, 2022). These studies are rarely done with behavioral outcome measures such as consumption and are typically based on the participant's rational judgement (Lee, Chang, Cheng, & Chen, 2018; Potter et al., 2021). The results of the consumer food journey study suggest that merely framing products as sustainable is not enough to ignite consumers' potentially underlying positive perceptions. An alternative explanation is that consumers' positive perceptions are overestimated, and consumers unconsciously form unfavorable associations with food products when it comes to having to consume the product.

Prior information that test foods contained new ingredients generally reduced the perceived sweetness of saltiness (depending on the type of food) for the food during tasting. These latter effects were not related to the specific test food, i.e., test foods with alternative ingredients taste less salty or sweet, irrespective of whether this food was e.g., cookie, yoghurt drink, lentil burger or Bolognese sauce. Physiological and facial expression responses showed more food-specificity and were not only affected by ingredient specification but also by sustainability information. Certain combinations of foods with alternative ingredients triggered higher arousal (e.g., yoghurt drink with protein from fava bean) whereas other combinations triggered lower arousal (lentil burger with protein from tomato leaves). Similarly, the believed alternative ingredients affected the valence of facial expressions during tasting for some foods positively (e.g., cookies) and other foods negatively (lentil burger). This specificity of effects demonstrates that the choice of ingredients, and probably the framing of the ingredient information to the consumer, needs to be tailored to the specific food. Certain ingredients that are either new, upcycled or from side streams, may trigger positive responses in consumers for some foods but may trigger no – or – worse even negative responses for other foods. Higher specificity of physiological responses and facial expressions was also observed in previous studies where these measurements showed larger effects compared to explicit responses of actual (laboratory versus home) or recreated consumption locations (recreated beach versus restaurant) (De Wijk et al., 2019; De Wijk et al., 2022).

4.3. Fabrics

Participants were clearly able to distinguish between the tactile properties of test T-shirt fabrics as demonstrated by declarative sensory attributes ratings and by the physiological skin conductance and heart rate measurements. In contrast to the test foods in the food study the differences between the fabric samples were relatively small because they were all made from the same material, namely cotton.

More interesting were the effects of the store and material information from the preceding "journey" on clothing fabric evaluations. Stores are often designed to trigger certain emotions that fit best a certain consumer segment. This means that a discount store probably triggers different emotions than an upscale store. These emotions were probably not well captured by declarative evaluations where store type affected primarily the amount that participants expected to pay for the sample, and the perceived fashionability of the T-shirt. Physiological measures showed larger effects. Feeling T-shirts believed to come from a discount store was generally associated with a higher heart rate but interactions between store type and material suggest a high degree of specificity. T-shirt fabric samples believed from organic cotton from an upscale store were associated with relatively low heart rate and skin conductance, whereas samples believed to be reused from the same store were associated with high heart rate and skin conductance. Possibly, clothing from an upscale store is expected to contain organic cotton and triggers mild reactions when these expectations are met. Similarly, reused clothing is probably not expected to be found in an upscale store, triggering more extreme reactions. Such differences are not found for the discount store. This suggests that participants expect to find clothing with only specific materials in upscale stores, and a much broader range of materials in discount stores.

Both subjective declarative evaluations and objective physiological measurements of heart rate, skin conductance and facial expressions showed positive reactions when T-shirt fabric samples believed to contain nettles, organic cotton and PLA were felt with the fingers. T-shirt fabric samples believed to contain recycled materials, and especially reused T-shirt samples triggered more negative subjective and objective reactions. Reactions to recycled T-shirt samples based on recycled clothing fabric were less negative and seemed to be qualitatively different from reactions to reused clothing, which is interesting because recycled clothing is in fact reused clothing: both types of clothing are pre-worn and thoroughly cleaned afterwards. The main difference is that recycled clothing is reduced to fibers which are used to remanufacture clothing whereas reused clothing is resold as is. Apparently, the remanufacturing step during recycling is critical to alleviate the feelings of disgust commonly found for reused clothing. Communicating the details of remanufacturing to consumers may therefore be a necessary element of the successful marketing of remanufactured clothing.

No negative reactions were found for fabric samples believed to be made from PLA or nettles. This is somewhat surprising because 'polylactic acid' may sound very chemical to participants, and they could have decided to avoid samples with this chemical. The fact that feeling PLA samples was not associated with increased skin conductance and negative facial expressions suggests that these negative associations were not triggered by the PLA fabrics used in the study. Similarly, clothing made from nettles may be associated with the unwanted stinging and prickling sensations that are typical when nettles are touched in nature. Again, no negative skin conductance and facial expression reactions were found when the nettle fabrics were felt in this study. Possibly, the information about the materials provided during the journey preceding the journey alleviated any initial negative feeling that participants may have had towards these materials in contrast to for example the material information for reused clothing. Differences between the results may also be related to the fact that the material information for reused clothing ended with recognizable images of -reused- clothing, whereas the information for the other materials all ended with clean clothing fabrics that had no or very little relation with the unprocessed materials shown at the beginning of the information block (see diagram 1).

4.4. Limitations and future studies

The selection of food and clothing fabrics, as well as the store and ingredient and material conditions used in this study was rather limited and rather arbitrary. Other studies should investigate for example other foods (e.g., indulgent foods, staple foods, basic versus A brands, level of familiarity), other types of clothing fabrics and types of clothing, other phases (e.g. include aspects of production such as farming), other points-of-sale (e.g. food canteens & restaurants, markets for foods & textiles), other ingredient/material specifications (e.g. clean labels), and logos (e.g. Nutri-Score for foods, sustainability logos). In the present studies, participants did not select themselves a specific product from a range of products. Scope of choice is probably an important determinant of consumers' reactions and should be included in future studies. This study heightened specific parts of the consumer journey (e.g., using pictures of ingredients and providing detailed information about fabric processing) to investigate their impact on consumer perception. The choice for this, while providing insight into explicit ingredient and fabric information's impact on consumer perception, does not fully represent typical store shopping experiences. Most importantly, validation studies should be carried out to verify that the results of studies with recreated consumer journeys resemble the results of studies with real-life journeys.

4.5. In conclusion

The present studies demonstrate a new technology for recreating a multi-phase consumer journey in a laboratory. The type of store or store assortment as well as the information about ingredients/materials contributed to subsequent evaluation tasting or feeling experiences assessed by physiological measures (heart rate, skin conductance), facial expressions, and declarative measures (questionnaires). The results showed opportunities for the development of reformulated foods and alternative fabrics that are acceptable to consumers. The methodology could therefore be a valuable tool in the development of sustainable food and non-food products successful in the marketplace.

Author statement

RdW, AJ and LD were all involved in the conception and design of the studies, data collection, analysis and interpretation of results, and manuscript preparation.

CRediT authorship contribution statement

René A. de Wijk: Writing – review & editing, Writing – original draft, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Anke M. Janssen:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Funding acquisition. **Liam Dwyer:** Writing – review & editing, Methodology, Investigation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

We thank Dr. Patrick Zimmerman and Dr. Leanne Loijens from Noldus Information Technology for their support during the preparation and execution of both studies. The food study was funded by the Dutch Ministry of Agriculture, Nature and Food Quality: KB37-004-009 Technology development for healthy and safe protein during bio-refinery. The clothing fabric study was funded by the Wageningen University & Research investment theme Transformative Bioeconomies: Towards a materials transition that phases out fossil feedstock (KB45).

Data availability

Data will be made available on request.

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