VINÍCIUS RODRIGUES ARRUDA PINTO

FOOD-EVOKED EMOTIONS: COMFORTING HINTS AND PSYCHOPHYSICS

Thesis submitted to the Food Science and Technology Graduate Program of the Universidade Federal de Viçosa in partial fulfillment of the requirements for the degree of *Doctor Scientiae*.

Adviser: Ítalo Tuler Perrone

Co-advisers: Laura Fernandes Melo Cabral
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Assent:

Vinícius Rodrigues Arruda Pinto
Author

Ítalo Tuler Perrone
Advisor

DEDICATION

Recent times have been unspeakable. Upon the synchronicity of the moon's phases, the movement of the waters, the cohesion between the seasons, and the direct contact with the sun, I realized that I could also acquire constancy of state. The doctorate was a stage of confrontation, above all because it reverberated questions that I needed to see in the light of humility. I visualized the need to have prudence, to understand my means of action in this world, justice, to understand how this action guides my will towards the other, temperance, to accept that most things in this world are not in the sphere of wanting, and strength to wage war against myself in favor of the pursuit of good.

It is said that those who are truly interested in psychology tend to question themselves excessively about the meaning of life. With me, it was no different. When I entered the paths of this field, I realized that I had a priestly soul. From then on, exchanging hours of sleep for suffering souls was very worthwhile. Whenever I started a new study in the field of consumer psychology, I was more interested in the human being than in the food itself. I immersed myself in the concepts of psychoanalysis, but I didn't see support in the theories of drives to explain consumer behavior globally. Other examples such as Maslow, Pavlov, Erik Erikson, Piaget, and Vygotsky also helped me to understand aspects of the human personality and its intertwined contexts, however, Skinner was the one who came closest to the relationship between the consumer and the food. However, Viktor Frankl was, in fact, the one who gave me a perspective of the human being, as a bio-psycho-socio-spiritual being, capable of choosing between stimulus and response. This premise made me see that my studies were not about a consumer who was not very aware of himself and his choices but about an individual who, although he could even reveal bad eating habits, could make choices in favor of the greater good. And often he just needs help to figure it out.

The meaning of this thesis came from the moment I realized the ultimate meaning of my life: to serve the Good and for Him to remain. Then came professors Luis Enrique Paulino Carmelo, Paulo Pacheco, and Miguel Soriani, who gave me an injection of courage to make these grains of meaning fruitful. Before these, I experienced a soul opening to life like I had never had until I met and drank from the spring water of my esteemed teacher Ítalo Marsili. If today I understand the purpose of my existence, it was certainly because he cared for him to open my eyelids to reality. As if the beauties already contemplated on this path weren't enough, here's Professor Thiago Andrade Vieira to lead me to realize everything I've noticed. To these last two, whom I boldly call your friends, I dedicate a good part of my action in this world,

because only they were able to show me in-depth the true and unique human psychology, which is what happens through love.

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"Don't aim at success. The more you aim at it and make it a target, the more you are going to miss it. For success, like happiness, cannot be pursued; it must ensue, and it only does so as the unintended side effect of one's personal dedication to a cause greater."

(Viktor Frankl)

ABSTRACT

PINTO, Vinícius Rodrigues Arruda, D.Sc., Universidade Federal de Viçosa, June 2022. **Food-evoked emotions: comforting hints and psychophysics**. Adviser: Ítalo Tuler Perrone. Co-advisers: Laura Fernandes Melo Cabral and Márcia Cristina Teixeira Ribeiro Vidigal.

Emotions evoked by food provide valuable information in new product development. A series of instruments have recently been proposed to capture emotional responses elicited by food to assess the total consumer experience. The use of emojis as an assessment tool is a potential current example. The literature has shown that the emotional profile provides additional information beyond the domain of taste, although it is still a challenge to use it to differentiate hedonically similar or utilitarian stimuli. Ideally, emotional and sensory profiles have been used together for better decision making, because the food contexts evaluated reveal perceptions at a multifactorial level. For example, new insect-based, plant-based, or meat-based products are strongly associated with sociocultural aspects, which makes their emotional profiles conditioned to hedonism. On the other hand, in scenarios determined by mood, as in the case of consumers suffering from some psychopathology, the emotional profile will be crucial and more determinant than hedonism. The objective of this research was to evaluate the emotional profiles of new foods in relation to the healthiness aspect, followed by the proposition of new sensory thresholds of emotion. To meet the objectives, the work was divided into four articles. In the first article, a study was carried out to survey perceptions around the healthiness of foods. The content analysis identified five dimensions: 'misconception, knowledge or cognition', 'pleasure', 'importance of health', 'purity', and 'ethical or environmentally friendly issues'. Overall, the desire for more palatable "healthy" foods may explain increasing attention to future foods that provide positive feelings (e.g., green comfort foods). In the second article, a broad view of how contemporary foods changed the concept of comfort foods was provided. Semi-structured interviews with 20 Brazilian participants showed that cultural predilections, health concerns, self-awareness, past experiences, familiarity, satiety, and taste can explain why comfort food preferences range from healthy to unhealthy foods, and from traditional foods to contemporaries. The psychological manifestation of comfort was more closely related to a sense of morality associated with healthier foods. In the third article, the acceptance, purchase intention, and emotional responses of consumers to mixed dairy drinks, with and without the addition of kefir, were evaluated, considering blind and informed conditions. Overall, expressions of positive emotion increased when participants were exposed to stimuli related to the health benefits of kefir (15%, 30%, and 50% w/v). The information provided from kefir

modified valence and arousal in subjects, and emojis proved to be viable to predict acceptability and purchase intention, although there are still controversies around arousal. Finally, the fourth article aimed to elucidate three new thresholds: the valence thresholds, represented by the compromised pleasure threshold (CPT) and unpleasure threshold (UT), and the arousal threshold (LA). The valence and arousal ratings were obtained using the Affective Slider (AS) rating scale, and CPT, UT, and AT were determined for images of Brazilian moldy carrot cake. The moldy carrot cake had negative valence in the region of low arousal. The methodology proved to be adequate to propose emotion thresholds, which highlights its potential to generate a deeper understanding of the psychophysiological reactions evoked from comforting stimuli. In this way, opportunities for psychoeducational interventions and improvements in decision-making may be more frequent in the studies, considering the positive association between experiences of comfort and healthiness to be more common.

Keywords: Comforting. Emoji. Emotion. Emotion thresholds. Healthiness.

RESUMO

PINTO, Vinícius Rodrigues Arruda, D.Sc., Universidade Federal de Viçosa, junho de 2022. **Emoções evocadas por alimentos: dicas reconfortantes e psicofísica**. Orientador: Ítalo Tuler Perrone. Coorientadoras: Laura Fernandes Melo Cabral e Márcia Cristina Teixeira Ribeiro Vidigal.

Emoções evocadas por alimentos fornecem informações valiosas no desenvolvimento de novos produtos. Uma série de instrumentos foram recentemente propostos para capturar respostas emocionais eliciadas pela comida, visando avaliar a experiência total do consumidor. O uso de emojis como ferramenta de avaliação é um exemplo atual em potencial. A literatura tem mostrado que o perfil emocional fornece informações adicionais para além do domínio do gosto, embora ainda seja um desafio utilizá-lo na diferenciação de estímulos hedonicamente semelhantes ou utilitários. Idealmente, perfis emocionais e sensoriais têm sido utilizados em conjunto para uma melhor tomada de decisão, porque os contextos alimentares avaliados revelam percepções a nível multifatorial. Por exemplo, novos produtos à base de insetos, à base de plantas ou à base de carne, estão fortemente associados a aspectos socioculturais, o que faz com que seus perfis emocionais estejam condicionados ao hedonismo. Por outro lado, em cenários determinados pelo estado de humor, como em caso de consumidores acometidos com alguma psicopatologia, o perfil emocional será crucial e mais determinante que o hedonismo. O objetivo dessa pesquisa foi avaliar os perfis emocionais de novos alimentos em relação ao aspecto saudabilidade, seguido da proposição de novos limiares sensoriais de emoção. Para atender os objetivos o trabalho foi dividido em quatro artigos. No primeiro artigo, foi feito um estudo de levantamento das percepções em torno da saudabilidade dos alimentos. A análise de conteúdo identificou cinco dimensões: ‘equívoco, conhecimento ou cognição’, ‘prazer’, ‘importância da saúde’, ‘pureza’ e ‘questões éticas ou ambientalmente amigáveis’. No geral, o desejo por alimentos “saudáveis” mais palatáveis pode explicar uma crescente atenção por futuros alimentos que proporcionam positivos sentimentos (por exemplo, alimentos verdes de conforto). No segundo artigo, foi fornecida uma visão ampla de como os alimentos contemporâneos alteraram a concepção de alimentos de conforto. Entrevistas semiestruturadas com 20 participantes brasileiros mostrou que as predileções culturais, preocupações com a saúde, autoconsciência, experiências passadas, familiaridade, saciedade e sabor podem explicar por que as preferências de alimentos de conforto variam de alimentos saudáveis a não saudáveis, e de alimentos tradicionais a contemporâneos. A manifestação psicológica de conforto mostrou-se mais intimamente relacionada com um senso de moralidade no que diz

respeito aos alimentos mais saudáveis. No terceiro artigo, avaliou-se a aceitação, a intenção de compra e as respostas emocionais dos consumidores às bebidas lácteas mistas, com e sem adição de kefir, considerando condições cegas e informadas. No geral, as expressões de emoção positiva aumentaram quando os participantes foram expostos a estímulos relacionados aos benefícios de saúde do kefir (15%, 30% e 50% m/v). A informação fornecida do kefir modificou a valência e a excitação nos sujeitos, e os emojis se mostraram viáveis para predizer aceitabilidade e intenção de compra, embora ainda existam controvérsias em torno da excitação. Por fim, o quarto artigo objetivou elucidar três novos limiares: os limiares de valência, representados pelo limiar de prazer comprometido (CPT) e limiar de desprazer (UT), e o limiar de excitação (LA). As classificações de valência e excitação foram obtidas através da escala de avaliação *Affective Slider* (AS), e CPT, UT e AT foram determinados para imagens de bolo de cenoura mofado brasileiro. O bolo de cenoura mofado teve valência negativa, na região de baixa excitação. A metodologia mostrou-se adequada para propor os limiares de emoção, o que destaca seu potencial para gerar uma compreensão mais profunda das reações psicofisiológicas evocadas de estímulos reconfortantes. Desta forma, oportunidades para intervenções psicoeducativas e melhorias na tomada de decisões poderão ser mais frequentes a partir dos estudos supracitados, considerando mais comuns a positiva associação entre experiências de conforto e saudabilidade.

Palavras-chave: Conforto. Emoji. Emoção. Limiares de emoção. Saudabilidade.

SUMMARY

1. GENERAL INTRODUCTION

Consumers value both experiences (e.g., tastiness) and credence (e.g., healthiness) characteristics in their food decisions Mai and Hoffmann (2015). In this context, the healthiness of foods (FH) is becoming increasingly important in consumer minds. FH represents the consumer's expectations and beliefs about the influence of the product on their health status or good shape Mai and Hoffmann (2015). These expectations explain why, for instance, consumers who value health factors shift more attention towards food options that holistically signal healthiness (Otterbring et al., 2020).

Evidence supporting the idea that the perceived healthiness (PH) has a significant impact on food intake and food choices are somewhat significant. Animal origin, environmentally friendly production, home-cooking, nutritional aspects (diet and/or light products), level of processing (natural vs transformed foods), preservation and freshness are among the main precursors to the healthiness associations towards foods (Manippa et al., 2020; Lusk, 2019; Yarar and Orth, 2018). Ditlevsen et al. (2019) have also identified three main factors influencing the perceived healthiness of foods (PH): nutritional value, followed by pleasure and purity. Moreover, previous studies have been shown that conventional and unconventional beliefs (e.g., “natural”, genetically modified, absence of pesticides/chemicals), consciousness/knowledge of food composition, type of food and susceptibility to positive and negative emotional states in food experiences (e.g., certain foods are comforting) can add value to PH (Ares and Varela, 2018; San-Cristobal et al., 2017). Oljans, Elmståhl, Mattsson Sydner, and Hjälmeskog (2017) reinforce that ‘health’ is interpreted as a dimension that includes the environmental and social aspects of well-being, which makes well-being experience an important precursor of the perceived healthiness of foods (Ares and Varela, 2018).

Some consumers felt emotionally motivated to eat natural foods for reasons as health, tranquility, connection to truth, comfort to their soul, and conscience (Lupton and Turner, 2018; Sijtsema et al., 2016). One study reported the association of unhealthy food to drugs (Schaefer et al., 2016). Two studies showed that FH was positively related to natural ingredients, i.e., those naturally present on food (Brownbill et al., 2020; Menegassi et al., 2019). One study showed the antinatural perception regarding plant-based products (one consumer), under the premise of being more processed (Peschel et al., 2019). The healthiness of processed foods was mainly related to the number of processes they were exposed to (ultra-processed foods) the amount of salt, fat, sugar, additives, and preservatives put into food, and the type of industrial process of manufacturing (Ares et al., 2016; Shan et al., 2016; Hoek et al., 2017; Gaspar et al.,

2020). For some consumers, independent of being a fruit, vegetable, pasta, or bread, it is crucial that food should be as natural as possible (Gaspar et al., 2020). Challenges linked to the role of the industry were also reported: new packaging and preservation techniques, use of 'natural' additives, absence of 'chemicals, and food processing as naturally as possible to confer healthiness to product (Shan et al., 2016; Sijtsema et al., 2016).

Some studies report the effect of external sources (e.g., brand name) on consumers' perceptions. Restrained eaters exposed to the healthful brand had more cookies than those exposed to a less healthy brand. Thus, data obtained by these studies show that the concept of "healthier food" may lead to an imbalance of food intake (Provencher et al., 2009). In regard to the effect of health-related information (e.g., health and nutrition claims, logos), some studies showed a mixed record. It has been argued that symbolic cues may be more related to healthiness when these cues have self-directed benefits (e.g., willing to purchase a product because of the claims offered) and are less dependent on hedonic goals (e.g., sensory pleasure) (van Ooijen et al., 2017). A health concern or self-perception of body weight could lead to a better PH. Nevertheless, the "halo" effect can substantially alter the perceived value of a stimulus (e.g., palatability, satiety, healthiness) (Bullock et al., 2020; Provencher and Jacob, 2016; Rosi et al., 2017), because many consumers believe more heavily on holistic features than in the front-of-package nutrition labels (Otterbring et al., 2020). n particular, the impacts of low health consciousness and low perceived usefulness (e.g., for the body image) can markedly exceed health-conscious decisions.

In a symbolic way, van Ooijen et al. (2017) argued that healthiness may spill over to packaging (e.g., slimmer package may induce higher healthiness inferences) and at the same time induce people's self-perception of their body and its relationship with FH. In this context, Faraji-Rad and Pham (2016) and Motoki et al. (2019) affirmed that anxiety (negative valence) may contribute to the state of uncertainty, which increases the reliance on perceived affective inputs, such as aesthetic appeal related to healthiness. The exposure to negative emotions (e.g., anxiety, stress) can induce unconscious decisions guided by pleasure, in turn influencing unhealthier food consumption (Flaherty et al., 2020).

Emoji use may provide additional data for non-sensory subjective emotional experiences beyond just liking (Schouteten et al., 2018). However, their effectiveness as a tool in Brazilian consumer studies is still scarce. Additionally, individuals' emotions have been studied for nearly half a century, but the literature has not advanced to the point of estimating the intensity of a stimulus capable of influencing valence and arousal. Mitigation efforts can

focus on the relationship between eating disorders and negative emotional states, which affect emotion thresholds and, in turn, decision-making. In this sense, this study aimed to evaluate the importance of healthiness in consumption of new foods, followed by the proposal of new emotion thresholds. To meet the objectives of the work, it was divided into three articles:

Article 1: Perceived healthiness of foods: A systematic review of qualitative studies

Article 2: Contemporary Foods – Can They Become New Comfort Foods or Simply Mimic Them?

Article 3: Health beliefs towards Kefir Correlate with Emotion and Attitude: a Study using an Emoji Scale in Brazil

Article 4: Proposal for determining valence and arousal thresholds: Compromised pleasure threshold, unpleasure threshold, and arousal threshold

This is the first study to investigate the relantionship between liking, purchase intent and emojis in Brazil. This also aims to contribute with reinforcement of the use of emojis as a marketing tool in the emotion measurements area.

References

Ares, G., Vidal, L., Allegue, G., Giménez, A., Bandeira, E., Moratorio, X., ... & Curutchet, M. R. (2016). Consumers' conceptualization of ultra-processed foods. *Appetite*, *105*, 611-617.

Ares, G., & Varela, P. (2018). Consumer-based methodologies for sensory characterization. In *Methods in Consumer Research, Volume 1* (pp. 187-209). Woodhead Publishing.

Brownbill, A. L., Braunack-Mayer, A. J., & Miller, C. L. (2020). What makes a beverage healthy? A qualitative study of young adults' conceptualisation of sugar-containing beverage healthfulness. *Appetite*, *150*, 104675.

Bullock, K., Lahne, J., & Pope, L. (2020). Investigating the role of health halos and reactance in ice cream choice. *Food Quality and Preference*, *80*, 103826.

Ditlevsen, K., Sandøe, P., & Lassen, J. (2019). Healthy food is nutritious, but organic food is healthy because it is pure: The negotiation of healthy food choices by Danish consumers of organic food. *Food Quality and Preference*, *71*, 46-53.

Faraji-Rad, A., & Pham, M. T. (2017). Uncertainty increases the reliance on affect in decisions. *Journal of Consumer Research*, *44*(1), 1-21.

Flaherty, S. J., McCarthy, M. B., Collins, A. M., McCafferty, C., & McAuliffe, F. M. (2020). A phenomenological exploration of change towards healthier food purchasing behaviour in women from a lower socioeconomic background using a health app. *Appetite*, *147*, 104566.

Gaspar, M. C. D. M. P., Garcia, A. M., & Larrea-Killinger, C. (2020). How would you define healthy food? Social representations of Brazilian, French and Spanish dietitians and young laywomen. *Appetite*, *153*, 104728.

Hoek, A. C., Pearson, D., James, S. W., Lawrence, M. A., & Friel, S. (2017). Shrinking the food-print: A qualitative study into consumer perceptions, experiences and attitudes towards healthy and environmentally friendly food behaviours. *Appetite*, *108*, 117-131.

Lupton, D., & Turner, B. (2018). "I can't get past the fact that it is printed": consumer attitudes to 3D printed food. *Food, Culture & Society*, *21*(3), 402-418.

Lusk, J. L. (2019). Consumer beliefs about healthy foods and diets. *PLoS One*, *14*(10), e0223098.

Mai, R., & Hoffmann, S. (2015). How to combat the unhealthy= tasty intuition: The influencing role of health consciousness. *Journal of Public Policy & Marketing*, *34*(1), 63-83.

Manippa, V., Giuliani, F., & Brancucci, A. (2020). Healthiness or calories? Side biases in food perception and preference. *Appetite*, *147*, 104552.

Menegassi, B., de Morais Sato, P., Scagliusi, F. B., & Moubarac, J. C. (2019). Comparing the ways a sample of Brazilian adults classify food with the NOVA food classification: An exploratory insight. *Appetite*, *137*, 226-235.

Motoki, K., Saito, T., Nouchi, R., Kawashima, R., & Sugiura, M. (2019). Anxiety increases visual attention to hedonic foods: A preliminary eye-tracking study on the impact of the interplay between integral and incidental affect on foods. *Appetite*, *137*, 218-225.

Oljans, E., Elmståhl, H., Mattsson Sydner, Y., & Hjälmeskog, K. (2018). From nutrients to wellbeing identifying discourses of food in relation to health in syllabi. *Pedagogy, Culture & Society*, *26*(1), 35-49.

Otterbring, T., Gidlöf, K., Rolschau, K., & Shams, P. (2020). Cereal deal: How the physical appearance of others affects attention to healthy foods. *Perspectives on Behavior Science*, *43*(3), 451-468.

Peschel, A. O., Kazemi, S., Liebichová, M., Sarraf, S. C. M., & Aschemann-Witzel, J. (2019). Consumers' associative networks of plant-based food product communications. *Food Quality and Preference*, *75*, 145-156.

Provencher, V., & Jacob, R. (2016). Impact of perceived healthiness of food on food choices and intake. *Current obesity reports*, *5*(1), 65-71.

Provencher, V., Polivy, J., & Herman, C. P. (2009). Perceived healthiness of food. If it's healthy, you can eat more!. *Appetite*, *52*(2), 340-344.

Rosi, A., Mena, P., Scazzina, F., Marino, B., Daneyko, O., Fasano, F., ... & Brighenti, F. (2017). Food perception at lunchtime does not depend on the nutritional and perceived characteristics of breakfast. *International journal of food sciences and nutrition*.

San-Cristobal, R., Navas-Carretero, S., Celis-Morales, C., Livingstone, K. M., Stewart-Knox, B., Rankin, A., ... & Martinez, J. A. (2017). Capturing health and eating status through a nutritional perception screening questionnaire (NPSQ9) in a randomised internet-based personalised nutrition intervention: the Food4Me study. *International Journal of Behavioral Nutrition and Physical Activity*, *14*(1), 1-12.

Schaefer, S. E., Biltekoff, C., Thomas, C., & Rashedi, R. N. (2016). Healthy, vague: Exploring health as a priority in food choice. *Food, Culture & Society*, *19*(2), 227-250.

Schouteten, J. J., Verwaeren, J., Lagast, S., Gellynck, X., & De Steur, H. (2018). Emoji as a tool for measuring children's emotions when tasting food. *Food quality and preference*, *68*, 322-331.

Shan, L. C., Regan, A., Monahan, F. J., Li, C., Murrin, C., Lalor, F., ... & McConnon, A. (2016). Consumer views on "healthier" processed meat. *British Food Journal*.

Sijtsema, S. J., Onwezen, M. C., Reinders, M. J., Dagevos, H., Partanen, A., & Meeusen, M. (2016). Consumer perception of bio-based products—An exploratory study in 5 European countries. *NJAS-Wageningen Journal of Life Sciences*, *77*, 61-69.

van Ooijen, I., Fransen, M. L., Verlegh, P. W., & Smit, E. G. (2017). Signalling product healthiness through symbolic package cues: Effects of package shape and goal congruence on consumer behaviour. *Appetite*, *109*, 73-82.

Yarar, N., & Orth, U. R. (2018). Consumer lay theories on healthy nutrition: AQ methodology application in Germany. *Appetite*, *120*, 145-157.

2. CHAPTER I
Perceived healthiness of foods: A systematic review of qualitative studies

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Perceived healthiness of foods: A systematic review of qualitative studies

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Beliefs

ABSTRACT

Perceived healthiness (PH) has been the subject of intensive research over the last years, mainly due to its huge impact on food choice. Nonetheless, consumers' perceptions of healthiness have predominantly been investigated from the quantitative perspective. This systematic review identified 60 qualitative studies to answer the following questions: How has the PH of foods been investigated and explored? How the importance of food healthiness (FH) influence consumer attitudes and food choices? How has FH been important to reinforce consumers' expectations? What opportunities and barriers can be identified in terms of ethical, sustainable, and environmental motivations? Content analysis identified five dimensions: 'misconception, knowledge or cognition', 'pleasure', 'healthiness importance', 'purity', and 'environmentally friendly or ethical issues'. We suggested that information about self-directed benefits can affect both the expectation and tasting of foods. Overall, the desire for more palatable "healthy" foods may explain a growing attention for future foods providing good feelings (e.g., green comfort foods). Making health policies and educational interventions may help increase the importance of healthiness in a stimulus-independent manner to maximize potential healthier choices, influencing sensory pathways. In this regard, it is important that the industry, consumers, and government priorities be aligned with in the future.

1. Introduction

Consumers value both experiences (e.g., tastiness) and credence (e.g., healthiness) characteristics in their food decisions Mai and Hoffmann (2015). In this context, the healthiness of foods (FH) is becoming increasingly important in consumer minds (Pinto et al., 2020a). FH represents the consumer's expectations and beliefs about the influence of the product on their health status or good shape Mai and Hoffmann (2015). These expectations explain why, for instance, consumers who value health factors shift more attention towards food options that holistically signal healthiness (Otterbring et al., 2020).

The need to better investigate the perceived healthiness of foods (PH) and the monitoring of its multiple impacts on the supply chain requires an understanding of consumers' values, motivations, and buying behavior, which can be gained through qualitative research (Pinto et al., 2020a). In parallel, there is a need for an overview of qualitative research on perceived healthiness and its place in information work from a practical perspective.

In general, qualitative research provides more holistic responses to consumer perceptions when compared to quantitative methods (Torrico et al., 2018). For particular contexts, qualitative data stand out because new ideas emerge outside of the rigid context of quantitative studies (Esmerino et al., 2017), without compromising on the richness and dimensionality of data (Banovic et al., 2018).

According to Ares and Varela (2018), qualitative methods "involve tasks that are less structured than quantitative methods. However, qualitative methods are able to provide a better understanding of consumer perceptions and researchers with the capacity to access perceptions and attitudes generated by a large amount of information". For Bristol and Fern (1993), qualitative research "provides accurate and useful infor-

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mation about consumers' attitudes, because they are best theorized and studied at the individual respondent level". Therefore, qualitative research has been included in studies and has recently been on the rise as a method of exploratory food research Ares and Varela (2018).

Qualitative research deals with the reasons behind consumer behavior (Hoek et al., 2017), in an interpretive, naturalistic approach to the world through the use of a variety of empirical materials without framing the inquiry within an explicit theoretical, philosophical, epistemological, or ontological tradition. Monitoring real-time food choices such as what was consumed, when, where, with whom, and why, including the usual verbal and nonverbal information involved in the buying process reinforces its potential to capture subjective experiences and perceptions of consumers (Ares and Varela, 2018; Doub et al., 2016; Hoek et al., 2017). Examples include, and are not limited to ethnographic inquiry (culture of the consumer), phenomenological study (the lived experience of the consumer), ethnomethodological research (everyday norms of the consumer) or a realist inquiry (identifying the mechanisms that support and explain consumer within a particular context) (Denzin & Lincoln, 2017; Patton, 2014). Emerging techniques, such as projective techniques, may also reveal subconscious feelings or thoughts by indirect questioning and stimuli (e.g., symbolic information) (Hoek et al., 2017).

2. Theoretical framework

Evidence supporting the idea that the PH has a significant impact on food intake and food choices are somewhat significant (Pinto et al., 2020a). Lusk (2019) affirms that PH does not consider the healthy dimension as a single unifying construct. Instead, animal origin, environmentally friendly production, home-cooking, nutritional aspects (diet and/or light products), level of processing (natural vs transformed foods), preservation and freshness are among the main precursors to the healthiness associations towards foods (Manippa et al., 2020; Lusk, 2019; Yarar and Orth, 2018). Ditlevsen et al. (2019) have also identified three main factors influencing the perceived healthiness of foods (PH): nutritional value, followed by pleasure and purity. Moreover, previous studies have been shown that conventional and unconventional beliefs (e.g., "natural", genetically modified, absence of pesticides/chemicals), consciousness/knowledge of food composition, type of food and susceptibility to positive and negative emotional states in food experiences (e.g., certain foods are comforting) can add value to PH (Ares and Varela, 2018; San-Cristobal et al., 2017, Pinto et al., 2020b). Oljans, Elmståhl, Mattsson Sydner, and Hjälmeskog (2017) reinforce that 'health' is interpreted as a dimension that includes the environmental and social aspects of well-being, which makes well-being experience an important precursor of the perceived healthiness of foods (Ares and Varela, 2018).

According to Grisolía (2018) and Pinto et al. (2020b), the PH is more linked to persons who belong to a richer and more educated group, while low health concern/consciousness is negatively correlated to these groups. Notably, researches have shown the effects of sociodemographic aspects on the PH, but also call attention to the eating habits and the number of misunderstandings and knowledge gaps that significantly influence the FH conceptions (Ares and Gámbaro, 2007; San-Cristobal et al., 2017; Sutterlin, and Siegrist, 2015).

Fielding-Singh (2017) investigated the food's symbolic value across the socioeconomic spectrum and found that low-income parents used food to buffer against deprivation, whereas high-income parents fulfill values around health and parenting. Rojas-Rivas et al. (2019) perceived a duality between the perception and consumption motives towards the healthiness of amaranth; the PH of amaranth was related to its symbolic value. "Conscious pragmatists towards their health" had conceptions of "health and well-being", "feeding" and "nutrition"; For "Unconscious pragmatists towards their health", "Mitigate hunger" was the main motivation, while predominantly traditionality and functionality responses were recorded for "Conscious pragmatists in transition towards their health". The authors concluded that gender, age, marital status, and cultural capital were internal dispositions that reflected their different food conceptions on amaranth. In the same direction, Lovell (2016) investigated the experiences of low-income parents by receiving sociocultural messages on child health and nutrition. Data obtained by this study suggest a theoretical model of "parental movement toward action", that depends on the culture, context, and parents' introjected values.

Some studies report the effect of external sources (e.g., brand name) on consumers' perceptions. These also have shown that overestimation of nutrients may be more salient in deprivation or overeating conditions (Polivy et al., 2005). Provencher et al. (2009) showed that restrained eaters exposed to the healthful brand ate more cookies than those exposed to the less healthy brand. Nevertheless, the study did not show any difference among unrestrained eaters in food intake. This heuristic was also demonstrated by Cavanagh and Forestell (2013) who perceived that "healthier" cookies were preferred than "unhealthy" cookies. Restrained eaters exposed to the healthful brand had more cookies than those exposed to a less healthy brand. Thus, data obtained by these studies show that the concept of "healthier food" may lead to an imbalance of food intake (Provencher et al., 2009).

In regard to the effect of health-related information (e.g., health and nutrition claims, logos), some studies showed a mixed record. It has been argued that symbolic cues may be more related to healthiness when these cues have self-directed benefits (e.g., willing to purchase a product because of the claims offered) and are less dependent on hedonic goals (e.g., sensory pleasure) (van Ooijen et al., 2017). A health concern or self-perception of body weight could lead to a better PH. Nevertheless, the "halo" effect can substantially alter the perceived value of a stimulus (e.g., palatability, satiety, healthiness) (Bullock et al., 2020; Provencher and Jacob, 2016; Rosi et al., 2017), because many consumers believe more heavily on holistic features than in the front-of-package nutrition labels (Otterbring et al., 2020). Prior research has also suggested using the level of knowledge (Health Consciousness) indicator to predict vulnerability behind negative emotional eating (Pinto et al., 2020b). In particular, the impacts of low health consciousness and low perceived usefulness (e.g., for the body image) can markedly exceed health-conscious decisions. In a symbolic way, van Ooijen et al. (2017) argued that healthiness may spill over to packaging (e.g., slimmer package may induce higher healthiness inferences) and at the same time induce people's self-perception of their body and its relationship with FH.

Pinto et al. (2020b) noted in their research that consumers with specific health issues (e.g., overweight or obese) are more vulnerable to present negative emotions when eating, which means that these consumers are more likely to choose "healthy" food options. Faraji-Rad and Pham (2016) and Motoki et al. (2019) indeed affirmed that anxiety (negative valence) may contribute to the state of uncertainty, which increases the reliance on perceived affective inputs, such as aesthetic appeal related to healthiness.

Although highly attractive unhealthy foods have been chosen anyway in many situations, recent interventions have contributed to improving the relationship between liking and PH (Poquet et al., 2020). Unfortunately, healthiness and tastiness have been still inversely associated ("unhealthy = tasty" lay belief) (Bullock et al., 2020; Jo and Lusk, 2018). In this line, the conceptual model grounded by Sato et al. (2020) proposed that the food (physical vs virtual) and sociocultural environments interact with cooking behaviors and food tastes to determine food consumption, especially in the case of ultra-processed foods consumption. Thinking about this, researchers have expended effort to evaluate the influence of cross-sensory cues on FH to improve sensory properties of foods, and have perceived that surface textures of biscuits are related to product healthiness Jansson-Boyd and Kobescak (2020). Recent theories on PH consider the link between extrinsic sources (e.g., sensory information) and vague conceptions.

Given that the impacts of PH have been frequently documented, it is remarkable how emotional well-being has a great influence on PH.

Rosi et al. (2017) perceived an opposite relationship between healthiness and appetitive beliefs. These social norms are strongly supported by perceptions towards food porn (e.g., unhealthy food advertising in social media) (Qutteina et al., 2019), but also, they have helped to change the expressions of deliciousness Ariyasriwatana and Quiroga (2016). From a practical point of view, the co-occurrence of incidental anxiety exposure (e.g., healthy food images posted by influencers linked to unrelated anxiety-inducing message) and integral hedonic feelings (healthy vs unhealthy food) is believed to be effective to improve the visual attention to food, in order to decrease unhealthy food intake (Motoki et al., 2019). The study of Jami (2016) partially attempted to fill this research gap investigating if the presence of a mirror can make food be perceived as less tasty. Their findings suggest that self-awareness about FH by the consumers may change taste perceptions of healthy and unhealthy foods.

Several studies also show that the positive synergy between PH and sustainability may stimulate healthy and sustainable food choices effectively (Peschel et al., 2019; Verain et al., 2016). From this point of view, Stanszus et al. (2019) used a controlled mixed-method intervention to assess the effect of mindfulness training to change unhealthy eating habits. They perceived that mindfulness-based interventions can stimulate sustainable nutritional behaviors, avoiding misleading perceptions and unconscious eating patterns. The authors also believe that the reconnection between internal hunger, satiety cues and disregard for external cues (e.g., unhealthy food advertisements) after intervention could be guaranteed.

On the basis of the assumptions presented, in order to better understand how perceived healthiness of foods has been explored in qualitative studies, this systematic review aimed to better elucidate the following research questions:

1. How has the perceived healthiness of foods been investigated and explored?
2. How the importance of food healthiness influences consumer attitudes and food choices?
3. How has food healthiness been important to reinforce consumers' expectations?
4. What opportunities and barriers can be identified in terms of ethical, sustainable and environmental motivations?

The comments harvested from the recent articles (Costa et al., 2019; Ditlevsen et al., 2019; Lavelle et al., 2016; Myers and Pettigrew, 2018; Morgan et al., 2016; Peschel et al., 2019; Pinto et al., 2020a; Qutteina et al., 2019; Tang et al., 2020; Yarar and Orth, 2018) were analyzed to derive these key issues. Open coding analysis was carried out individually by V.R.A.P. in a silent environment and transcription, based on an analysis of the small sections of text representing a certain idea or concept (Data not shown). These issues, coupled with the main findings raised by reading the full text of each article were utilized to derive a set of main questions used in this review. We aimed to give a broad overview of the research questions and to compare it to qualitative studies, the reason why we extend these results with the additional strengths of quantitative or mixed studies in the derivation process (Bullock et al., 2020; Lusk, 2019; Manippa et al., 2020; Motoki et al., 2019 Otterbring et al., 2020; Poquet et al., 2020; Stanszus et al., 2019).

Interventions for healthier food choices can improve quality of life, prevent chronic disease, and boost mood. However, many factors impede engagement for consumers. Therefore, we have conducted a systematic review and synthesis of qualitative evidence on perceived healthiness from the perspective of consumers. Some implications were discussed for future research from various conceptions on PH.

3. Materials and methods

3.1. Search process

The search for articles was carried out in April 2020. We conducted a systematic review in three phases according to procedures adopted by Pedro et al. (2013):

(i) Planning: definition of research guidelines using the PRISMA Statement protocol (Román et al., 2017);
(ii) Conduction: searching, screening and selection of papers of interest according to the checklist of quality, inclusion and exclusion criteria defined in the PRISMA (CASP, CASP Critical Appraisal Skills Programme, 2018; Dos Santos et al., 2013);
(iii) Data extraction: analyses of selected qualitative and mixed studies to investigate the findings on PH.

Scopus and Science Direct were searched for studies published over the past five years (i.e., from 2016 to 2020). Search terms were tested and finalized for each database (see Appendix 1). Articles were included for review if (1) they reported empirical studies that were written in English and published in peer-reviewed journals, (2) they clearly examined PH, (3) they proposed qualitative methods as research methodology with consumers' studies or used mixed method research, and (4) they included an a priori limit for only consumer studies. Inclusion and exclusion criteria are shown in Table 1. A control articles plane was used in order to define the key terms of searching (Ditlevsen et al., 2019; Feucht and Zander, 2018; Flaherty et al., 2020; Hoek et al., 2017; Landry et al., 2018; Lupton and Turner, 2018; Myers and Pettigrew, 2018; Sato et al., 2020; Shan et al., 2016; Yarar and Orth, 2018). In this step, Scopus has been chosen because it is the largest database at the moment (searching: food AND consumer AND healthiness). It was observed that 'health' is more common than their derived forms: 'healthiness', 'healthy', 'healthier'. Thus, this resulted in the combination of the following keywords (descriptors): food AND consumer AND health. The research terminologies were also limited to the title, abstract or keywords.

As shown in Fig. 1, the opening process given 3.601 publications. In total, 837 articles were excluded because they were duplicates; this procedure resulted in 2.764 potentially relevant titles and abstracts, which were screened by two independent reviewers. Fifteen studies were added based on the references cited in the publications included in the review (snowballing). The screening of the titles and the abstracts yielded 303 articles. From the total articles collected, after implementing the inclusion and exclusion criteria, 60 articles were selected and analyzed in full.

3.2. Quality appraisal process

Two researchers independently (V.R.A.P. and S.J.S.S.R authors), using the Critical Appraisal Skills Programme (CASP) qualitative checklist (CASP, CASP Critical Appraisal Skills Programme, 2018), the checklist of quality criteria adopted by Dos Santos et al. (2013) and the Consolidated Criteria for Reporting Qualitative Research (COREQ) (Casey et al., 2014), conducted the screening process to determine the rigor of the qualitative studies included in this study (Table 1). To further assess each of the 60 articles, data were extracted on study proposal/objectives, theoretical or philosophical framework, methodology justification, sample size, use of data triangulation, data analysis, data saturation, and implications for future research. The analysis followed a three-stage process.

First, using qualitative data management software to search for evidence in the scientific literature (StArt version 3.0.2 Beta, 2013; LAPES UFSCar Inc), two reviewers independently evaluated each study, and discrepancies were resolved through discussion. Secondly, the key concepts and categories that emerged were then discussed by the same reviewers, and V.R.A.P. performed a line-by-line coding framework, conceptualized the data, and inductively identified concepts relating to PH. Similarly to Casey et al. (2014), we used thematic analysis to analyze all the text and consumer quotations under the main findings of each article. Thematic analysis identified conceptual links among themes to develop an analytical thematic schema; this procedure allowed us to compare different themes and codes and analyze patterns from article results. Here, we examine the text using existing concepts or new

Table 1
Inclusion, exclusion and quality criteria used in article screening.

Inclusion criteria	Exclusion criteria	Quality Criteria (QC)	
Qualitative research (empirical and review study, including mixed research) English language The study population are consumers Food research Health behavior, attitude to health, health knowledge/consciousness, perceived healthiness, healthiness of foods, health choice, health perceptions, health concerns and health beliefs Human studies, food consumers, perception, awareness, attention, consumer behavior, consumer preference, consumer attitude, consumer psychology, decision making, cognition, emotions, information processing, purchase intention, sensory perception	Quantitative research Non-English language Population are performed by industry, policymakers and experts Not food research Animal studies, clinical studies, studies focused on food technology and microbiology, guidelines and technical reports Duplicate study	QC_1 QC_2 QC_3 QC_4 QC_5 QC_6 QC_7 QC_8	Were the study proposal/objectives described in a clear and appropriate way? Does it explain why the research is important? Were the theoretical or philosophical frameworks specified to guide the study? Were the methods or techniques, participants and settings, interview/observation protocol used in primary studies reported clearly? Was the data triangulation used in primary studies reported clearly? Was the study proposal evaluated/validated? Were the results reported clearly in relation to research questions? Was data analysis specified and clearly applied? A range of data saturation was clearly specified by authors? Were the implications for future research/practice specified?

Note: Quality Criteria adapted from Dos Santos, Delamaro and Nunes (2013).

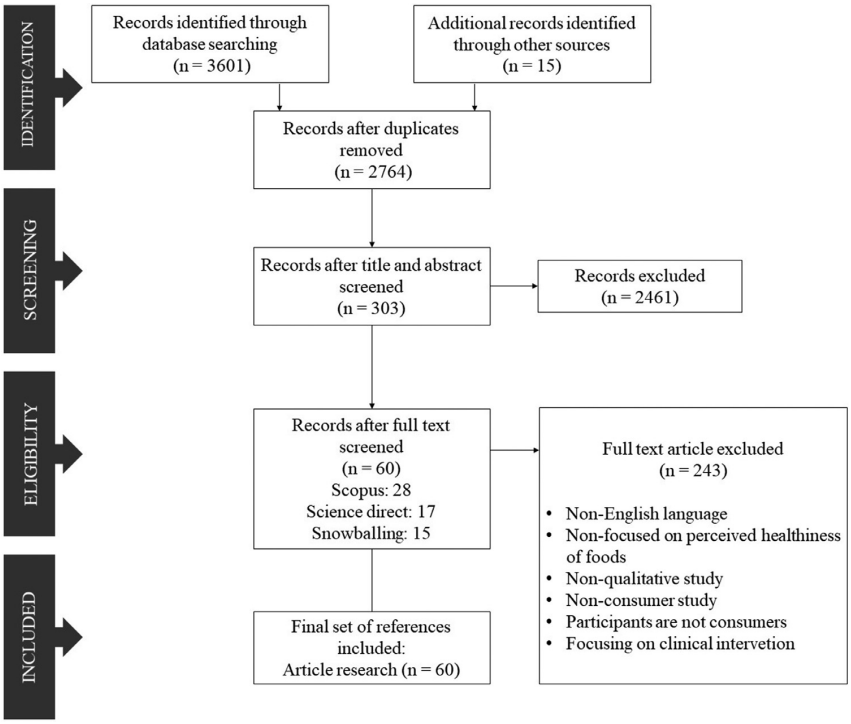

Fig. 1. PRISMA flow diagram. Throughout the body of this article, all references were numbered in alphabetical order, with superscript numbers (N = 60).

concepts created by the researchers (V.R.A.P and S.J.S.S.R.). Following procedures by Brownbill et al. (2020), the final themes were developed for addressing the research question rather than their prevalence within the data, as is appropriate for a qualitative approach. Finally, researchers discussed results and proposed improvements in transcription and codes. A professional translator revised the English and scientific writing.

Finally, the revision of data included in the coding stage and analytical framework, and the discussion of the addition or revision of themes and codes were conducted by two members of the research team (M.C.T.R.V. and M.L.E. authors). Any inconsistency between final themes and codes generated was resolved by consensus among team members. This triangulation approach guarantees the alignment of themes and analytical frameworks to reflect the full breadth of data (Casey et al., 2014).

4. Results

4.1. Global analysis

This review shows that there has been much qualitative research done in the field of PH. The search process retrieved 60 studies eligible for inclusion (Fig. 1). Of these, thirteen employed a mixed-method approach; seven used a conceptual model grounded to develop an explanatory model of PH; nine reported the use of data triangulation; and a range of data saturation, i.e., when little or no new pertinent con-

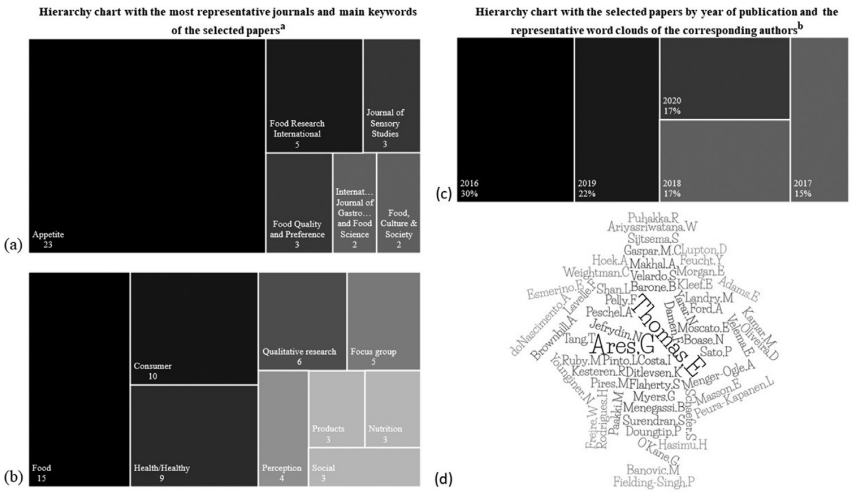

Fig. 2. Summary of characteristics of the selected papers. (a) Hierarchy chart with the most representative journals, and (b) main keywords of the selected papers; (c) hierarchy chart with the selected papers by year of publication, and (d) the representative word cloud of the corresponding authors to papers. [a]Categories based on frequency obtained of the total of 60 papers and 238 keywords. [b] Categories based on percentage and frequencies of words obtained from the total of papers (N = 60). Source: Scopus (2020).

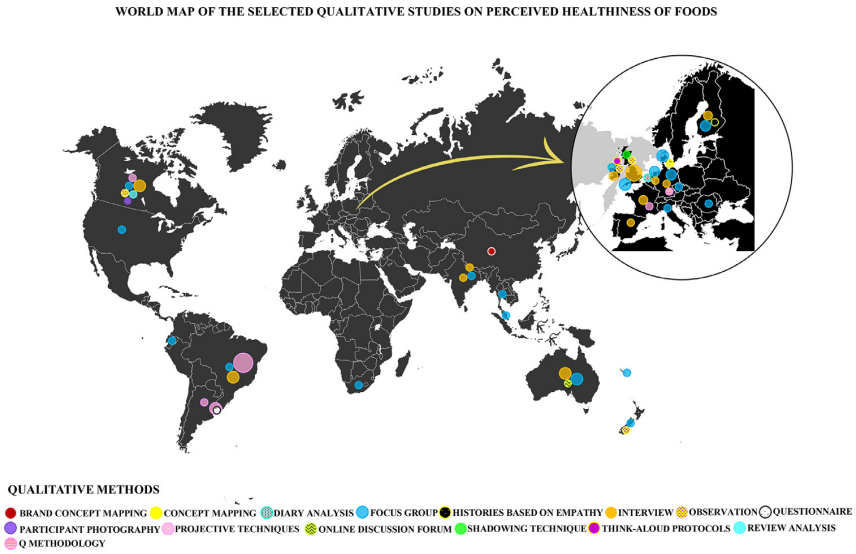

Fig. 3. World map of the selected qualitative studies on perceived healthiness of foods, and their projection by each country. The corresponding qualitative methods are represented by colored markers, and their position on the map is not realistic in terms of geographic coordinates. The size of the projection was proportional to the number of the studied samples.

cepts were arising from subsequent data gathering (Casey et al., 2014), was specified by eighteen. The analysis strategy most commonly used was content or thematic analysis (n = 52). The majority of the studies described the proposals in a clear and appropriate way, adopted theoretical or philosophical frameworks to guide the study, and specified the limitations and implications for future research. In Appendix 2, the findings are summarized from 60 qualitative studies that examined the perceived healthiness of foods.

Fig. 2 shows that there were publication peaks in Appetite journal (23 papers). The keywords most frequently were 'food', 'health' or 'healthy', 'qualitative research' 'focus group', 'nutrition' and 'perception'. To date, the year 2016 had the highest number of published articles. However, an overview of the all studies included in the review shows the evolution of the PH theme regarding the number of published articles, since 42 of the 60 studies appearing after 2016 (Fig. 2).

The 60 articles involved 10,369 consumers, and the samples represented 26 countries with the majority from Europe, followed by South America, Oceania, and North America. Fig. 3 plots the studies into the world map and their projections proportional to the frequency of application in each country. Australia, Brazil, United Kington, and United States contain the highest number of published articles (32 papers), and the main techniques used in the studies were focus groups and face-to-face interviews (see Appendix 2). Following the procedures adopted by Casey et al. (2014), the comprehensiveness of methodological reporting in included studies are shown in Table 2.

4.2. How has the perceived healthiness of food been investigated and explored?

Healthiness perceptions have been investigated and explored through content analysis of individual interviews and focus groups in the majority of the studies (Appendix 2). Some consumers experienced lasting food-related worry (e.g., concern with sugar content), but for how long or to what degree is unclear. Appendix 2 emphasizes the main findings of the studies, in order to gain a better understanding of how the PH has been explored and evaluated qualitatively. We identified five themes related to PH: 'food preservation', 'misconception, knowledge, or cognition', 'pleasure', 'healthiness importance', and 'environmentally

Table 2
Details of the included qualitative studies on perceived healthiness of foods.

Topic	Corresponding studies	Number of studies
Theoretical or philosophical frameworks	2, 3, 7, 10, 11, 15, 17, 18, 24, 27, 33, 36, 37, 40, 42, 43, 45, 47, 48, 51, 57, 58, 60	23
-A theory-based qualitative study	4, 6, 11, 12, 14, 15, 16, 19, 30, 33, 37, 43, 46, 56	14
Characteristics of interviewers/moderators	4, 11, 30, 33, 37, 43, 46, 49, 56	9
-Interviewer/moderator identified	4, 6, 11, 15, 16, 18, 20, 23, 24, 30, 37, 52, 46, 48, 49, 56, 57	17
-Occupation of interviewer/moderator	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 23, 24, 28, 29, 30, 31, 33, 34, 35, 37, 41, 42, 43, 52, 44,	45
-Experience or training in qualitative research	45, 46, 48, 49, 50, 51, 53, 54, 56, 57, 58, 59	32
Participants recruitment	3, 4, 6, 7, 9, 10, 11, 13, 19, 21, 22, 23, 26, 27, 28, 29, 30, 32, 33, 35, 38, 39, 41, 42, 52, 44, 49, 51, 56, 57, 58, 59	56
-Criteria for recruitment of participants	1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36,	60
-Recruitment strategy (e.g., snowball, purposive, convenience, comprehensive)	37, 38, 40, 41, 42, 43, 52, 44, 45, 46, 47, 48, 49, 50, 51, 53, 54, 55, 56, 57, 58, 59, 60	55
-Method of approach or recruitment	All studies	2
-Sample size	1, 3, 4, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 26, 27, 28, 29, 30, 31, 33, 34, 35, 36, 37, 38,	41
Data collection	39, 40, 41, 42, 43, 52, 44, 45, 46, 47, 48, 49, 50, 51, 53, 54, 55, 56, 57, 58, 59, 60	18
-Questions, prompts, or topic guide	8, 33	41
-Repeat interviews/observations	2, 3, 4, 6, 10, 11, 13, 15, 16, 17, 18, 19, 20, 21, 22, 24, 26, 30, 32, 33, 34, 36, 40, 43, 52, 44, 45, 46, 47, 48, 49, 50,	49
-Audio/visual recording	51, 53, 54, 55, 56, 57, 58, 59, 60	18
-Field notes	15, 17, 20, 21, 22, 23, 24, 28, 29, 30, 33, 44, 45,	9
-Duration of data collection (interview, focus group or observations)	50, 55, 57, 58, 59	52
-Protocol for data preparation and transcription	3, 4, 7, 10, 11, 12, 14, 16, 17, 18, 21, 23, 24, 26, 27, 28, 29, 30, 32, 33, 34, 36, 37, 38, 39, 40,	23
-Data (or theoretical) saturation	41, 42, 43, 44, 45, 50, 51, 53, 54, 55, 56, 57, 58, 59, 60	47
Data analysis	2, 3, 4, 6, 7, 8, 10, 11, 12, 14, 15, 16, 17, 18, 19, 20, 21, 22, 24, 25, 26, 27, 28, 29, 30, 33, 34, 35, 36, 38,	
-Data triangulation	39, 40, 41, 42, 43, 52, 44, 45, 46, 48, 50, 51, 53, 54, 55, 56, 57, 58, 59	
-Derivation of themes or findings (e.g., inductive, constant comparison)	3, 4, 6, 10, 18, 23, 26, 30, 36, 40, 42, 44, 46, 50, 54, 56, 57, 58	
-Use of software (e.g., Atlas.ti, Dedoose™, MAKQDA, NVivo)	13, 15, 21, 27, 28, 35, 39, 48, 60	
Practical implications	1, 2, 3, 4, 6, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 32, 33, 34, 35, 36, 38,	
-Limitations and future perspectives	39, 40, 41, 42, 43, 44, 45, 46. 47, 48, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59	
	6, 8, 10, 11, 12, 15, 16, 17, 24, 28, 29, 30, 34, 35, 37, 42, 43, 45, 46, 50, 51, 53, 58	
	3, 4, 6, 7, 9, 10, 11, 12, 14, 15, 16, 18, 19, 21, 22, 23, 26, 27, 28, 29, 30, 33, 35, 37, 38, 39, 40, 41, 42, 43, 52, 44,	
	45, 46, 47, 48, 49, 50, 51, 53, 54, 55, 56, 57, 58, 59, 60	

Note: Comprehensiveness of reporting in qualitative studies adopted by Casey et al. (2014).

friendly or ethical issues'. Based on these five dimensions, PH relies on a scientific tripod-taking nature as a research object of the quotations: introjections (beliefs and values), knowledge and sensoriality.

4.2.1. Internal dispositions that reflected different conceptions towards the healthiness

There are many reasons why consumers concern about the FH. However, the approach and recognition of this concept are still scarce. Ditlevsen et al. (2019) presented a conventions approach to health understanding. The approach sought to fill the gaps in the literature by explaining how consumers understand healthiness. The 'purity' concept was more related to organic foods, and the nutritional importance was intrinsically linked to healthy eating demand. Yarar and Orth (2018) identified four lay theories on healthy nutrition, among which the FH was related to production methods (i.e., organic vs. industrial). Our findings also indicated that these conceptualizations have been explicitly or implicitly interpreted in somewhat similar ways by various authors. Looking at the results of the systematic review from a broader perspective, we detailed the five themes related to PH. Table 3a, 3b, 3c, 3d and 3e shows the summary of the quotations extracted from papers, in order to illustrate each theme and their respective codes:

i. Misconception, knowledge, or cognition category represent thoughts, feelings, and perceptions related to consumer understanding of nutritional components, symbols, and other intrinsic/extrinsic cues (e.g., smell, taste, health claims, country of origin), which can lead to healthy decisions or represent traps for the food choices. Consumers relate some characteristics such as the absence of genetically modified organisms, additive, preservative and coloring, and low in sugars, fats, and sodium to good quality food.
ii. In this category, the PH is defined by pleasure. Therefore, it represents a minimal health perspective in consumers' motivations and preferences, i.e., Reasons such as well-being, taste expectations, comfort, indulgence, contextual necessity, cultural and social influences strongly affect food choices by the consumers. Therefore, consumers are not likely to choose healthiness over pleasure, being it considered secondary in this topic.
iii. Relations between FH and health issues are presented in this category. This theme revealed that the main motivational concerns for consumers were the functionality of food, the healthiness of the product in terms of security, trust, self-directed benefits, and physiological conceptions; skepticism, health beliefs, and attitude to health were also considered.
iv. Food preservation demonstrated ideas related to how food should be prepared, focusing on naturalness, purity, home-cooking, processing, and freshness aspects, as well as the importance of origin and local production. This category indicates the importance of the encouragement of unprocessed or minimally processed ingredients.

This fifth category refers to consumers' drivers to sustainable and environmentally friendly food choices. As for the ethical issues, sustainability, animal welfare, ecological conception, the healthfulness of the environment, and a healthy diet were identified as contributing to the health consciousness on food choices.

As shown in Table 3a, various concepts were associated to unhealthy foods: 'bad for you', 'caloric', 'poorly food', 'tasty', 'quenched', 'less healthy', 'junk food', 'bad', 'inappropriate', 'dense in sugars, fats and salt', 'trash food', 'rubbish', 'filth', 'bullshit'; and healthy foods: 'safe', 'expensive', 'green food', 'fresh', 'sustainable', 'ecological', 'pure', 'natural', 'natural healing', 'health', 'vitamin', 'nature', 'purity', 'nutritious', 'herbal medicine', 'good for you', 'reduce diseases', 'dietetic', 'appropriate', 'balanced', 'good' 'quality food', 'with no pesticides or GMOs', 'tastes good', 'seasonal', 'local products', 'not packaged', 'not pre-cooked', 'not frozen', 'no fast food', 'low or absence in additives, colorings, and preservatives'.

The concept of FH also goes together with food-as-medicine (e.g., preventing diseases) (Brownbill et al., 2020; Fielding-Singh, 2017; Gaspar et al., 2020; Kamar et al., 2016), food-as-friendly (e.g., vegan foods, bio-based foods, food providing self-directed benefit) (Costa et al., 2019; Sijtsema et al., 2016; Fielding-Singh 2017; Freire et al., 2017;

Table 3a
Impact of misconception, knowledge, or cognition on perceived healthiness.

Contributing studies	Codes	Comments
Theme 1: Misconception, knowledge or cognition 1, 3, 5, 8, 10, 11, 16, 17, 18, 20, 23, 27, 28, 30, 34, 35, 36, 40, 42, 43, 46, 49, 51, 52, 53, 54, 58, 59	Awareness	"Vitamins from red meat cannot be the same as those from white meat"; "Ham fortified with omega-3 from fish? That has to taste of fish and well, I'm not sure I know what it is at the end of the day…I can't imagine … Really, it's not ham anymore! And how would you eat that?"[5] "Nourishing foods" (e.g. meat, carbohydrates, and dairy products): "energy," "vitamins," and "goodness that strengthens and builds the body"; "light foods"(e.g. fruit and vegetables): "sweep out the bad stuff". "Fruit helps with transit, with digestion. Vegetables especially, they unblock you, because they are full of fibre"; "that also bring vitamins, everywhere in the body. Especially if they have grown where there has been a lot of sunshine."; "Butter and fatty cheeses head straight for the spare tyre, they turn into cholesterol straight away".[5] [Probiotic milk] "basketball", "dance", "exercise", "vitality" and "gut flora".[8] "I think of healthy choices – as far as snacking goes. Um, we use kind of two words in my house. There's snack and then there's treat. So treats would be maybe, you know, more sugary kind of cookies and things like that and snacking in my house is usually we go for, you know, I give a few choices, healthy choices"; "It's weird, cause you think of both [snacks - healthy and not healthy]. You think of junk food. You think of chips, popcorn, and then you also think of fruit, peanut butter, peanuts, and stuff like that. I typically try to lean towards the healthy side, but there's times when you go to the corner store and grab a little 36 cent bag of chips and a quart of juice, water, or whatever that crap is, and then you call it a day. But usually I would say fruit (healthy food)".[17] "Because candy isn't healthy for you and snacks, some snacks, aren't that healthy but most snacks are usually healthy"; "Healthier stuff goes in here [snack pile] because well my mom just says that candy isn't really a snack".[18, C] [Organic foods] "Healthy; safe; expensive; green food; pure; natural".[23] [Food Product made with flowers] "Natural healing; health; vitamin; nature; purity"; [Yoghurt made with flowers] "healthy; nutritious; herbal medicine; natural; nature; pure".[27] "Cereals have a negative association; the intensive agriculture and the genetic manipulation causes intolerance";[28, M, O] "I associate products with increased protein content to being in a hospital"; In my opinion these products have no benefits, unless a doctor advices otherwise.[28, F, O] [Probiotic and organic formulations] "People who seek well-being through food," "worried about the health and life quality," "seeking a health and nutritious alimentation," and "worried about the food quality".[35] "Some things you can tell are unhealthy. Like if you bite into a cream bun the cream in it is sweet so they must have put sugar in it, and you can taste that it wouldn't be healthy".[36] "For me, healthiness is something about a varied diet with vitamins, vegetables and fat… I am not afraid of fat, but I consider which kind of fat I use for cooking".[43] [Omega-3] "A type of oil; a food supplement; contained in fish, but consumption is low; present in egg, milk, and margarine; regulates cholesterol; cleanses the body; is a fat that the body produces in little quantity; fish oil".[49] "I saw the caffeine content [in the energy drink] is still 13, actually, it's actually pretty like, in milligrams, is that high or is that low?"; "[…] water might be a really good choice but you might want something that can help provide additional nutrients to help build up your body (energy drinks). So it just depends on what the objective you're looking for"; "It [energy drink] seems like it's unnecessary and probably bad for you, if your body has all this crap that it has to deal with is".[51] [Ginseng food products] "Healthy; high price; premium quality; rare; traditional; beauty".[52] "The snacking thing is quite hard[…] you look down the content and you're like 'oh actually I'm thinking yogurt coated blueberries is really healthy and actually it's totally not'."; "My kids are at the stage of being really busy and so snacking seems [inevitable][…] but trying to find a good snack, because you feel like dried fruit has got lots of sugar in it and then cereal bars have lots of sugar".[53] ["healthy" foods] "dietetic; good; appropriate; balanced". ["unhealthy" foods] "less healthy; junk food; bad; inappropriate; trash food; rubbish; filth; bullshit"; "Healthy food? Fruits and vegetables come to mind, because that's what everyone is thinking: healthy food? Fruits and vegetables"; "Good quality food, with no pesticides or GMOs or anything like that, and that tastes good, seasonal, local products"; "The healthiest foods are: seasonal foods that are very fresh and very natural, not packaged, not pre-cooked, not frozen, no fast food, all those things with additives, colorings and preservatives"; [Healthy food] "A food that helps to digest, which provides energy without being harmful to my health. All those foods and cereals called antioxidants and that people say to be good to prevent cancer […] The healthiest are generally fruits, cereals, avocado […] Obviously foods that don't either add up to a lot of calories. But, for example, avocados seem healthy and oily just like smoked salmon. I eat them considering them as healthy".[54]
	Nutritional conception	"Milk is a good source of protein, but again I try to be mindful of the fat that's in it."[10] "Glass of wine is better than a beer, it's less bloating and has fewer calories".[16] "Well um they [candy] have sugar, a lot of sugar in it and those [snacks] don't have as much sugar".[18] "I consider them healthy and suitable products for breakfast [fermented beverage products]. It's better than eating bread, cake…they are less caloric."; "I consume yoghurt because it is a healthy product, source of calcium, protein and it is easy to digest. I do not know if other products have similar benefits."[20] "[…] especially with the veggies, it's … it's a healthy meal [steak with greens], it's a hearty meal also because there's a lot of protein, fat, and at the same time, well, we've got our veggies".[30] "Shellfish are high in fat".[40] […] "the other one and the last one would be the completely industrialized foods, right? Cookies, snacks, this here is Nuggets®, right? Lasagna, beef broth and soda, right? These, for me, are the ones with higher concentrations of fat, sodium, and the ones that bring no benefit to health, right, in terms of food".[46]

(*continued on next page*)

Table 3a (*continued*)

Contributing studies	Codes	Comments
	Health beliefs	"I am not sure what they are but I've heard that they are not good for health (ultra-processed foods)".[1] "And I think they're all processed and I think they're all bad for you [...] (processed meat)".[11] "A meal is probably um stuff that has just has no sugar in it, mostly just health".[18] "You are what you eat. Food is your medicine. As a mom, you tell them as much as you possibly can throughout their life. Your health is gonna depend on what you put into your body."[21, F, LI] "Cholesterol in shellfish is detrimental to health".[40] "She gets 3 candies, I think candy is not too bad"; "I gave him a cookie which is better than a lollypop"; "He got a spelt cookie, this is a healthy cookie, so a good choice"; "I gave him apple pie because it is fruit too".[42, F, LI] "[...] Like, if you compare Coke and water, there's a big difference in taste but if you compare like iced tea and water that one's just a bit more flavored and sugar so you think, oh I'm really not being that unhealthy".[51] "[...] but if I had to take a stance, I would say that no food is healthier than any other"; "There is no such thing as healthy food, there is a healthy diet"; "I don't see the point of a light product, it's adulterated [...] I think a light product is less healthy than real butter".[54] "Brinjal and potato will not be consumed for reasons that it will cause arthritis"; "Spinach and tomato should not eat they (doctors) say which caused stones in kidneys".[58] "I guess if it is healthy, I will give him a good portion, for example, roasted hazelnuts, raisins. For the packaged snacks, I tend to buy snacks for babies. It says on the packaging "no nasties". It must be healthier and contain less artificial sugar than other cookies[...] He won't stop until it is finished. I guess eating a whole bag of biscotti must be better than eating a whole pack of 'Oreo' cookies".[59]
	Mood	"Foods that contain fat, sugar and salt in a combination that make them almost addictive (ultra-processed foods)".[1] "In the advert it says [whole grain is] fuel for the brain."; "does it like calm the nervous system?"; "feeds the immune system? [3] "Eating chocolate makes you happy"; "with active ingredient that combats low mood".[5] "Sometimes I care about health when I go to the shop, but not always. I can't explain it but sometimes I just really want something that's yum. I like to see what's healthier only if I'm in the mood".[36] "I guess they [energy drinks] provide a temporary benefit for students going through stressful times".[51]
	Satiety or portion size conception	"Insects are usually too skinny to have any goodness in them anyway".[34, F, O] "If it's healthy, breakfast cereals without added sugar, (I'll give them) as much as they want".[59, F, HI]

Note: Socio-demographic characteristics were included in the consumers' comments if they have been specified. [F]: Female
[M] : Male
[C] : Children
[O] : Older people (> 60 y.o.)
[LI] : low-income
[HI] : high-income.

Gaspar et al., 2020; Menger-Ogle & Graham, 2018; Thomas et al., 2016a), food-as-occasion (i.e., the change of viewing of the consumers about foods influenced by taste and/or occasions that may involve feelings and well-being) (Gaspar et al., 2020; Hoek et. al, 2017; Schaefer et al., 2016), food-as-sacred (e.g., family tradition, culture) (Ditlevsen et al., 2019; Gaspar et al., 2020; Hoek et al., 2017), food-as-appearance (i.e., insects as a taboo) Myers and Pettigrew (2018) food-as-satiety (i.e., high food intake of foods considered healthy) (Tang et al., 2020), and food that mimics healthy concept (i.e., foods that contain one or some ingredients considered healthy or foods considered similar (as an alternative) to healthy foods); (Brownbill et al., 2020; Damen et al., 2019; Tang et al., 2020).

A wide range of food products was studied in the selected papers. The most frequent categories found were functional foods, ultra-processed foods, plant products, veggie foods, junk foods, meat products, fruit and vegetables, snack foods, drinks, dairy products, insect foods, organic foods, among others. In general, some categories had mixed perceptions: snacks were considered as junk food, perceived as both healthy (e.g., meal) and unhealthy (e.g., candy) food (Adams and Savage, 2017; Ford et al., 2020; Younginer et al., 2016); energy drink was related to 'crap' and nutritive (Brownbill et al., 2020); cereals were associated with intensive agriculture, genetic manipulation, intolerance, high in proteins, 'hospital', 'no benefits'(Banovic et al., 2018), but also high in antioxidants, low in calories, healthy (Gaspar et al., 2020). Organic and flower products were perceived as healthy, safe, expensive, green food, pure, natural, nutritious, and medicine (Banovic et al., 2018; Peura-Kapanen et al., 2017); moreover, ginseng food products were also associated to healthy, high priced, premium quality, rare, traditional, and good appearance (Doungtip et al., 2019).

4.2.2. Misconception and knowledge in the perceived healthiness

Among the toughest challenges confronting consumers is the understanding of food labels to food choices adequate and safe, lack of knowledge on healthiness, and price (Freire et al., 2017). Three studies showed that some consumers were unaware of the meaning of nutritional components, had no knowledge of the existence of certain nutrients, or were not fully aware of how to differentiate similar nutrients (e.g., saturated fats, polyunsaturated fats, trans-fat) (Brownbill et al., 2020; Flaherty et al., 2020; Thomas et al., 2016b). However, reports of a consumer showed that sometimes is the lack of seriousness, and not the difficulty of understanding, the reason for the lack of interest in the use of food labels (Freire et al., 2017).

Two studies reported that consumers expect authentic products that reflect healthiness, led them to infer that reliable or conveyed dubious statements designs (e.g., trying to be healthy, but it is not at all) are generally perceived as harmful to health (Sijtsema et al., 2016; Lupton and Turner, 2018). But instead, when provided symbolic information related to self-direct benefit, it was possible to observe a positive association with healthiness (Freire et al., 2017; Thomas et al., 2016a). Consumers reported that the healthiness of products will be sought for their compelling design; then non-discretionary foods (e.g., vegetables and fruits) should be improved in this regard (Tang et al., 2020).

As expected, consumers assess FH primarily by the nutritional value. Taken together, amount of proteins, fats, calories, sodium, and vitamins were used to rank foods in terms of healthiness (Adams & Savage, 2017; Boase et al., 2019; Esmerino et al., 2017; Landry et al., 2018; Masson et al., 2016; Menegassi et al., 2019; Schaefer et al., 2016; Weightman et al., 2019). According to Ares et al. (2019), consumers

Table 3b
Impact of pleasure on perceived healthiness.

Contributing studies	Codes	Comments
Theme 2: Pleasure 2, 6, 10, 19, 22, 24, 25, 30, 31, 41, 43, 45, 50, 54	Taste	"Safe to say, I love the food here. Unhealthy, yes. But who can argue food that's always delicious?"[2] "Sometimes if they don't like [the vegetables we prepare] then they don't eat well and then we have to combine and give them some other kinds of food, like cereal…so that their stomach are full when they go out to school".[6] "Well, they're these really tiny little hard things with not much flavor (a cereal). Therefore, they have to be healthy […] 'cause otherwise, who would eat them? There's no other reason."[10] "[nutritional quality] is important, but not especially for bread – the important thing is to taste good. I can eat salad, wholegrain rice, can eat healthily in so many other ways"; "I like to buy what I like to eat, no matter what the price tag is - nutritional value comes second. I worry about sodium content, but if it is convenient, I will end up paying more"[19] "I haven't noticed any difference in what I buy since the traffic light nutrition label was implemented. Generally, healthy food is not for us. The more sugar it has, the better it tastes. Generally, we like what tastes best because taking care of our health is not for us".[22] "[…]And dairy, I couldn't go without diary. Dairy is something that I 100% will not ever give up[…]My cholesterol is very good by the way, so I'm monitoring that, so that's not an issue. So it's purely, purely enjoying, for enjoyment. Yep. And I don't want to give that up".[24] "There has to be cream and butter in food for it to have any taste. And once you've turned 80, it doesn't really matter anymore (healthiness), as long as the food tastes good".[25, M, O] "Fruit salad, also, I like when there's many fruits together. So I think it's good and healthy at the same time".[30] "I would need to taste this item before making a decision. Texture has so much to do with how delicious something is. Just to look at it, it doesn't appeal to me—it looks artificial. The green item on the plate looks like a jellied green vegetable. It doesn't look appealing at all"; "I think it's very natural and probably healthy for you as it's ground insects, but I'm not sure if I would like the taste, I have never eaten insects before. The idea of ground insect makes me squirmy".[31] "I already know that the food tastes so good. I want to eat it even though I know that the food contains a lot of sugar. I do not think I need to read the nutrition information". [45, M, AD]
	Wellbeing, comfort or indulgence	"I love tomatoes. And somebody can say, they could even have all these published reports out that say they're unhealthy, but because I love them so much, I will look at them as healthy. So, just don't take my tomatoes away. So, whether they're healthy or not, I'm going to say that they are"; "When I bite into a raspberry truffle with dark chocolate on the outside, I'm not thinking about the nutritional content of that, but if I bought it and I'm feeling that good about it, it was still a healthy choice for me. Somebody else may not think that it's healthy, but to me that's a very healthy choice."; "It's lot of fat and a lot of sugar mixed with the good dairy and some Oreos [laughing]. I think, yeah, it was, it's an indulgence, you know."[10] "[…]Now like I look at food differently, and probably more like … I'm like 'oh yeah that's junk food, that's healthy food, that's good for your soul, that's gonna make me feel better than eating a massive pile of junk food."[41]
	Contextual necessity, cultural and social influences	"I actually buy nice cuts of meat because if they taste nice, they're tender and I just like[…] I just like it, that's just[…]the way I've been brought up I guess, so".[24] "Of course, there has to be a reasonable relation between different nutrients, but for me it is also important that the food tastes of something […]The mental aspect of sitting around the table with family and friends and having nice meals… it goes far beyond those food pyramids and nutritional guidelines!"[43] "I am convinced that, for instance when you are at a terrace and you get a wonderful whole-wheat sandwich with lettuce and whatever, that looks so tasty, people will choose that. So if you offer that in a good way people will choose it here as well".[50] "You say "fruit is healthy", but sometimes a woman has PMS and needs something sweet, so candy is not so bad then and there. Or perhaps the person is going out with friends, so it depends on the moment".[54]

Note: Socio-demographic characteristics were included in the consumers' comments if they have been specified. [M]: Male
[AD] : Adolescent
[O] : Older people (> 60 y.o.).

interpreted nutritional warnings as a tool that helps to identify the excessive quantity of nutrients and show the truth behind products with deceptive marketing.

Six studies showed that PH has been related to psychological effects. Ares et al. (2016) showed that ultra-processed foods were perceived as high in fat, sugar, and salt, the reason why they were related to addictive effects similar to drugs. Kamar et al. (2016) showed that claims based on the brain, calming, and immune system effects caught the most consumer attention in advertisements of whole grain. According to Masson et al. (2016), chocolate was related to an active ingredient centered on happiness effect and combating low mood. Velardo and Drummond (2018) perceived that good humor influenced positively the PH since it motivated the consumers to have more attention to FH. Brownbill et al. (2020) perceived that the healthiness of energy drinks was positively related to reducing stress effects. In a study by Fielding-Singh (2017), the high-SES parents use healthiness as a resource to take root a sense of worth and competence as caregivers, i.e., their healthy eating practices stimulate additional insight into the foods symbolic meaning towards health and parenting. Many high-SES parents were disappointed and overtaken by the sense of failure when their adolescents have not embodied the healthiness values that these parents sought to transmit through food.

Among the health beliefs related to FH, two studies reported that processed meat and ultra-processed foods are synonymous with unhealthiness (Ares et al., 2016; Shan et al., 2016), three reported the consumers made relative comparisons among foods to define the degree of healthiness (Brownbill et al., 2020; Damen et al., 2019; Tang et al., 2020), one showed that light product was considered less healthy than traditional (Gaspar et al., 2020), and one showed that the healthiness of meal was defined by the absence of sugars Adams and Savage (2017). Two studies reported the relationship between FH and satiety or portion size conceptions. Myers and Pettigrew (2018) showed that the size of an insect portion was negatively related to the healthiness, as the sense of proportion of nutrients related to size the portion prevailed over the sense of quality. Tang et al. (2020), in turn, demonstrated that when food is perceived as healthy, many people did not control the amount of food consumed, i.e., they consume healthy foods up till they become full.

Table 3c
Impact of healthiness importance on perceived healthiness.

Contributing studies	Codes	Comments
Theme 3: Healthiness importance 4, 10, 11, 12, 13, 14, 18, 20, 22, 24, 25, 26, 28, 31, 32, 37, 38, 43, 44, 45, 47, 50, 51, 53, 54, 55, 56, 57, 58, 59	Safe or trust	"You can use [artificial sweeteners]; they are much safer than refined sugar".[22, M, A] "No, I haven't considered, not even considered (functional foods), because we have regular oatmeal and buckthorns and blueberries and lingonberries. I trust them more". [26, F, O] "We don't know what it [conventionally produced food] contains of toxins and how it will affect us in the future. In fact, that's the main reason that I buy organic food. I am not sure there is scientific evidence for it, but I am sure that you avoid toxins and drug residues when doing so"; "So I am thinking…. what are we eating? If you buy organic, at least something is discarded. I see how more and more people are having fertility problems and more and more get allergies and get sick from something undefined".[43] "I believe that the information [on nutrition labels] is true because the food comes from a reputable manufacturer endorsed by the government"; [45, M, AD] "Nutrition label tells us whether the food contains natural or artificial coloring. So we can assess the food from the health and safety aspects of ingredients before purchasing a food product"; "I will trust the information if the food is good for the health. For example, I will trust the nutrition label on less fat or less sugar food".[45, F, AD]
	Skepticism or lack of trust	"They're fairly healthy, but yet the negative is more like, it's a prepared food, so, we don't really know what's in it and I know, like, a lot of the additives and stuff I've been hearing about is not good."[10] "I have my doubts (about the quality of the product). It should not be as healthy as yoghurt [fermented milk beverage]; otherwise it would be better explained in the product disclosure. I never noticed, but feel cheated to buy (fermented) milk beverage instead of yoghurt. They are all very similar. This should be more explicit."[20] "Some of the ingredients in the picture were added there kind of as a side dish, and the meal doesn't really contain them"; [25, M, O] "The worst thought is having a so-called convenience meal made of ingredients with which you can't tell where they've come from and what they really are".[25, F, O] "Hmm…I don't believe in that. They promise everything that you'll become young and beautiful, but we all get older so it doesn't. . . those advertisers just make up these claims. And you can see that we women get tricked much more, we believe in all these, few men eat natural products… and all these beauty lotions and all, they are meant for women, women get into them easier than men".[26, F, O] "These products (with increased protein) must have correct indications on the label. We are not sure if the producer correctly declares the composition on the label".[28, F, A] "Because front-of-pack nutrition claims mentions that it is fat free but [the food] makes you fat".[32] "I do not trust the information because the manufacturer can manipulate the details. They always claim that food is nutritious to attract buyers. However, it is actually high in fat and sugar, which is unhealthy"; "I purchased a supposedly low-sugar yoghurt, but it ended up being too sweet. So I do not trust the information so much".[45] "It's always at the back of my mind, 'is that healthy or not?' and to be honest most of the time it's not really".[53] "I still think that that rating (Health Star Rating Labelling Scheme) is very high with all that sugar in it"; "The sceptic in me says that those scientists are lobbied by the food industry to present things that will be favorable towards agricultural, you know, whatever".[56]
	Self-directed benefit or diseases	"[Does eating whole grain] help in old people sickness like keeps people living longer e antioxidant?"[3] "I know that if I cook it … natural ingredients, proper ingredients that I can eat it and it doesn't irritate my stomach".[4] "It's good because I like it and that's what I wanted. But then when you look at how you prepare the corn and stuff, all that grease and stuff, then it's not that healthy cause it'll clog my arteries and stuff like that".[10] "It might be that I see that there is a lot of fat, so I eat less, and when I see that there is a lot of salt, I shouldn't consume much because I have a bad kidney. So I consume less"; [22, M, A] "I use the traffic light food labelling now because of my illness. I see that something is high in fats, high in salt, so I don't buy it and I buy what is low. And it's helped because now my health is quite good".[22, M, O] "[...]I disagree with that, in a way because I think dairy is really, really important for your bones. So, you don't get like osteoporosis, especially, for women. Meat[...] Many red meat has like a lot of iron in it for you that's really good in moderation".[24] "I am diabetic; I buy sugar free products by looking at labels".[32] "[...] It is, for example, a lot more important to be healthy and free of illness. Thinking about nutrition should only be the second or third most relevant thing. If I am terminally ill, eating lettuce or cucumbers won't make me healthy again".[37] "Excess of sugar, fat and sodium kill more people than cigarettes"; "excess of sugar and fat don't only make you fat, they make you ill"; "excessive consumption of sugar increases the risk of diabetes and cardiovascular diseases".[38] "Now these days they sell the items where pesticides were used, and they also say that the diseases like cancer are more prevalent because of consuming such type of fruits. Some of the people are fearing to eat wondering if they will also get the diseases".[58]
	Health concern and functionality of foods	"I am always very worried about the sugar content, because if you look at all the diseases that younger crowds are having, it's more related, like diabetes and everything […]. Even if you're buying salty stuff here, you still see sugar in it. So if they could reduce the sugar levels".[11] "All that salt, when I looked at them more closely, how much salt they contain and all those additives and all, it makes me shiver afterwards".[25, F, O] "Normally I will read the glucose content of food to monitor my daily sugar intake because I am afraid of having diabetes"; "I will read the sugar content on the label to choose more nutritious food".[45] "It's more about 'me feeling bad because I've eaten a plate of pasta'. If I eat vegetables there is no problem because I know it's healthy, but if I eat carbohydrates, they make me fat and I feel bad".[54] "Yes… because I don't really like to give him [son] fatty foods, because his grandmother has high triglycerides. So, we think about her [grandmother], him [son] and the two of us [couple], because if we eat too much grease, we will be like her when we get older, having to diet and eating only grilled foods".[57]

(*continued on next page*)

Table 3c (*continued*)

Contributing studies	Codes	Comments
	Body weight conception	"[…] Cause snacks are healthy and good for you and they also give you energy"; "Uh it's really healthy things and it keeps your body moving."[18, C] "I prefer the full-fat product, it is tastier, but I can change it for a similar light product with less calories if I'm in weight loss process."[20] "Amino acids (from animal-based protein) are very important for the body.";[28, M, O] "I buy such products [food with increased protein content] to feel healthy and active";[28, M, A] "Body can't function without proteins"; "Protein are needed for brain to function".[28, F, A] "[…] if I do not look after that (calorie and fat content) and eat foods inconsiderately, I automatically gain weight and follow an unhealthy eating pattern. Therefore, I believe that fat and calorie content of a meal should be considered first in order to be able to maintain a healthy diet".[37] "Choosing foods without excess of sugar, fat and sodium you can maintain a healthy weight and achieve all its positive consequences".[38] [Organic food] "But you cannot prove that it is better for your body"; "There is simply no evidence yet".[43] "I want to reduce my fat intake because I want to lose weight. So every time I purchase food, I will look for information on fat content". [45, F, AD] "I don't want to become or be overweight. Therefore, I keep an eye on it. So, if my pants are getting tight, I will ensure that they get less tight (reason to choose healthy food)".[50]
	Visual aspects of package and meal	"It is not good. It says that on one hand, it is produced from essential oils, and on the other that children shouldn't come close to it. that information is enough for me not to use it. I prefer using water-based paint."[12] [Image of a heart] "raised blood pressure," "good circulation," and "no stress".[13] "Knowing what the saturated fats, polyunsaturated fats, and all the different types of fats are. You get bombarded with so many different types of things on news reports or academic reports about what's good for you and what you should eat and it all kind of blends in, it kind of goes in and you don't really understand".[14] "When there is red (traffic light food labelling), it's high in fat or salt; that is, we shouldn't eat it or at least we should eat less. We should be cautious"; "It's very easy to understand the traffic light label, but it's hard to apply it. That is, we understand but we don't take it to heart day to day. It's there and I'm going to buy it because I like it".[22] "The rose design (printed chocolate) is also not natural but this isn't attempting to be an actual rose (like the carrots and chicken were attempting to be natural foods) and so it gets points for being artistic rather than fake".[31] "The symbols (nutritional warnings) show you the truth behind products with [deceptive] marketing"; "Avoid foods with excess of sugar, sodium and fat, which are identified with these signs".[38] "[…] I need peas … no added sugar, I didn't even know there is sugar added in some of them … there's probably more sugar in that … take the less sugar".[44] "Nutrition label is the expiry date on food packaged. I always read the expiry date to know the lifespan of a food product. It tells me if the food is already rotten";[45, M, AD] "Nutrition label tells if the food is good for our health. If we over consume a particular nutrient, we can get sick. If we eat more fat, we can become obese or get other diseases".[45, F, AD] "In my life, I link aesthetics with functionality and some kind of ease of use and pleasantness and peace of mind […] it is just like some kind of holistic impression that everything is all right"; "I think that if there are colors at a salad buffet, they tempt you to eat more salad. More than if there was only one color, some light green cabbage… That's why it also has the health impact".[47] "Yeah it's like, it's packaged to look healthier than normal so it must be, because otherwise they wouldn't, you know, package it like that"; "In comparing the two V products, that one [V Pure] looks healthier because you can see inside of it; […] that's like what healthier drinks are in, like Kombucha and stuff".[51] "I would choose A (carrot without shape defect). Well, they both look healthy, but B (carrot - shape defect) looks different, it's twisted, but there's no difference in the healthiness".[55, M, C] "Vegetables and fruits need to be improved… Healthy yoghurt is simple, but the sugary ones have got designs[…] Make healthy appealing to children. You would never ever see characters on healthy foods packaging!"[59]

Note: Socio-demographic characteristics were included in the consumers' comments if they have been specified. [F]: Female
[M] : Male
[C] : Children
[AD] : Adolescent
[A] : Adult people (Up to 60 y.o.)
[O] : Older people (> 60 y.o.).

4.3. How the importance of food healthiness influences consumer attitudes and food choices?

As expected, the results suggest that eating pleasure and healthy eating were generally irreconcilable concepts among consumer perceptions in the 'pleasure' dimension (Table 3b). This shows how these consumers still limit the coverage of healthiness in their diets, associating FH with discomfort/unpleasure (the point of consumer choice).

Many consumers believed that FH represented added value to the pleasure in certain foods or dishes (e.g., "In my life, I link aesthetics with functionality and some kind of ease of use and pleasantness and peace of mind […] it is just like some kind of holistic impression that everything is all right"; "I think that if there are colors at a salad buffet, they tempt you to eat more salad" – Paakki et al. (2019)). We also identify that pleasure permits generalization across different perception modalities. In this way, according to its definitions of healthy eating, a consumer can adjust the "level of healthiness" when deciding whether to consume apparently ambiguous food (e.g., pleasurable and healthy): "When I bite into a raspberry truffle with dark chocolate on the outside, I'm not thinking about the nutritional content of that, but if I bought it and I'm feeling that good about it, it was still a healthy choice for me. Somebody else may not think that it's healthy, but to me, that's a very healthy choice – Schaefer et al. (2016). Together, the results suggest that wellbeing plays an important role in explaining consumers'

Table 3d
Impact of purity on perceived healthiness.

Contributing studies	Codes	Comments
Theme 4: Purity 1, 4, 5, 6, 7, 10, 11, 12, 24, 31, 33, 46, 48, 51, 54, 60	Naturalness	"I've just been brainwashed by my grandpa, you know. You can find natural things. You don't have to take drugs (unhealthy foods)".[10]
		"Using natural preservatives, flavorings, new packaging and preservation techniques"; "If they could come up with natural forms of preservatives"; "Is there a natural way of processing foods? The smoked salmon and all those meats that are cured naturally (to make processed meat healthier)".[11]
		"I would think that it would be healthier for your body when you use natural products on your body. It should but I don't know if that's true"; "Naturalness, that you have something on your body that is natural and that has not been produced chemically but that has been made of plants. That gives you a good feeling and sooths your conscience".[12]
		"This item looks like it is made from a lot of artificial colors which are not good for anybody's health[...]It looks highly artificial. I definitely wouldn't eat it or present it to any guests to consume"; "If it is 100 percent carrot, it would be very healthy. What additional ingredients are there (3D printed carrots)? ... Again, my answer depends on what has been added to the carrot puree, such as colors, preservatives etc. Are these additives natural or artificial?".[31]
		"I consider brown sugar to be a natural product, because it comes from sugarcane"; "this may be a more natural sweet food [referring to jam]".[46]
		"I am against all kind of plant-based products. I think it's kind of everything unnatural even if they pretend to be natural"; [plant-based products] "I think I would still prefer to use something like eggs or chickpeas or something that is less processed or made in a lab, a bit more natural. I think that would be more me".[48]
		"Straight coconut water is just as healthy as water because that's essentially what it is. Essentially it's just ... plant drinks the water, the water seeps in, gets a bit flavored by the coconut and everything else the plant has and stays there until somebody opens it"; "I think it's [coconut water] more healthy because it's natural sugar".[51]
	Processing	"They have a very low nutritional quality due to the number of processes they have been exposed to (ultra-processed foods)".[1]
		"Reducing salt, fat, sugar, additives, preservatives, and minimizing the processing (to make processed meat healthier)".[11]
		"[...]So anything that is highly processed [...] I'd rather stay away from those".[24]
		"Is milk healthy? A priori yes, but the industrial process of manufacturing these foods also matters to me"; "I am always thinking of a product that is the least industrialized and adulterated possible. It doesn't necessarily have to be a fruit or a vegetable, of course that's healthy, but pasta or bread is also healthy, the food has to be as natural as possible"; "Food purchased near my house, food that is the least processed possible, it could be vegetables; the food does not necessarily have to be ecological, but it should be produced nearby, by local producers who use fewer pesticides and fertilizers. And, in the case of meat, the producer should be local".[54]
	Home-cooking	"I've become aware...about cooking from scratch to reduce the salt content and to reduce the sugar content because a lot of pre-prepared food is high in salt or sugar"; "as much basic ingredients as possible" (cooking from scratch)".[4]
		"[...] I'm not sure why you would eat this (printed pizza) when you could make a real pizza with cheese. Even if it is made from real ingredients, it still seems to be unnatural because of the fact that it is printed"; "[...] I'm not a fan of getting fruit and veg from a pill either, because I believe eating as close to source as possible is preferable, although I appreciate this is not always achievable".[31]
		"The kitchen is a comforting place and it feels really natural to have things produced from the kitchen even if it's making homemade pizza using this from a jar or opening a can of this whatever... I guess, seeing and participating in the process of creating it or knowing what it is that goes in there... What I think feels natural about that is just seeing all these things kind of put together from scratch".[33]
		"Healthy food is food made in the most natural and homemade way possible".[54]
		"I just think the less junk you can give her [daughter] the better - at least you know what's going in there (house)".[60]
	Freshness	"If you were making your own sauces, all like fresh food, using actual spices, I would consider made from scratch meals obviously the healthiest".[4]
		"[Fruits and vegetables] The best thing is to pick them from the garden and to eat them straight away so as not to lose any goodness". [5]
		"[The] first thing I see [is] the color [the cabbage] has to be...green. Secondly, I see the freshness you know, we see [...] sometimes they [harvest] these vegetables the day before and they want to sell it the next day. And the third thing: the price".[6]
		"Appreciation of food is for me, it's about [...] how fabulous it looks when it's fresh ... The flavor of it, the knowledge that you're actually putting proper good nutrients into your system too ... And it lasts longer in the fridge"; 'The taste benefits of a salad made with freshly picked ingredients'; 'the visual entertainment of bruschetta made with yellow tomatoes and purple basil' give him a real thrill.[7]

willingness/intentions to eat food. For low-income people, it is important to remember that price is also a key purchase factor for healthiness criteria (Kamar et al., 2016; Morgan et al., 2016; Pelly et al., 2020; Surendran et al., 2020; Velema, 2019) (Appendix 2). "High food prices limit consumption and harm well-being for low-income people" (Bai, Naumova & Masters, 2020).

4.3.1. Socio-demographics inequalities in the food choices

Several studies have demonstrated sociodemographic differences in the consumers' attitudes towards FH. Usually, the FH is more important for older and female people, as well as for people with higher health and ethical concerns.

Gender differences in the willingness to consume healthy foods were reported by three studies (Boase et al., 2019; Freire et al., 2017; Ruby et al., 2016). Of these, two demonstrated that women are more likely to choose foods that contain low amounts of fat, sugar, and salt (Freire et al., 2017; Ruby et al., 2016). Furthermore, Ruby et al. (2016) showed an important source of ambivalence regarding ethnicity, i.e., Brazilian and American women reflected frequent negative associations to beef (e.g., "fatty"), and they also were more rigorous in their food choices compared to French and Argentinean women. On the other hand, Boase et al. (2019) found a positive relationship between healthy food and male consumers. Older, wealthier males showed

Table 3e
Impact of environmentally friendly or ethical issues on perceived healthiness.

Contributing studies	Codes	Comments
Theme 5: Environmentally friendly or ethical issues 2, 6, 7, 9, 11, 24, 28, 29, 34, 37, 39, 41, 43, 48	Animal welfare	[Free Associations to beef] "Death/violence" (animal welfare) and "fat/fatty".[9]
		"…Well I'm sort of environmentally, I look towards our poor little creatures, our chickens and how, if they're barn-laid or caged, and I just think those poor little animals. And yeah, I gotta tend to agree, I do pay a little bit for eggs and that. Just I suppose that's peace of mind, more so than you get anything else."[24]
		"The thought of eating meat again is sickening […] even the thought of eggs now really grosses me out […]. It's not even food anymore […] like I can't help but think about animals' meat as if it was my own like it's just disgusting (veganism)".[41]
		"I buy organic because I believe that it is the only way to put together environment, animals and humans in a proper manner".[43]
	Sustainability and ecological conceptions	"I've got some genetic urge to grow vegetables, especially tomatoes… Well, it's probably more nurture than nature".[7]
		"A more human friendly versions of the chemicals or something (processed meat)".[11]
		"In terms of food, yeah, the health would be the main aspect. For environmental reasons, I've never really[…] It's never been the sole reason to do something with food because of the environment…I think more of saving water and electricity around the house and things like that".[24]
		"Plant protein maybe ecologically better from the point of view of production, I have the impression that animal production is not very wise ecologically, plant production has less burden for the environment".[28, F, O]
		"Insects are necessary for the survival of the planet as well, so if we all start pigging out on insects, we have to catch a hell of a lot of them to make a decent meal".[34, F, O]
		[sustainable food] "Fruit"; "vegetables"; "salads"; "healthy eating"; "healthy food"; "healthy"; "good for health"; "promote health and wellness"; "alternatives for health care"; "ideal for long and healthy life"; "maintain health"; "quality of life".[39]
		"The first thing I think about is the environment (plant-based food products), and then the bonus is just that I would feel more healthy and so for me, the first thing, healthy, environment, reducing carbon footprint".[48]
	Healthfulness of the food environment	"Bathrooms are very important. If the bathroom is dirty and/or has no soap, what does that say about the cleanliness of the kitchen and the food?"[2]
		"When you see rubbish laying carelessly, you know, at the vendor's [stall], I don't buy from [them]. And if I see flies and stuff like that, and when they put it on the floor, [I don't buy it] because it's unhygienic with the dust".[6]
		"I prefer it generally, climate-friendly. I guess if it's local and organic then it's going to be more climate friendly than some that's not local and organic".[29]
		"If one gets proper counseling on healthy nutrition, like for example in a health food store, one realizes very quickly and it is very obvious that these food products are clearly healthier, produced in an honest way and that unhealthy foods cannot be bought in these shops in the first place".[37]
	Lifestyle	"It's like it [veganism] made me look at food healthier. I'm just more aware of what I'm buying and what I'm eating so that's been really positive…so I just feel like my body just feels better in general".[41]

Note: Socio-demographic characteristics were included in the consumers' comments if they have been specified. [F]: Female
[O] : Older people (> 60 y.o.).

more intentions to consume shellfish than their younger, female and deprived consumers counterparts.

Four studies explored the relationship between parents' willingness and income to provide healthy and unhealthy foods to their children. Results obtained demonstrated that there are many health beliefs towards FH, and these beliefs are commonly used by consumers to create zones of relative comparison among foods, taking into account a broad spectrum of social representations. Low-income consumers chosen a reference food (healthy food) and next guided their attitudes by comparison of its "healthiness" between other foods, over or under-estimating their PH (e.g., healthy ingredients in a food that is considered unhealthy) (Damen et al., 2019). The decisions about portion size provided mixed records. Tang et al. (2020) reported that high-income consumers were more likely to provide healthier foods to children; however, portion size judgments were defined based on child appetite, i.e., they consumed healthy foods up till they become full. The author also has indicated some ethnic differences between oriental and occidental mothers (Chinese and American). Chinese mothers were more inclined to limit portion sizes of sweet snacks and sugar-sweetened beverages. van Kesteren and Evans (2020) also observed that low-income consumers were more inclined to associate negatively satiety and FH, i.e., being positively inclined to reflect more urgent priorities than future-oriented health beliefs. Similar results were observed by Fielding-Singh (2017) who showed that low-income parents used food to buffer against deprivation, whereas high-income parents fulfilled values around health and parenting. Like low-income people, consumers with a low level of education are also more likely to choose unhealthy foods, since the FH is not the main concern for these consumers in general (Brownbill et al., 2020; Velema et al., 2019).

Overall, our review identified 12 articles that emphasized the link between age on attitudes towards FH. Younger individuals reflect evidence of a common misperception of healthiness since they are more likely to choose unhealthy foods. Moreover, the study of Sato et al. (2020) indicated that the virtual food environment was considered a critical factor in younger consumers' demand for ultra-processed foods, especially influencing pleasure-seeking.

Adams and Savage (2017) and Damen et al. (2019) observed how children at a poverty level perceive the healthiness of snack foods, adopting relative comparison in their perceptions (meal vs snack vs candy). Particularly, less amount of money, limited understanding of labels, and the ability to comprehend written information were negatively related to PH. This explained a higher susceptibility of younger children to advertising processed foods and consumption of inexpensive items (sweets) (Freire et al., 2017). Makhal et al. (2020) showed that an unfamiliar appearance was a disadvantage for the non-acceptance of suboptimal products, even if children have not observed compromising of the healthiness (optimal vs suboptimal carrots); however, the author perceived that, unlike adults, children are more accepting of suboptimal produce, being less rigorous to establish differences in their PH.

Two articles focused on the relevance of the FH for adolescents in their food choices. Adolescents were more likely to guide their food choices by pleasure, despite their knowledge about the FH. Jefrydin et al. (2019) showed that health consciousness and the specific curiosity (e.g., nutrition information) had an important influence

on Malaysian adolescents' food choices for using nutrition labels, despite their lack of interest in the use of labels was related to past experiences, hunger and cravings, time constraints, and the taste of the food. Listed amongst these main reasons why adolescents were less likely to value the FH was the price, which was considered negatively associated with FH (e.g., healthy food, high price). Kamar et al. (2016) identified some differences in the attitudes of adolescents, who compared wholegrain foods with organic foods for being more expensive. Additionally, the healthiness of wholegrains was negatively associated with taste and product processing, under the premise of "isn't it cheaper to make?".

Five studies reported that older consumers were less likely to choose processed, convenience, and unfamiliar foods, conjuring images of non-traditional, non-trust, or non-natural. Puhakka et al. (2017) identified motives and barriers for using health-enhancing products according to the necessity to take preventive actions (belief in the health benefits, trust in science, technology, and marketing, willingness to try various products, habit and giving status) or no specific health problems (disbelief in the health benefits, lack of trust in science, technology, and marketing, unfamiliar usage patterns, unpleasant sensory properties of the product, perceived risks, contradiction with a lay understanding of health, lack of knowledge and high price). They perceived that the older consumers' market is not homogeneous, comprising health-seeking consumers, cautious consumers, critical consumers, and natural health consumers.

Results by Peura-Kapanen et al. (2017) showed that FH, easy-to-use and environmentally friendly packaging, freedom of choice, and right of self-determination in eating were reasons for the choice of convenience foods (Peura-Kapanen et al., 2017). One study reported that older consumers (more than 40 years old) reflected a higher willingness to purchase products with a pungent aroma and bitter tastes than their younger counterparts because they offered health benefits that were aligned with their health expectations (Doungtip et al., 2019). On the other hand, two studies reflected their skepticism regarding the consumption of unfamiliar foods with increased protein content. Older consumers (more than 60 y. o.) also reflected low levels of awareness of the environmental and nutritional advantages of entomophagy practices (e.g., beliefs towards the size of insects) Myers and Pettigrew (2018), and preferred to consume more conventional products than the processed foods with increased protein content, in consequence of beliefs towards unnaturalness, harmful consequences on their health (overconsumption of protein), and distrust in imprecise information on the label (lack of information about type and amount of protein). (Banovic et al., 2018).

4.3.2. Food healthiness versus tastiness: contrasting attitudes and behaviors

Eighteen articles focusing on the relationship between FH and tastiness were found. In general, tastiness was preferred over all other tested health aspects, except for highly involved participants (e.g., ideologically, high concern with own health, weight loss). Tastiness had an even more important role than healthiness when the choice for novel/unfamiliar foods was on the line (Banovic et al., 2018; Lupton and Turner, 2018). In general, taste, price, habit, and convenience were mentioned spontaneously as a priority in food choices, while health aspects were considered as secondary key quality attributes (Ariyasriwatana and Quiroga, 2016; Banovic et al., 2018; Ditlevsen et al., 2019; do Nascimento et al., 2017; Freire et al., 2017; Hoek et al., 2017; Jefrydin et al., 2019; Landry et al., 2018; Lupton and Turner, 2018; Menger-Ogle and Graham, 2018; Morgan et al., 2016; Sato et al., 2020; Schaefer et al., 2016; Shan et al., 2016; Velema et al., 2019; Yarar and Orth, 2018). The results of the studies further stress that the taste-oriented motivations still outweigh health motivations when making food choices.

Two articles showed that a self-perception of the stage of life influences the behaviors towards healthiness aspects of the foods (Table 3c). Some university students reported that the nutritional information is not yet important for itself (Freire et al., 2017), and an older consumer (more than 80 y.o.) considered that taste is the only motivator worth with the advanced age (Peura-Kapanen et al., 2017).

Two studies perceived that the lack of flavor and undesirable taste were indicative of healthiness, and sometimes 'healthy' was what tastes good (Schaefer et al., 2016; Yarar and Orth, 2018). In contrast, one study found that 'healthy deliciousness' may be preferred over 'unhealthy deliciousness' if food pleasure and nutrition coexist (Ariyasriwatana and Quiroga, 2016). O'Kane (2016) also emphasized that the 'philosophy' of taste went well beyond mere descriptions of taste when put 'freshness', 'organic', 'naturalness', 'local origin' aspects into perspective on the front line.

4.4. How has food healthiness been important to reinforce consumers' expectations?

Conscious, health-concerned consumers expect food to be less fatty and contain fewer sugars and calories. Biased by their expectation, consumers considered the "artificial" processed or "unhealthy" foods, and tasty than the "friendly" foods (minimally or non-processed foods). Sustainable, organic, natural, and homemade foods have been constituted "real food" due to their safety and efficacy well established. Our major finding is that vegetables and fruits are becoming increasingly important as comforting foods. Although there is still some resistance from consumers to novel foods (e.g., edible insects), healthiness is an aspect of becoming increasingly important. The amount of nutrients into contemporary, exotic (insects), and reinvented healthy foods (e.g., proteins) stimulates a sense of 'green' comfort foods in diverse positive experiences (e.g., "ethical comfort", "comfort to the soul and conscience") (Pinto et al., 2020a) (e.g., "[...]Now like I look at food differently, and probably more like … I'm like 'oh yeah that's junk food, that's healthy food, that's good for your soul, that's gonna make me feel better than eating a massive pile of junk food.".

4.4.1. Consumer trust in the food healthiness

A total of 11 studies combined safe and trust in considering consumers' perceptions. Freire et al. (2017) reported that artificial sweeteners were perceived as safer rather than refined sugar. Puhakka et al. (2017) found a positive association between trust and the healthiness of traditional foods; food habit was the most important factor for a higher preference for traditional foods compared to functional foods. (Ditlevsen et al. 2019) found that the absence of toxins and drug residues was the main resource for why consumers viewed organic foods as healthier than conventional food products. Jefrydin et al. (2019) showed that FH was positively related to trust in reputable manufacturers endorsed by the government; they also perceived that nutrition labels were considered a tool to judge the health and safety aspects of ingredients.

In nine studies, skepticism or lack of trust was emphasized among a range of conceptions negatively related to FH, such feel like that there is a lack of knowledge of the origin of the food (Peura-Kapanen et al., 2017; Schaefer et al., 2016), feel like misled in the food choices of similar products (e.g., yogurt vs fermented milk) (Esmerino et al., 2017), seeing claimed ingredients that are not actually in the product (Peura-Kapanen et al., 2017), disbelief in the health claims and advertisers arising from misleading experiences (Puhakka et al., 2017), uncertainty about the veracity of the health claims (Banovic et al., 2018), nutrition claims of products inconsistent with the negative effects of their consumption Menger-Ogle and Graham (2018), lack trust in industries (Jefrydin et al., 2019; Pelly et al., 2020), and disbelief in the healthy food (Ford et al., 2020). Modified foods in native form were associated with fertility problems, allergies, and other diseases as "undefined foods" (Ditlevsen et al., 2019).

FH was positively related to health concerns and body health. Low in calories, sugars, fats, and sodium products were strongly related to FH. Probiotic milk and snack were related to higher energy to the body by consumers who practice exercises (Adams and Savage, 2017;

Oliveira et al., 2016), and dairy products were considered good for osteoporosis (Hoek et al., 2017). Low-fat and salt foods were related to renal health and 'good' health (Freire et al., 2017), 'natural' ingredients were perceived as non-irritant to the stomach (Lavelle et al., 2016), sugar-free foods were associated with the maintenance of diabetes (Menger-Ogle, and Graham, 2018), and proteins were related to body and brain health (Banovic et al., 2018). Overall, excess of sugar, fat, and sodium was perceived as more dangerous than cigarettes (Ares et al., 2019), mainly related to diverse illness and weight gain (Ares et al., 2019; Esmerino et al., 2017; Gaspar et al., 2020; Jefrydin et al., 2019; Peura-Kapanen et al., 2017; Sato et al., 2020; Schaefer et al., 2016; Shan et al., 2016; Velema et al., 2019; Yarar and Orth, 2018). In addition, some foods considered healthy sometimes occupied the status of an 'unhealthiness' food or dangerous: fruits were associated with pesticides and cancer, brinjal and potato with arthritis, and spinach and tomatoes with kidney stones (Surendran et al., 2020).

One study reported that some consumers believe that is more important to be healthy and free of illness than observe the FH (Yarar and Orth, 2018). For example, the belief that products considered as healthy will not be able to cure diseases (e.g., "[...]If I am terminally ill, eating lettuce or cucumbers won't make me healthy again") Yarar and Orth (2018). Furthermore, some consumers believe that the moderation of food intake is sufficient for maintaining healthy eating behaviors (Hoek et al., 2017). One last showed that the pieces of evidence are crucial to be able to prove that foods are better for the body, and then to solve doubts about the FH (Ditlevsen et al., 2019).

4.4.2. Encouraging preservation to improve the quality of foods

A major concern for some consumers was the lack of knowledge and awareness of the health benefits of the foods. There is disbelief by the consumers about the ability of industry manufacturing healthy foods to them, particularly because of bad past experiences. Some studies described food preservation as the state-of-the-art of the FH.

Some consumers felt emotionally motivated to eat natural foods for reasons as health, tranquility, connection to truth, comfort to their soul, and conscience (Lupton and Turner, 2018; Sijtsema et al., 2016). One study reported the association of unhealthy food to drugs (Schaefer et al., 2016). Two studies showed that FH was positively related to natural ingredients, i.e., those naturally present on food (Brownbill et al., 2020; Menegassi et al., 2019). One study showed the antinatural perception regarding plant-based products (one consumer), under the premise of being more processed (Peschel et al., 2019). The healthiness of processed foods was mainly related to the number of processes they were exposed to (ultra-processed foods) the amount of salt, fat, sugar, additives, and preservatives put into food, and the type of industrial process of manufacturing (Ares et al., 2016; Shan et al., 2016; Hoek et al., 2017; Gaspar et al., 2020). For some consumers, independent of being a fruit, vegetable, pasta, or bread, it is crucial that food should be as natural as possible (Gaspar et al., 2020). Challenges linked to the role of the industry were also reported: new packaging and preservation techniques, use of 'natural' additives, absence of 'chemicals, and food processing as naturally as possible to confer healthiness to product (Shan et al., 2016; Sijtsema et al., 2016).

With regard to preference for home-cooking, five studies focused on the natural appeal. In a study by Lavelle et al. (2016), consumers indicated that they enjoyed and valued food made in the most natural and homemade way possible because it is possibly known what's eating (e.g., regarding ingredients used in the preparation) and controlling the amount of sugar, fats, and sodium, obtaining more 'real' and healthy foods. The home-cooking rituals, including prepare foods from the kitchen, the comfort of the kitchen, and the participation in the process of creating were considered a natural process that joins food homemade and healthiness (Gaspar et al., 2020; Lupton and Turner, 2018; Moscato & Machín, 2018; van Kesteren & Evans, 2020).

Freshness was positively associated with FH in three studies. Consumers were conscious of the importance of colors, taste, ingredients and visual aspects to judge the freshness of the food, and then its healthiness (Lavelle et al., 2016; Morgan et al., 2016; O'Kane, 2016). Specifically, O'Kane (2016) showed that consumers considered a conjoint analysis of these attributes in healthiness judgments, taking into consideration the price as the determinant of food decisions.

4.5. What opportunities and barriers can be identified in terms of ethical, sustainable, and environmental motivations?

Consumers' willingness for ecological food behaviors has been weighted according to the border between pure and adulterated, moral and immoral. Some consumers believed avoiding package products had the strongest impact on health for reducing the consumption of toxins and chemical residues (Ares et al., 2016; Gaspar et al., 2020; Hoek et al., 2017; Shan et al., 2016), whereas others rated purchasing organic food as the strongest pure and environmentally beneficial (Feucht and Zander, 2018; Ditlevsen et al., 2019) (Tables 3d and 3e). An important barrier to effective implementation of healthy food was the lack of beliefs in the capacity of tastiness and satiety of these foods, including those associated with individual and shared socio-cultural values (e.g., consumption of edible insects). Social context and individual preferences have an impact on how food relates to mood Spence (2017).

"I think it's very natural and probably healthy for you as it's ground insects, but I'm not sure if I would like the taste, I have never eaten insects before. The idea of ground insect makes me squirmy". (Lupton and Turner, 2018).

We found twelve articles that examined willingness to adopt environmentally friendly or ethical issues as a starting point in the FH judgments. Two studies examined the influence of FH on consumers' intentions to eat meat foods, and they observed that FH importance was strongly associated with frequent moral value, ethical, health, and weight maintenance concerns (Ruby et al., 2016; Hoek et al., 2017). Although the environmental aspect has been merely considered an additional benefit in food choices, Hoek et al. (2017) showed a positive association between FH and environmentally friendly foods. Consumers who were more aware that the production and consumption of meat has a huge impact on the environment expressed positive attitudes and behaviors towards reducing food waste and overconsumption, which could lead these consumers to eat less processed and packaged foods, mostly to avoid excessive packaging and 'chemicals' in foods. They displayed both negative attitudes and lower motivations toward eating animal-derived products, which they were considered less healthy when compared to plant-based foods. Peschel et al. (2019) also perceived that consumers looked to reduce their meat consumption, and they interpreted plant-based food products as sustainable, healthy, or with a transparent ingredient focus. However, Ruby et al. (2016) observed that the consumption of beef was yet maintained at a high level mainly in the male population.

Four studies showed that the healthfulness of the food environment/store influenced individuals' PH. Ariyasriwatana and Quiroga (2016) reported that the healthfulness of bathrooms says about the cleanliness of the kitchen and the food. Morgan et al. (2016) showed that rubbish laying carelessly on food retail is sufficient to cause negative perceptions regarding the FH and make them unacceptable. Whereas Yarar and Orth (2018) pointed out that counseling on healthy nutrition in food stores make products clearly healthier for consumers, Feucht and Zander (2018) showed that the importance of food environment being local and organic induced positive perceptions of healthier and climate-friendly foods.

A particular dietary lifestyle, such as reported by one study on veganism (Costa et al., 2019), demonstrated that mental health, physical health, and social health was associated with the sense of healthiness, i.e., foods are connecting to the expression of the self and end up being perceived as healthier.

A study by Ditlevsen et al. (2019) presented a view of consumers who have a preference for organic food. Firstly, the healthiness of organic

food was related to nutritional value, followed by purity and pleasure (e.g., 'happy' body). Specifically, 'good nutritional value of products', 'sensory quality of food products', 'food products free of contamination', 'environment, climate and animal friendly production' were the main qualified factors for FH. Barone et al. (2018) also perceived that 'healthy' was positively related to sustainable and organic foods, whereas non environmentally friendly was the characteristic of unsustainable food. However, these authors observed a strong mediating effect of the level of education among conceptions of the sustainable diet concept. Individuals of higher educational levels associated sustainable foods with more conscious conceptions (e.g., natural resource preservation and reuse), while individuals with lower educational levels reported the association with healthiness, nutrition, and food of plant origin (more holistic perceptions). Feucht and Zander (2018) also observed that a high level of education was a propulsor to the willingness to buy carbon-labeled products, which could be considered a facilitator of 'very' healthier choices.

Two studies did not show a significant effect of ethical effects on motivations for consumption. Although the ecological value of plant protein has been observed by some consumers, the majority part of them was skeptical of food products with increased protein, mainly due to lack of trust in the product, unethical production, bad sensory qualities in terms of product taste, as well as perceived lack of healthiness and its consequences such as provoking some health difficulties, such as allergies (Banovic et al., 2018). Low levels of awareness of the environmental and nutritional advantages also were observed regarding entomophagy, mainly due to lack of food safety (healthfulness of insects), cultural beliefs, and values (Myers and Pettigrew, 2018).

5. Discussion

This review identified some differences across studies on PH. We derived data from a comprehensive systematic review on PH, emerging five conceptual links from the content analysis: the impact of misconceptions and knowledge gaps on attitudes; the role of pleasure on food choices; how healthiness importance mold perceptions; the importance of purity; and the sense of environmentally friendly or ethical issues.

As expected, the effect of healthiness importance on consumers' attitudes varied by health consciousness, level of education, income, and mainly pleasure. As presented in Tables 3a and 3b, although nutritional value has been a key factor to judge the FH, its influence on the willingness to buy foods does not exclude the priority of tastiness, which is psychologically confronting. It could be argued that for some consumers the lack of positive emotional associations with FH is mainly due to its conjoint effect 'bad or non-attractive taste' and 'bad experiences'. In the opposite way, health concerns, mainly linked to body conceptions, such as those related to body image, generally evoke positive emotions towards the FH; this understanding permeates consumers' perceptions towards comfort healthy foods (Spence, 2017). Some children mentioned repulse, stomach pain, and negative feelings when they are forced to eat healthy foods. Damen et al. (2019) reported that experiences in the childhood phase may compromise the judgments towards FH so that the PH becomes compromised in the adult phase. Metaphorically, we suggest that childhood or past experiences are a kaleidoscope of looks, sensations, and experiences for the future, which have strongly influence consumer's responses to PH.

The majority of health-conscious consumers were acutely aware that their health depends on a healthier food choice and therefore have struggled to improve it. One key result of the present review is that there is a very high consumer belief that food could be seen as a medicine. Specifically, for consumers requiring self-directed benefits, FH is more than a simple quality criterion, it is self-representative. Younginer et al. (2016) and Otterbring et al. (2018) found consistent evidence that in the majority of cases consumers ranked healthy, unhealthy or junk foods based on holistic features or the nature of specific health benefits (e.g., less in saturated fats – good for the body), rather than specific nutrient or sensory attributes.

There is a general tendency for low health-conscious consumers to be better able to see liking as personally relevant, regardless of their ability or understanding health-related information (Freire et al., 2017). In addition, research on unhealthy food choices showed that exposure to negative emotions (e.g., anxiety, stress) can induce unconscious decisions guided by pleasure, in turn influencing unhealthier food consumption (Flaherty et al., 2020).

Our results show that satiety, liking, the need for taste, and indulgence emerged as the driving forces behind the "anti-healthiness" movement, but we agreement that most people who are wary of healthy foods likely have good intentions and goals similar to "pro-healthiness" consumers: understanding the benefits of healthiness for wellbeing. In addition, corroborating Maehle et al. (2015), we perceived that consumers are more likely to perceive the healthiness of a product if they consume it for the nutritional or ecological value (utilitarian products) than in the case of products consumed for hedonism.

For these consumers, it is particularly challenging to find solutions that are effective across the large and diverse range of food products. Their health expectations have gone to cross the border between pleasure and unpleasure, comfort and uncomfortable, thus, it is necessary a specific combination of quality attributes to determine expected quality. Take for example this statement: "I would need to taste this item before making a decision. Texture has so much to do with how delicious something is. Just to look at it, it doesn't appeal to me—it looks artificial. The green item on the plate looks like a jellied green vegetable. It doesn't look appealing at all" Lupton and Turner (2018). In response to those pressures, recent efforts to work with, rather than against, healthy foods that mimic desired sensory aspects or elicit similar emotional effects to unhealthy foods, suggest a path forward (Pinto et al., 2020b). Progress in relation to the actions discussed will have important benefits to food chain, since the consumers focus on a holistic vision of the role of food rather than in physical health only (Landry et al., 2018).

Previous studies have demonstrated that a self-assessment state can modulate behavioral responsiveness to FH by influencing sensory pathways. Jami (2016), through the mirror experiment, that the confront between unhealthiness and healthiness motivates healthier food choices, so that the self-assessment seems to consciously activate the concerns with health so that the consumer-healthiness link becomes more pronounced. A consumer's perception of pleasure can change dynamically on the basis of its current internal state (Pinto et al., 2020a). Notably, this has an interesting parallel with the study of Mergelsberg et al. (2019). In healthy shopping intentions (positive self-assessment), consumers were more likely to consider health aspects in their food choices, regardless of the food's tastiness. This is a critical adaptive mechanism allowing the organism to make cost-benefit decisions about healthiness versus tastiness. Thus, we infer that self-assessment substantially alters the perceived value of a stimulus (e.g., healthiness), even to the extent that the same sensory cue can trigger antagonistic behaviors.

In this study, we also observed that the FH concept is relative for some consumers. Contextual necessity (e.g., recompense), cultural and social influences could activate compensatory beliefs and lead to subsequent engagement in "healthy" actions ("candy is good for reducing stress"). Recently, Petersen et al. (2019) have recently shown that the perceived unhealthy actions activate compensatory beliefs and lead to subsequent engagement in healthy actions. We also suggest that there are many mechanisms to relativize the PH, in such a way that perceived "healthy" actions could activate compensatory beliefs, covering unhealthy food actions.

In summary, the elements that appeal because of their sustainability, purity, and naturalness are also likely to satisfy consumers' inner motivations for well-being and ethical consumption. Indeed, these motivations linked to symbolic information (e.g., clean label) should decrease the PH of discretionary foods (e.g., processed meat) and increasing PH of green comfort foods (e.g., organic food). In this regard, traffic label was reported as a tool to guide the purchase and consumption of processed

foods (Puhakka et al., 2017) by offering self-direct benefits (e.g., hypertension, diabetes) (Freire et al., 2017). Providing safe and credibility information via pack labels and digital marketing (e.g., on social media), as well communicating a healthier packaging appearance, could improve consumers' awareness of the FH (van Rompay et al., 2016; Zandstra et al., 2017). We suggest that the sense of well-being activates the dimension of self-ethical, allowing healthier food choices.

Our analysis also has shown that action for changing behaviors and attitudes, the adoption of standards with food waste considerations and impacts of products on biodiversity, and changes to food practices are highly influential, and could have a long-lasting impact. There is considerable potential for healthiness to boost future foods, such as contemporary, exotic, and uncommon foods as is seen in Pinto et al. (2020b). Delabre et al. (2021) propose that consumers be given greater access to information about life cycle impacts and ecological footprints of the products that they purchase; this will help them to better understand the impacts of products on biodiversity, health and sustainability.

In this context, the challenge is to convince policymakers to direct their strategies to promote effective investments, technologies, and solutions for providing safer and healthier foods, mainly to disadvantaged populations, such as those presenting socioeconomic inequalities in the healthiness of food choices. Consistent findings across several studies have been found that food marketing influences eating preferences and choices, especially among low-income and children consumers, contributing to the rise of wrong decisions about the FH. These consumers' perception of healthiness was mainly depended on the relative comparison. In addition, as mentioned above, emotionally-involved consumers in their health beliefs (e.g., weight loss or emotional benefits) were more vulnerable to unconscious decisions. Future studies should include the relationship between relative comparison and the 'halo' effects evoked by PH, in which health-conscious and non-conscious participants are exposed to health messages, considering both intervention messages and no-message conditions (Zandstra et al., 2017).

When it comes to improving the healthiness of foods, previous studies found that a reduction of sugars, fats, and sodium for improving nutrient levels can be adopted without compromising sensory acceptability (Lima Filho et al., 2019; Souza et al., 2021; Torrico et al., 2020). Pinto et al. (2020a) have suggested another strategy to reach this goal. A pleasant ingredient or product may serve as a stepping-stone for healthy food acceptance. For example, like combining pleasant food (e.g., lasagna) with unpleasant food (e.g. eggplant), tying this to the flavor of lasagna (tasty), and invoking a fond brain (new food experience - eggplant lasagna). The artistic plating is also important as most strategies to increase healthiness importance are focused on improving intrinsic properties Pinto et al. (2020a).

Consumers seemed to perceive the food as a service for the body and mind, but the perceptions do not necessarily lead to an accurate portrait of the attitudes and behaviors associated with healthiness. For this reason, transversal qualitative studies may not adequately capture the persistent and intrusive nature of the experience, and the impact of the PH on lasting worry (e.g., health concern). In this sense, we also perceived the need for longitudinal qualitative studies to expand the limits among preferring, rejecting, feeling, and buying. In this regard, exploring PH will provide additional information beyond perceptions, and enhance product development and marketing decision making.

6. Limitations and future research

From the above considerations, the main limitation of this work comes from the nature of the qualitative criteria adopted in the studies. First of all, adopting a rigorous qualitative protocol remains a challenge to be overcome. Only nine studies reported use of data triangulation, so the validity of the results, mainly resulting from cross-cultural investigations, should be improved in future research; data saturation, use of multiple or mixed methods, and multiple samples are also efficient methodological strategies in the same direction. Secondly, we excluded non-English articles and most studies were conducted in European countries; therefore, the transferability of the findings to African populations, for example, is uncertain.

Another subject to be investigated regards the capacity to examine the causal relationships involved in the decision-making process. For many consumers, healthy food choices are still viewed as non-discretionary acts. Realist inquiry, identifying the mechanisms that support and explain consumers within a particular context, and process tracing, understanding how individuals make decisions, constitute research lines that can be further explored (Denzin & Lincoln, 2017; Tessem, 2017). We believe that measures or data points to underpin theoretical concepts, explain events, and construct theories, may help to understand what extent and to what degree FH has been important. It also is recommended that a future systematic review under a quantitative perspective allows us to triangulate mixed records. This creates opportunities for targeted mitigation, making more conscious consumers and healthy foods more friendly and tasty for consumers.

To conclude, we have consolidated information on the PH of a wide range of scientific papers. From this research, we have provided in-depth holistic perceptions of the qualitative research for sustaining the health benefits of foods into the future. However, few periodicals have addressed PH in a qualitative form, indicating barriers for advancing qualitative research. At the same time, few studies investigated inter-individual variations in the intention-behavior among people intending to shop healthily, as assessed by Mergelsberg et al. (2019), which can be considered as a gap in this research area. The individual inequalities in decision making, such as expectations in the healthiness of food choices represent complex challenges for PH importance. Therefore, exploring the mediating effect of individual aspects (e.g., body image concern) on healthiness ratings of foods can allow identifying some market demands that were still not fulfilled.

We hope our findings stimulate progress in this crucially important area for making major changes to the food sector, enhancing product development and marketing decision making, mainly by placing the healthy, natural, sustainable, and environmentally-friendly foods in perspective. Making health policies and educational interventions also may help resolve the cognition unpreparedness that consumers experience with misleading information, lack of knowledge, or trust about the FH in their food choices. Ethical consciousness and health consciousness are also expected to increase in frequency, and consumers performing an important role by lowering the consumption of more discretionary products (oils, sugar, alcohol, and stimulants) Poore and Nemecek (2018).

Providing consumers with multiple ways to reduce their unhealthy food choices impacts also requires a step-change in thinking: that practices such as make healthier products or provide concise information are not solutions in themselves but options that industries should choose from to help consumers build positive trust in food products .

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.

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Appendix 1

Search Scopus (April 2020)

TITLE-ABS-KEY (food AND consumer AND health) AND AND (LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR

LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016)) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "re")) AND (EXCLUDE (SUBJAREA, "MEDI") OR EXCLUDE (SUBJAREA, "ENER") OR EXCLUDE (SUBJAREA, "ECON") OR EXCLUDE (SUBJAREA, "BIOC") OR EXCLUDE (SUBJAREA, "ENGI") OR EXCLUDE (SUBJAREA, "COMP") OR EXCLUDE (SUBJAREA, "PHAR") OR EXCLUDE (SUBJAREA, "MULT") OR EXCLUDE (SUBJAREA, "EART") OR EXCLUDE (SUBJAREA, "CHEM") OR EXCLUDE (SUBJAREA, "IMMU") OR EXCLUDE (SUBJAREA, "CENG") OR EXCLUDE (SUBJAREA, "VETE") OR EXCLUDE (SUBJAREA, "MATH") OR EXCLUDE (SUBJAREA, "MATE") OR EXCLUDE (SUBJAREA, "PHYS") OR EXCLUDE (SUBJAREA, "DENT") OR EXCLUDE (SUBJAREA, "BUSI"))

Total of results: 2,334

Search Science Direct (April 2020)

Find articles with these terms: food consumer health
Year: 2016-2020
Article types: research articles
Total of results: 1,267
Total of results (SCOPUS and Science Direct): 3,601
Records after removal duplicates: 2761

Appendix 2

Summary of the included studies on perceived healthiness of foods.

Note: '—' Not specified. In the appendix, the type of methodology followed the same descriptions reported in the selected papers.

Citation and country	Sample size (N) and age range (Y)	Gender (M:F)	Methodology	Data collection	Data analysis	Main findings
Ares et al. (2016)[1] Uruguay	N = 2381	7:13	Qualitative (Online study)	Open-ended question, free listing	Inductive coding	-Most of the participants perceived ultra-processed foods as highly processed products that usually contain additives and other artificial ingredients, with low nutritional quality and unhealthful. -Some processed foods, culinary ingredients and minimally processed foods (e.g. pasteurized milk, flour, meat, cheese, bread) were wrongly perceived as ultra-processed foods.
Ariyasriwatana & Quiroga (2016)[2] US	N = 205	—	Mixed methods	Reviews on the social network	Inductive and deductive	-Healthiness along with deliciousness were the main expectations explaining restaurant reviews on the social network site Yelp. -"Healthy Deliciousness" was referred to as deliciousness, i.e., a healthy food choice (e.g. veggie sushi).
Kamar et al. (2016)[3] UK	N = 50 11-17	23:27	Qualitative	Focus groups	Thematic analysis	-Some adolescents associated FH with higher prices. -Beliefs towards the healthiness of whole grains were linked to the presence of antioxidants and positive effects on the brain (e.g., calming, relaxedness).
Lavelle et al. (2016)[4] Ireland	N = 27 18-58	10:17	Qualitative	Telephone semi structured interviews	Thematic analysis	-FH was considered very important for consumers preferring home-cooking. -Natural, fresh and unprocessed ingredients were the most important factors of influence on the PH of home-cooking foods. -FH was positively associated with preparing food from basic or raw ingredients (i.e. low in fat, added sugars, salt, additives, and preservatives).
Masson et al. (2016)[5] UK	N = 89 >18	15:74	Psychosocial-anthropological	Shadowing technique, face-to-face semi structured interview, focus group	Systematic qualitative data analysis	-The very principle of fortification (e.g. omega 3 from fish oil in ham) disrupts culture-based representations French consumers have of the link between food and health.
Morgan et al. (2016) [6] Fiji	N = 57 >18	7:50	Qualitative	Focus groups	Thematic analysis	-The PH of vegetables was related to freshness and color. -A hostile retail atmosphere (e.g. rubbish laying carelessly, presence of flies, fruits and, vegetables put on the floor) influences negatively FH and purchasing decisions.
O'Kane (2016)[7] Australia	N = 20 27-66	7:13	Narrative inquiry	Focus groups	Narrative analysis	-Eating fresh, authentic, seasonal produce represented traditional and ethical values implicitly associated with taste, healthiness, and naturalness.
Oliveira et al. (2016)[8] Uruguay	N = 60 18-45	20:40	Mixed methods	Word association	Content analysis	-Graphic design was more important than the functional aspect of food products (i.e. probiotic milk) as a factor affecting the PH of the consumers of functional foods.
Ruby et al. (2016)[9] Argentina, Brazil, France, and US	N = 1695	569:1126	Mixed methods	Free association	Descriptive analysis	-The PH of meat was an important source of ambivalence regarding gender. While Brazilian and American women reported frequent negative associations to beef (e.g. "disgusting", "fatty"), Brazilian, American, French and Argentinean men were more pro-beef.

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Citation and country	Sample size (N) and age range (Y)	Gender (M:F)	Methodology	Data collection	Data analysis	Main findings
Schaefer et al. (2016)[10] US	N = 25 30-65	5:20	Mixed methods	Face-to-face in-depth interviews	Grounded theory analysis	-Nutritional and affective values were the most important factors to make PH elastic (i.e. pleasure and wellbeing were also synonymous with healthiness).
Shan et al. (2016)[11] Ireland	N = 40 >18	10:30	Qualitative	Focus groups	Constant comparative analysis	-The influence of naturalness on FH was moderated by health beliefs passed down throughout generations (e.g. grandfather's influences on PH of food).
Sijtsema et al. (2016)[12] Germany, Netherlands, Czech Republic, Denmark and Italy	N = 89 >20	37:52	Qualitative	Focus groups	Content analysis	-Taste, healthiness, and shelf life were the most important factors that influence consumers' concerns towards meat choice.
Thomas et al. (2016a)[13] UK	N = 1191	—	Mixed methods	Face-to-face in-depth interviews	Content analysis	-Consumers' uncertainty and unfamiliarity, perceived risks of the overall functional food concept, and minimal belief in the impact that additional healthy ingredients would have on the overall healthiness of processed meat were possible obstacles in the acceptance of processed meat (novel food).
Thomas et al. (2016b)[14] UK	N = 36 23-58	14:22	Qualitative	Focus group	Thematic analysis	-'Bio-based' products were more related to positive environmental issues, such as naturalness and environmentally friendly, and less to PH.
van Kleef et al. (2016)[15] Netherlands	N = 85 Mothers: 24-47 Children: 7-12 Experts: —	0:32 22:22 —	Grounded Theory	Focus group, face-to-face semi structured interview	Thematic analysis	-Consumer perceptions of bio-based products depended mainly on self-benefit, such as feeling good, or personal motives, such as having a sustainable and healthy lifestyle.
Weightman et al. (2016)[16] South Africa	N = 44 >18	23:21	Qualitative	Focus groups	Thematic analysis	-PH of "heart symbol" indicated "heart health". The mainframes of heart symbol were "raised blood pressure," "good circulation," and "no stress", which allowed "Heart symbol" as a healthy symbol for stimulating healthy choices at the point-of-purchase.
Younginer et al. (2016)[17] US	N = 59 >18	4:55	Grounded Theory	Face-to-face semi structured interview, open-ended interviews	Constant comparative analysis	-PH of foods was interpreted by calorie totals and saturated fat content. -Consumers reported that a confident decision about the overall healthiness of a product cannot be taken through unique key nutrients (e.g. sugar content), but from the overall balance of essential and non-essential nutrients.
Adams & Savage (2017)[18] US	N = 41 5-8	20:21	Qualitative	Face-to-face semi structured interview	Grounded Theory analysis	-Many children reported that FH seems to be the main factor why their parents wanted them to eat breakfast. -Some children revealed to have nervousness in the stomach when their parents urge them to eat healthy foods.
do Nascimento et al. (2017)[19] Brazil	N = 21 24-78	3:18	Qualitative	Face-to-face interviews	Thematic analysis	-Information from different sources (e.g. social influences, social media) fed beliefs towards wine. In general, consumers believed that the healthiness of wine was higher than the other alcoholic beverages.
Esmerino et al. (2017)[20] Brazil	N = 126 >18	40:86	Qualitative	Focus groups, word association, projective mapping	Thematic and textual analysis, multiple factor analysis	-FH was identified as a defining characteristic of a snack. -PH of snack was not evaluated by specific nutritional qualities (e.g. calories, sugars), but in terms of healthy, unhealthy, or junk foods.
Fielding-Singh (2017)[21] US	N = 160	—	Qualitative	Face-to-face in-depth interviews, observations	Content analysis	-PH was one of the themes that distinguished among candy, snack foods, and food served at meals. -PH of snack foods depended on the food category. Children considered snack foods to be healthier than candy, but food served at meals were healthier perceived than snack foods.
Freire et al. (2017)[22] Ecuador	N = 178 5-64	—	Grounded theory	Focus groups	Grounded theory analysis	-PH (e.g. sodium content) was considered a secondary factor to optimal sensory characteristics in choice of gluten-free bread bun.

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Citation and country	Sample size (N) and age range (Y)	Gender (M:F)	Methodology	Data collection	Data analysis	Main findings
Hasimu et al. (2017)[23] China	N = 50 >18	23:27	Qualitative	Brand concept mapping	Network and cluster analysis	-Health claims related to dairy fermented products, such as light, zero fat, and probiotic, as well as PH, were the main extrinsic characteristics of choosing fermented dairy products.
Hoek et al. (2017)[24] Australia	N = 29 18-64	11:18	Theory of Planned Behaviour	Face-to-face semi structured interview	Thematic analysis	-FH was more important among High- and middle-socioeconomic status (SES) consumers as compared to low-SES consumers. The contrast between healthiness and deprivation values explained these findings.
Peura-Kapanen et al. (2017)[25] Finland	N = 168 65-82	67:101	Qualitative	Focus groups, histories based on empathy	Thematic and textual analysis, multiple factor analysis	-Some consumers ignore factors related to FH (e.g. traffic light) when seeking junk foods (e.g. because of taste, brand). -FH was more important among women and consumers concerned with health (low in fat, sugar and salt foods). For older consumers, FH was negatively associated with processed and unfamiliar foods. -Consumers believe the traffic light label demonizes products that have higher concentrations of fat, sugar, or salt, giving the impression of being harmful to health.
Puhakka et al. (2017)[26] Finland	N = 13 65-79	3:10	Qualitative	Face-to-face in-depth interviews	Content analysis	-The healthiness of organic foods was the first most important factor to conceptualize consumers' perception, followed by "safe" and "expensive". These associations were also linked to "green food", "pure and natural" and "tasty". -Mixed records regarding perceptions of organic foods were reported: natural product x technology advanced product.
Rodrigues et al. (2017)[27] Brazil	N = 549 19-51	—	Qualitative	Word association Projective mapping	Content analysis	-FH was negatively associated with processed and packaged foods, due to excessive packaging and the presence of "chemicals". -The association between FH and environmentally friendliness was an acceptable idea in the consumer mind (e.g. motivations to eat less animal-derived products and more plant-based foods).
Banovic et al. (2018)[28] Finland, Germany, Romania and Denmark	N = 52 24-74	24:28	Qualitative	Focus groups	Content analysis	-Easy-to-use and environmentally friendly packaging, as well FH, were central motivators of convenience foods.
Feucht & Zander (2018)[29] France, Germany, and the UK	N = 32 >18	9:23	Mixed methods	Face-to-face semi structured interview	Content analysis	-Four clusters of consumers with diverse lay understandings of health and attitudes towards health-enhancing products were identified: health-seeking consumers, cautious consumers, critical consumers and natural health consumers. -Whereas health-seeking and cautious consumers demonstrated the importance of health-enhancing products, rural people were more propensity to accept 'radical' health innovation, due to higher familiarity with products connected to the living environment. -Consumers concerned about health issues linked naturalness with healthiness closely.
Landry et al. (2018)[30] Canada	N = 92 19-49	44:48	Qualitative	Focus groups	Thematic analysis	-Consumers believed that food products made with flowers expressed healthiness (health care). -Good perceptions of flowers (less processed food- "healthy") could improve the PH of processed foods made with flowers (e.g. yoghurt).

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Citation and country	Sample size (N) and age range (Y)	Gender (M:F)	Methodology	Data collection	Data analysis	Main findings
Lupton & Turner (2018)[31] Australia	N = 30 >18	11:19	Qualitative	Online discussion forum	Thematic analysis	-The healthiness of products with increased protein content was a strong concern for consumers worried with correct quantities of proteins in their diets. -Taste, habit, sustainable production, and perceived product naturalness were the most important reasons in the preference of cereal plant protein. In contrast, lack of trust in the product, unethical production, bad sensory qualities in terms of product taste and perceived lack of healthiness and its consequences (e.g. allergies) were the main obstacles for legume protein preference. -Although healthiness, environmental friendliness, and ethical production have positively influenced perceptions of plant proteins, mixed-age group demonstrated preference proteins from cereals in relation to protein from legumes; thus, the type of protein influence the willingness to consume these foods.
Menger-Ogle & Graham (2018)[32] Nepal	N = 239 >18	98:141	Mixed methods	Face-to-face semi structured interview	Constant-comparative analysis	-FH was more related to organic and local production then and carbon-labeled products. -Unfamiliarity, knowledge, and skepticism towards carbon-labeled products were the main factors of influence on consumer preferences.
Moscato & Machin (2018)[33] US	N = 20 24-46	0:20	Qualitative	Focus groups, participant photography	Constant comparative analysis	-Consumers believed that FH represented added value to the pleasure in certain foods or dishes.
Myers & Pettigrew (2018) [34] Australia	N = 77 60-100	10-67	Qualitative	Face-to-face in-depth interviews	Thematic analysis	-3D printed sugar confections were negatively associated with healthiness and naturalness and positively to deliciousness. -FH and naturalness positively influenced the idea of eating an insect snack. -The 3D print pizza was rated highly for deliciousness, healthiness, and naturalness due to their natural ingredients. - "Processed pizza" (past experience) was rated very low for healthiness when compared to "real one" pizza (3D print).
Pinto et al. (2018)[35] Brazil	N = 550 >18	217-333	Qualitative	Shopping list, Word association	Content analysis, chi-square test	-Front-of-package nutrition claims (FOPNCs) were inconsistent or absent impact on food perceptions and purchase intentions among Nepali consumers, and FH had less importance on shopping priorities. -FOPNCs most often influenced perceptions of snack foods' healthfulness for children (i.e. halo effect heuristics) which implies a higher vulnerability to unduly attribute healthiness to unhealthful food products.
Velardo & Drummond (2018)[36] Australia	N = 38	2:3	Qualitative	Focus groups, face-to-face semi structured interview	Thematic analysis	-FH was the common property cited to rank natural food (i.e. healthy food), as well the authenticity, and emotional and psychological well-being.
Yarar & Orth (2018)[37] Germany	N = 30 18-66	14:16	Mixed methods	Q methodology	Q methodological analysis	-FH was not an important factor in the Western consumers' perception towards entomophagy -Very low levels of awareness of the environmental and nutritional advantages of entomophagy were found.
Ares et al. (2019)[38] Uruguay	N = 518 >18	202:316	Qualitative	Open-ended question	Content analysis	-PH of probiotic and organic formulations was associated with people who seek well-being through food, worried about the health and life quality, seeking a health and nutritious alimentation, and worried about the food quality. -The healthiness of organic fermented milk was associated with pesticides free, value aggregated (i.e. high in nutritional value) and friendly-environmentally foods.
Barone et al. (2019)[39] Brazil	N = 150 18-60	57:93	Qualitative	Word association, Free listing, conclusion sentence task	Content analysis	-FH positively influenced willingness to try conventional, organic and functional foods (fermented milk) -The willingness to buy light and lactose-free products (fermented milk) were associated with perceived self-directed benefit (e.g. health disorders)

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Citation and country	Sample size (N) and age range (Y)	Gender (M:F)	Methodology	Data collection	Data analysis	Main findings
Boase et al. (2019)[40] UK	N = 26 18-65	8:18	Mixed methods	Face-to-face semi structured interview	Inductive and deductive	- Four major lay theories regarding healthy nutrition were identified: (1) "Healthy is what tastes good, in moderation", (2) "Healthy nutrition is expensive and inconvenient", (3) "Healthy is everything that makes me slim and pretty", and (4) "Only home-made, organic, and vegetarian food is healthy". -FH was related to organic or conventional production methods. -Consumers consider FH is intrinsically related to home-cooking and environmentally friendly production.
Costa et al. (2019)[41] Australia	N = 10 18-25	0:10	Phenomenology	Face-to-face semi structured interview	Interpretative Phenomenological Analysis	-Consumers frequently mentioned that would include messages of choosing foods without the excess of sugar, fat, and sodium associated with wellbeing and healthy weight in a communication campaign targeted at encouraging healthier foods. -To induce self-awareness on food perceptions (e.g. perceived healthiness) and motivate healthier food choices, consumers considered effective the use of images of healthy people, with normal weight, happy people, and wellbeing, as well images showing the negative consequences of unhealthy eating and shocking images of diseases.
Damen et al. (2019)[42] Netherlands	N = 136 24-47	0:136	Grounded Theory	Diaries	Content analysis	-FH was the fifth term most frequently mentioned defining sustainable diet category. The main terms were healthy, good for health, promote health and wellness, alternatives for health care, ideal for long and healthy life, maintain health and quality of life.
Ditlevsen et al. (2019)[43] Denmark	N = 39 27-65	17:22	Conventions approach	Focus groups	Content analysis	-PH of shellfish (source of protein and omega-3 oils) was positively influenced by knowledge of health and environmental benefits. -Erroneous beliefs, such as health issues (e.g. being allergic to shellfish), and religious and dietary reasons (e.g. being vegan) affect negatively PH towards shellfish.
Flaherty et al. (2019)[44] Ireland	N = 10 30-45	0:10	Phenomenology	Think-aloud protocol, observations, face-to-face in-depth interviews	Interpretive phenomenological analysis	-PH of vegan foods was related to moral, ethical, and environmental issues towards animals, conscious consumption, origin or method of production (home-cooking vs processed food), naturalness, and sustainability of the world.
Jefrydin et al. (2019)[45] Malaysia	N = 33 13-16	11:22	Qualitative	Focus groups	Thematic analysis	-Motives related to FH were more frequently used by higher educated mothers as reasons to provide snacks to children. -Mothers of first children are more careful regarding the healthiness of the snacks they provide. -The lower educated mothers were less concerned with FH or nutritional value of snack they provide, compared to the higher educated mothers
Menegassi et al. (2019)[46] Brazil	N = 24 19-57	12:12	Qualitative	Face-to-face semi structured interview	Content analysis	-FH was synthesized through three dimensions: health as nutritional value, health as pleasure, and health as purity. -FH was less perceived as pleasure perspective.
Paakki et al. (2019)[47] Finland	N = 12 27-64	2:10	Mixed methods	Group interviews	Thematic analysis	-Overall, unhealthier foods were chosen through emotional goals (e.g. sense of reward), but the conflict between unhealthiness and healthiness influenced healthier food choices as well. -Consumers believed that nutrition knowledge and self-control were sufficient to make FH an important tool for food choice. -The healthy app encouraged women from a lower socioeconomic background to more conscious attitudes to food purchasing.
Peschel et al. (2019)[48] Denmark	N = 87 18-50	32:55	Qualitative	Concept mapping approach, focus groups	Coding, text mining, network analysis, thematic analysis	-Knowledge, misperception, awareness, and trust was reported to significantly impact on adolescents' healthiness perceptions.

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Citation and country	Sample size (N) and age range (Y)	Gender (M:F)	Methodology	Data collection	Data analysis	Main findings
Pires et al. (2019)[49] Brazil	N = 16 31-43	8:8	Mixed methods	Focus groups	Descriptive analysis	-Some people compared "real food" to nutritional foods. -Some participants classified French bread and white sugar together under the name "sugar", while others referred to them as "carbohydrates". Overall, all these foods were perceived as unhealthy.
Velema et al. (2019)[50] Netherlands	N = 45 18-62	23:22	Qualitative	Focus groups	Thematic analysis	-FH, diversity, and taste were the main arguments for the perceived importance of the visual aesthetics of foods. -Rational reasons, such as FH or the nutritional values of food, were the main propulsors in eating lunch routines, but visual aesthetics affected food choices as well.
Brownbill et al. (2020)[51] Australia	N = 32 18-25	15:17	Qualitative	Focus groups	Thematic analysis	-FH is have played a central role in communicating the benefits of a plant-based diet. -Both health and sustainability communication result in a higher complexity when compared to communicating the substitution ingredient (e.g. potato protein as a substitute for animal-based ingredients). A Health communication perspective was focused on food product properties (e.g. processing degree, nutritional quality, and chemicals), while sustainability was more associated with the environmental impact and authenticity of the product.
Doungtip et al. (2020)[52] Thailand	N = 51 >20	8:43	Mixed methods	Focus groups	Descriptive analysis	- Knowledge about health benefits was one of the main factors that explained the greater perceived importance of sodium content compared to omega-3 content (bologna sausages).
Ford et al. (2020)[53] UK	N = 91 (parents/caregivers of primary school aged children – 5 to 11 years)	—	Qualitative	Focus Groups	Thematic analysis with deductive and inductive approach	-FH, price, and taste were the most important drivers in food selection. -FH was the important factor for food choice, but less important in visiting or making food choices in the worksite cafeteria. -Feeling of deserve, taste and price were the most important factors for choosing unhealthy foods.
Gaspar et al. (2020)[54] Brazil, France and Spain	N = 131 18-30	—	Qualitative	Face-to-face semi structured interview	Thematic analysis	-Sugar content, nutritional value, naturalness (depending on the level of processing, presence of additives and colors), and functionality (e.g. body needs) were the most important factors in judgments of beverage healthiness. -PH of beverages was conceptualized through beverage ingredients and the balance properties (harmful vs beneficial to health). -Awareness about high amounts of sugar by itself is not sufficient to avoid sweetened-beverages consumption. -Soda (soft drink) and energy drink were perceived as the least healthy beverages, and water the healthiest.
Makhal et al. (2020)[55] New Zealand	N = 97 5-11	46:51	Qualitative	Focus groups, observations	Content analysis	-FH was the most important factor to describe perceptions towards ginseng (e.g. due to health benefits).
Pelly et al. (2020)[56] Australia	N = 15 >25	3:12	Phenomenology	Focus groups	Thematic analysis	-Healthiness of snack food items and participants' susceptibility to impulse purchases were the main motives of influence on parents' and caregivers' perceptions and attitudes towards checkout food items and supermarket checkout policies. -Parents'/ caregivers' concern towards the healthiness of snacks was mainly due to the pressure they felt to make healthy food choices for their children (e.g. pressure from school and media reports around diet and food).
Sato et al. (2020)[57] Brazil	N = 40 17-43	0:40	Grounded Theory	Face-to-face in-depth Interviews	Grounded Theory analysis	-In addition to scientific-nutritional rationality, value systems and different scientific, symbolic, and moral rationalities (i.e. eco-ideological, physiological, nutritional, and functional conceptions) were important criteria to determine the polysemic character of the classification of healthy food.

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Citation and country	Sample size (N) and age range (Y)	Gender (M:F)	Methodology	Data collection	Data analysis	Main findings
Surendran et al. (2020)[58] India	N = 112 15-65	37:75	Interpretative approach	Focus groups Face-to-face in-depth Interviews	Line-by-line and constant comparative analysis	-Contrary to adults, some children have not found a difference between the PH of sub-optimal and optimal carrots.
Tang et al. (2020)[59] UK	N = 21 24-51 (mothers of children aged 1 – 5 years)	0:21	Qualitative	Face-to-face semi structured interview	Thematic analysis	-PH was related to sugar, fat, saturated fat, and food additives contents. -The importance of FH was influenced by individual health conditions, personal nutritional priorities, allergies, food safety, weight control, taste, and price. -The nutrition information panel was most used than particular to front-of-pack nutrition label to determine FN -Incongruence of the PH was mainly related to the lack of dissuasive impact of the Health Star Rating and its misleading effect in some cases.
van Kesteren and Evans (2020)[60] UK	N = 25 >18	0:25	Mixed methods	Practice-oriented in-depth interviews, ethnographic observations	—	-Some consumers believed that ultra-processed foods were healthier than traditional processed foods because their "healthiness" was related to weight-loss diets (such as light cream-cheese, meal replacement shakes, light toasts, and low-fat yogurt). -Consumers associated FH and price with food safety. Negative aspects of food safety were frequently attributed to increased pesticide use and potentially increasing demand for unhealthy foods. -Decisions about portion size were based on FH. When mothers perceived food as healthful then they encouraged more intake of foods by children. -Low-income food norms under the influence of social context tended to show more urgent priorities than FH.

Note: '—' Not specified. In the appendix, the type of methodology followed the same descriptions reported in the selected papers.

References

Adams, E.L., Savage, J.S., 2017. From the children's perspective: what are candy, snacks, and meals? Appetite 116, 215–222. doi:10.1016/j.appet.2017.04.034.

Ares, G., Gámbaro, A., 2007. Influence of gender, age and motives underlying food choice on perceived healthiness and willingness to try functional foods. Appetite 49, 148–158. doi:10.1016/j.appet.2007.01.006.

Ares, G., Varela, P., 2018. Consumer-based methodologies for sensory characterization. Methods in Consumer Research. New Approaches to Classic Methods G. Ares & P. Varela. Woodhead Publishing, Cambridge, UK.

Ares, G., Machín, L., Vidal, L., Aschemann-Witzel, J., Otterbring, T., Curutchet, M.R., Giménez, A., Bove, I., 2019. How can we motivate people to use nutritional warnings in decision making? citizen co-created insights for the development of communication campaigns. Health Educ. Behav. 47 (2), 1–11. doi:10.1177/1090198119889086.

Ares, G., Vidal, L., Allegue, G., Giménez, A., Bandeira, E., Curutchet, M.R., 2016. Consumers' conceptualization of ultra-processed foods. Appetite 05, 611–617. doi:10.1016/j.appet.2016.06.028.

Ariyasriwatana, W., Quiroga, L.M., 2016. A thousand ways to say 'Delicious!' – categorizing expressions of deliciousness from restaurant reviews on the social network site Yelp. Appetite 104, 18–32. doi:10.1016/j.appet.2016.01.002.

Bai, Y., Naumova, E.N., Masters, W.A., 2020. Seasonality of diet costs reveals food system performance in East Africa. Sci. Adv. 6, eabc2162. doi:10.1126/sciadv.abc2162.

Banovic, M., Arvola, A., Pennanen, K., Duta, D.E., Brückner-Gühmann, M., Lähteenmäki, L., Grunert, K.G., 2018. Foods with increased protein content: a qualitative study on European consumer preferences and perceptions. Appetite 125, 233–243. doi:10.1016/j.appet.2018.01.034.

Barone, B., Nogueira, R.M., de Queiroz Guimarães, K.R.L.S.L., Behrens, J.H., 2018. Sustainable diet from the urban Brazilian consumer perspective. Food Res. Int. 124, 206–212. doi:10.1016/j.foodres.2018.05.027.

Boase, N., White, M.P., Gaze, W.H., Redshaw, C., 2019. Why don't the British eat locally harvested shellfish? The role of misconceptions and knowledge gaps. Appetite 143, 104352. doi:10.1016/j.appet.2019.104352.

Bristol, T., Fern, E.F., 1993. Using qualitative techniques to explore consumer attitudes: insights from group process theories. Adv Consum Res 20, 444–448.

Brownbill, A.L., Braunack-Mayer, A.J., Miller, C.L., 2020. What makes a beverage healthy? A qualitative study of young adults' conceptualisation of sugar-containing beverage healthfulness. Appetite 150, 104675. doi:10.1016/j.appet.2020.104675.

Bullock, K., Lahne, J., Pope, L., 2020. Investigating the role of health halos and reactance in ice cream choice. Food Qual Prefer 80, 103826. doi:10.1016/j.foodqual.2019.103826.

CASP (Critical Appraisal Skills Programme), 2018. CASP Checklist: 10 questions to help you make sense of a Qualitative research https://casp-uk.net/wp-content/uploads/2018/01/CASP-Qualitative-Checklist-2018.pdf(Accessed 25 March 2020).

Cavanagh, K.V., Forestell, C.A., 2013. The effect of brand names on flavor perception and consumption in restrained and unrestrained eaters. Food Qual Prefer 28 (2), 505–509. doi:10.1016/j.foodqual.2012.12.004.

Casey, J.R., Hanson, C.S., Winkelmayer, W.C., Craig, J.C., Palmer, S., Strippoli, G.F.M., Tong, A., 2014. Patients' perspectives on hemodialysis vascular access: a systematic review of qualitative studies. Am. J. Kidney Dis. 64 (6), 937–953. doi:10.1053/j.ajkd.2014.06.024.

Costa, I., Gill, P., Morda, R., Ali, L., 2019. More than a diet": a qualitative investigation of young vegan women's relationship to food. Appetite 142, 104418. doi:10.1016/j.appet.2019.104418.

Damen, F.W.M., Luning, P.A., Fogliano, V., Steenbekkers, B.L.P.A., 2019. What influences mothers' snack choices for their children aged 2-7? Food Qual Prefer 74, 10–20. doi:10.1016/j.foodqual.2018.12.012.

Denzin, N.K., Lincoln, Y.S., 2017. Introduction: The Discipline and Practice of Qualitative Research. SAGE Publications, Thousand Oaks, CA.

Delabre, I., Rodriguez, L.O., Smallwood, J.M., Scharlemann, J.P.W., Alcamo, J., Antonarakis, A.S., Rowhani, P., Hazell, R.J., Aksnes, D.L., Balvanera, P., Lundquist, C., Gresham, C., Alexander, A.E., Stenseth, N.C., 2021. Actions on sustainable food production and consumption for the post-2020 global biodiversity framework. Sci. Adv. 7, eabc8259. doi:10.1126/sciadv.abc8259.

Ditlevsen, K., Sandøe, P., Lassen, J., 2019. Healthy food is nutritious, but organic food is healthy because it is pure: the negotiation of healthy food choices by Danish consumers of organic food. Food Qual Prefer 71, 46–53. doi:10.1016/j.foodqual.2018.06.001.

Do Nascimento, A.B., Fiates, G.M.R., Teixeira, E., 2017. We want to be normal! Perceptions of a group of Brazilian consumers with coeliac disease on gluten-free bread buns. Int J Gastron Food Sci 7, 27–31. doi:10.1016/j.ijgfs.2017.01.001.

Dos Santos, A.C.C., Delamaro, M.E., Nunes, F.L.S., 2013. The relationship between requirements engineering and virtual reality systems: a systematic literature review. In: Virtual Augment. Real. (SVR), XV Symp, pp. 53–62.

Doub, A.E., Small, M.L., Levin, A., LeVangie, K., Brick, T.R., 2016. Identifying users of traditional and Internet-based resources for meal ideas: an association rule learning approach. Appetite 103, 128–136. doi:10.1016/j.appet.2016.04.006.

Doungtip, P., Sriwattana, S., Kim, K.T., 2019. Understanding Thai consumer attitudes and expectations of ginseng food products. J Sens Stud e12553. doi:10.1111/joss.12553.

Esmerino, E.A., Ferraz, J.P., Tavares Filho, E.R., Pinto, L.P.F., Freitas, M.Q., Cruz, A.G., Bolini, H.M.A., 2017. Consumers' perceptions toward 3 different fermented dairy products: insight from focus groups, word association, and projective mapping. J. Dairy Sci. 100, 8849–8860. doi:10.3168/jds.2016-12533.

Faraji-Rad, A., Pham, M.T., 2016. Uncertainty increases the reliance on affect in decisions. SSRN J. 44, 1–59. doi:10.1093/jcr/ucw073.

Feucht, Y., Zander, K., 2018. Consumers' preferences for carbon labels and the underlying reasoning. A mixed methods approach in 6 European countries. J. Clean. Prod. 178, 740–748. doi:10.1016/j.jclepro.2017.12.236.
Fielding-Singh, P., 2017. A taste of inequality: food's symbolic value across the socioeconomic spectrum. Sociol. Sci. 4, 424–448. doi:10.15195/v4.a17.
Flaherty, S.J., McCarthy, M.B., Collins, A.M., McCafferty, C., McAuliffe, F.M., 2020. A phenomenological exploration of change towards healthier food purchasing behaviour in women from a lower socioeconomic background using a health app. Appetite 147, 104566. doi:10.1016/j.appet.2019.104566.
Ford, A., Stead, M., Eadie, D., Adams, J., Adamson, A., White, M., 2020. Parents' and careers' awareness and perceptions of UK supermarket policies on less healthy food at checkouts: a qualitative study. Appetite 147, 104541. doi:10.1016/j.appet.2019.104541.
Freire, W.B., Waters, W.F., Rivas-Mariño, G., Nguyen, T., Rivas, P., 2017. A qualitative study of consumer perceptions and use of traffic light food labelling in Ecuador. Public Health Nutr 20 (5), 805–813. doi:10.1017/S1368980016002457.
Gaspar, M.C.M.P., Garcia, A.M., Larrea-Killinger, C., 2020. How would you define healthy food? Social representations of Brazilian, French and Spanish dietitians and young laywomen. Appetite 153, 104728. doi:10.1016/j.appet.2020.104728.
Grisolía, J.M., 2018. Lifestyle and heart diseases in choice experiments. Lifestyle in Heart Health and Disease 163–173. doi:10.1016/B978-0-12-811279-3.00012-4.
Hoek, A.C., Pearson, D., James, S.W., Lawrence, M.A., Friel, S., 2017. Shrinking the footprint: A qualitative study into consumer perceptions, experiences and attitudes towards healthy and environmentally friendly food behaviours. Appetite 108, 117–131. doi:10.1016/j.appet.2016.09.030.
Kamar, M., Evans, C., Hugh-Jones, S., 2016. Factors influencing adolescent whole grain intake: a theory-based qualitative study. Appetite 101, 125–133. doi:10.1016/j.appet.2016.02.154.
Jami, A., 2016. Healthy reflections: the influence of mirror induced self-awareness on taste perceptions. J. Ass. Consumer Res. 1, 57–70. doi:10.1086/684288.
Jansson-Boyd, C.V., Kobescak, M., 2020. To see is to hold: Using food surface textures to communicate product healthiness. Food Qual Prefer 80, 103866. doi:10.1016/j.foodqual.2019.103866.
Jefrydin, N., Nor, N.M., Talib, R.A., 2019. Nutrition labelling: an exploratory study on personal factors that influence the practice of reading nutrition labels among adolescents. Mal. J. Nutr. 25 (1), 143–153. doi:10.31246/mjn-2018-0123.
Jo, J., Lusk, J.L., 2018. If it's healthy, it's tasty and expensive: Effects of nutritional labels on price and taste expectations. Food Qual. Prefer 68, 332–341. doi:10.1016/j.foodqual.2018.04.002.
Landry, M., Lemieux, S., Lapointe, A., Bédard, A., Bélanger-Gravel, A., Bégin, C., Provencher, V., Desroches, S., 2018. Is eating pleasure compatible with healthy eating? A qualitative study on Quebecers' perceptions. Appetite 125, 537–547. doi:10.1016/j.appet.2018.02.033.
Lavelle, F., McGowan, L., Spence, M., Caraher, M., Raats, M.M., Hollywood, L., McDowell, D., McCloat, A., Mooney, E., Dean, M., 2016. Barriers and facilitators to cooking from "scratch" using basic or raw ingredients: a qualitative interview study. Appetite 107, 383–391. doi:10.1016/j.appet.2016.08.115.
Lima Filho, T., Della Lucia, S.M., Minim, L.A., Gamba, M.M., Lima, R.M., Minim, V.P.R., 2019. Directional hedonic thresholds for sodium concentration in hamburger. Food Qual. Prefer. 78, 103722. doi:10.1016/j.foodqual.2019.103722.
Lovell, J.L., 2016. How parents process child health and nutrition information: a grounded theory model. Appetite 97, 138–145. doi:10.1016/j.appet.2015.11.024.
Lupton, D., Turner, B., 2018. I can't get past the fact that it is printed": consumer attitudes to 3D printed food. Food Cult Soc 21 (3), 402–418. doi:10.1080/15528014.2018.1451044.
Lusk, J.L, 2019. Consumer beliefs about healthy foods and diets. PLOS ONE 14 (10), e0223098. doi:10.1371/journal.pone.0223098.
Maehle, N., Iversen, N., Hem, L., Otnes, C, 2015. Exploring consumer preferences for hedonic and utilitarian food attributes. Br. Food J. 117 (12), 3039–3063. doi:10.1108/BFJ-04-2015-0148.
Mai, R., Hoffmann, S., 2015. How to combat the Unhealthy = tasty intuition: the influencing role of health consciousness. J. Public Policy Mark. 34 (1), 63–68. doi:10.1509/jppm.14.006.
Makhal, A., Thyne, M., Robertson, K., Mirosa, M., 2020. I don't like wonky carrots"- an exploration of children's perceptions of suboptimal fruits and vegetables. J. Retail. Consum. Serv. 54, 101945. doi:10.1016/j.jretconser.2019.101945.
Manippa, V., Giuliani, F., Brancucci, A., 2020. Healthiness or calories? Side biases in food perception and preference. Appetite 147, 104552. doi:10.1016/j.appet.2019.104552.
Masson, E., Debucquet, G., Fischler, C., Merdji, M., 2016. French consumers' perceptions of nutrition and health claims: a psychosocial-anthropological approach. Appetite 105, 619–629. doi:10.1016/j.appet.2016.06.026.
Mergelsberg, E.L.P., MacLeod, C., Mullan, B., Rudaizky, D., Allom, V., Houben, K., Lipp, O.V., 2019. Food healthiness versus tastiness: Contrasting their impact on more and less successful healthy shoppers within a virtual food shopping task. Appetite 133, 405–413. doi:10.1016/j.appet.2018.11.029.
Menegassi, B., Sato, P.M., Scagliusi, F.B., Moubarac, J.-C., 2019. Comparing the ways a sample of Brazilian adults classify food with the NOVA food classification: an exploratory insight. Appetite 137, 226–235. doi:10.1016/j.appet.2019.03.010.
Menger-Ogle, A.D., Graham, D.J., 2018. The influence of front-of-package nutrition claims on food perceptions and purchase intentions among Nepali consumers. Food Qual. Prefer 66, 160–170. doi:10.1016/j.foodqual.2017.12.017.
Morgan, E.H., Vatucawaqa, P., Snowdon, W., Worsley, A., Dangour, A.D., Lock, K., 2016. Factors influencing fruit and vegetable intake among urban Fijians: a qualitative study. Appetite 101, 114–118. doi:10.1016/j.appet.2016.03.003.
Moscato, E.M., Machin, J.E., 2018. Mother natural: Motivations and associations for consuming natural foods. Appetite 121, 18–28. doi:10.1016/j.appet.2017.10.031.
Myers, G., Pettigrew, S., 2018. A qualitative exploration of the factors underlying seniors' receptiveness to entomophagy. Food Res Int 103, 163–169. doi:10.1016/j.foodres.2017.10.032.
Motoki, K., Saito, T., Nouchi, R., Kawashima, R., Sugiura, M., 2019. Anxiety increases visual attention to hedonic foods: a preliminary eye-tracking study on the impact of the interplay between integral and incidental affect on foods. Appetite 137, 218–225. doi:10.1016/j.appet.2019.02.009.
O'Kane, G., 2016. A moveable feast: Exploring barriers and enablers to food citizenship. Appetite 105, 674–687. doi:10.1016/j.appet.2016.07.002.
E. H. Oliveira, D., Machín, L., Deliza, R., Rosenthal, Walter, Giménez, A., Ares, G., 2016. Consumers' attention to functional food labels: Insights from eye-tracking and change detection in a case study with probiotic milk. LWT - Food Sci. Technol. 68, 160–167. doi:10.1016/j.lwt.2015.11.066.
Oljans, E., Elmståhl, H., Mattsson Sydner, Y., Hjälmeskog, K., 2017. From nutrients to wellbeing identifying discourses of food in relation to health in syllabi. Pedagog. Cult. Soc. 26 (1), 35–49. doi:10.1080/14681366.2017.1345974.
Otterbring, T., Gidlöf, K., Rolschau, K., Shams, P., 2020. Cereal deal: how the physical appearance of others affects attention to healthy foods. Perspect. Behav. Sci. 43 (3), 451–468. doi:10.1007/s40614-020-00242-2.
Paakki, M., Aaltojärvi, I., Sandell, M., Hopia, A., 2019. The importance of the visual aesthetics of colours in food at a workday lunch. International Journal of Gastronomy and Food Science 16, 100131. doi:10.1016/j.ijgfs.2018.12.001.
Patton, M.Q., 2014. Qualitative Research & Evaluation Methods, 4th ed. SAGE Publications, Thousand Oaks, CA.
Pedro, R.W.D., Nunes, F.L.S., Machado-Lima, A., 2013. Using grammars for pattern recognition in images. ACM Comput. Surv. 46 (2), 1–34. doi:10.1145/2543581.2543593.
Pelly, F.E., Swanepoel, L., Rinella, J., Cooper, S., 2020. Consumers' perceptions of the australian health star rating labelling scheme. Nutrients 12 (3), 704. doi:10.3390/nu12030704.
Peschel, A.O., Kazemi, S., Liebichová, M., Sarraf, S.C.M., Aschemann-Witzel, J, 2019. Consumers' associative networks of plant-based food product communications. Food Qual. Prefer 75, 145–156. doi:10.1016/j.foodqual.2019.02.015.
Petersen, J.M., Prichard, I., Kemps, E., Tiggemann, M., 2019. The effect of snack consumption on physical activity: a test of the compensatory health beliefs model. Appetite 141, 104342. doi:10.1016/j.appet.2019.104342.
Peura-Kapanen, L., Jallinoja, P., Kaarakainen, M., 2017. Acceptability of convenience food among older people. SAGE Open 7 (1). doi:10.1177/2158244017698730.
Pinto, V.R.A., Milião, G.L., Balbino, D.F., Della Lucia, S.M., Vidigal, M.T.C.R., Cabral, L.F.M., da Rocha, S.J.S.S., de Carvalho, A.F., Perrone, I.T., 2020a. Contemporary foods – can they become new comfort foods or simply mimic them? Int J Gastron Food Sci 22, 100271. doi:10.1016/j.ijgfs.2020.100271.
Pinto, V.R.A., Teixeira, C.G., Lima, T.S., Prata, E.R.B.A., Vidigal, M.C.T.R., Martins, E., Perrone, I.T., Carvalho, A.F., 2020b. Health beliefs towards kefir correlate with emotion and attitude: a study using an Emoji scale. Food Res Int 129, 108833. doi:10.1016/j.foodres.2019.108833.
Polivy, J., Coleman, J., Herman, C.P., 2005. The effect of deprivation on food cravings and eating behavior in restrained and unrestrained eaters. Int J Eat Disord 38, 301–309. doi:10.1002/eat.20195.
Poore, J., Nemecek, T., 2018. Reducing food's environmental impacts through producers and consumers. Science 360 (6392), 987–992. doi:10.1126/science.aaq0216.
Poquet, D., Ginon, E., Sénécal, C., Chabanet, C., Marette, S., Issanchou, S., Monnery-Patris, S., 2020. Effect of a pleasure-oriented intervention on the nutritional quality of midafternoon snacks and on the relationship between food liking and perceived healthiness within mother-child dyads. Food Qual. Prefer 84, 103947. doi:10.1016/j.foodqual.2020.103947.
Provencher, V., Jacob, R., 2016. Impact of perceived healthiness of food on food choices and intake. Curr. Obes. Rep. 5 (1), 65–71. doi:10.1007/s13679-016-0192-0.
Provencher, V., Polivy, J., Herman, C.P., 2009. Perceived healthiness of food. If it's healthy, you can eat more!. Appetite 52 (2), 340–344. doi:10.1016/j.appet.2008.11.005.
Puhakka, R., Valve, R., Sinkkonen, A., 2017. Older consumers' perceptions of functional foods and non-edible health-enhancing innovations. Int. J. Consum. Stud. 42 (1), 111. doi:10.1111/ijcs.12400.
Qutteina, Y., Hallez, L., Mennes, N., De Backer, C., Smits, T., 2019. What do adolescents see on social media? a diary study of food marketing images on social media. Front. Psychol. 22. doi:10.3389/fpsyg.2019.02637.
Rojas-Rivas, E., Espinoza-Ortega, A., Thomé-Ortíz, H., Moctezuma-Pérez, S., Cuffia, F., 2019. Understanding consumers' perception and consumption motives towards amaranth in Mexico using the Pierre Bourdieu's theoretical concept of Habitus. Appetite 139, 180–188. doi:10.1016/j.appet.2019.04.021.
Román, S., Sánchez-Siles, L.M., Siegrist, M., 2017. The importance of food naturalness for consumers: results of a systematic review. Trends Food Sci Technol 67, 44–57. doi:10.1016/j.tifs.2017.06.010.
Rosi, A., Mena, P., Scazzina, F., Marino, B., Danyego, O., Fasano, F., Di Dio, C., Riggio, L., Brighenti, F., 2017. Food perception at lunchtime does not depend on the nutritional and perceived characteristics of breakfast. Int J Food Sci Nutr 69 (5), 628–639. doi:10.1080/09637486.2017.1401981.
Ruby, M.B., Alvarenga, M.S., Rozin, P., Kirby, T.A., Richer, E., Rutsztein, G., 2016. Attitudes toward beef and vegetarians in Argentina, Brazil, France, and the USA. Appetite 96, 546–554. doi:10.1016/j.appet.2015.10.018.
San-Cristobal, R., Navas-Carretero, S., Celis-Morales, C., Livingstone, K.M., Stewart-Knox, B., Rankin, A., et al., 2017. Capturing health and eating status through a nutritional perception screening questionnaire (NPSQ9) in a randomised internet-based personalised nutrition intervention: the Food4Me study. Int. J. Behav. Nutr. Phys. Act. 14 (1), 168. doi:10.1186/s12966-017-0624-6.

Sato, P.M., Couto, M.T., Wells, J., Cardoso, M.A., Devakumar, D., Scagliusi, F.B., 2020. Mothers' food choices and consumption of ultra-processed foods in the Brazilian Amazon: a grounded theory study. Appetite 148, 104602. doi:10.1016/j.appet.2020.104602.

Schaefer, S.E., Biltekoff, C., Thomas, C., Rashedi, R.N., 2016. Healthy, vague: exploring health as a priority in food choice. Food Cult Soc 19 (2), 227–250. doi:10.1080/15528014.2016.1178527.

Shan, L.C., Regan, A., Monahan, F.J., Li, C., Murrin, C., Lalor, F., Wall, P.G., McConnon, A., 2016. Consumer views on "healthier" processed meat. Br Food J 118 (7), 1712–1730. doi:10.1108/BFJ-11-2015-0447.

Sijtsema, S.J., Onwezen, M.C., Reinders, M.J., Dagevos, H., Partanen, A., Meeusen, M., 2016. Consumer perception of bio-based products—an exploratory study in 5 European countries. NJAS-WAGEN J LIFE SC 77, 61–69. doi:10.1016/j.njas.2016.03.007.

Souza, L.B.A., Pinto, V.R.A., Nascimento, L.G.L., Stephani, R., Carvalho, A.F., Perrone, I.T., 2021. Low-sugar strawberry yogurt: hedonic thresholds and expectations. J. Sens. Stud. e12643. doi:10.1111/joss.12643.

Spence, C., 2017. Comfort food: a review. Int J Gastron Food Sci 9, 105–109. doi:10.1016/j.ijgfs.2017.07.001.

Stanszus, L.S., Frank, P., Geiger, S.M., 2019. Healthy eating and sustainable nutrition through mindfulness? Mixed method results of a controlled intervention study. Appetite 141, 104325. doi:10.1016/j.appet.2019.104325.

Surendran, S., Selvaraj, K., Turner, C., Addanki, S., Kannuri, N.K., Debbarma, A., Kadiyala, S., Kinra, S., Walls, H., 2020. Characterising the fruit and vegetable environment of peri-urban Hyderabad. India. Glob. Food Sec. 24, 100343. doi:10.1016/j.gfs.2019.100343.

Sutterlin, B., Siegrist, M., 2015. Simply adding the word "fruit" makes sugar healthier: the misleading effect of symbolic information on the perceived healthiness of food. Appetite 95, 252–261. doi:10.1016/j.appet.2015.07.011.

Tang, T., Wang, W., Croden, F., Vazirian, M., Hetherington, M.M., 2020. "Wrap healthy snacks with cool packaging" - a qualitative study of mothers' portion size strategies for their children. Appetite 147, 104537. doi:10.1016/j.appet.2019.104537.

Tessem, B., 2017. The customer effect in agile system development projects. A process tracing case study. Procedia Comput. Sci. 121, 244–251. doi:10.1016/j.procs.2017.11.034.

Thomas, E.L., Puig Ribera, A., Senye-Mir, A., Eves, F.F., 2016a. Health representations, perceived valence, and concept associations for symbols as food cues: a mixed-methods approach. Health Commun 31 (11), 1421–1425. doi:10.1080/10410236.2015.1077412.

Thomas, E.L., Puig Ribera, A., Senye-Mir, A., Eves, F.F., 2016b. Promoting healthy choices in workplace cafeterias: a qualitative study. J. Nutr. Educ. Behav. 48 (2), 138–145. doi:10.1016/j.jneb.2015.11.001.

Torrico, D.D., Hutchings, S.C., Ha, M., Bittner, E.P., Fuentes, S., Warner, R.D., Dunschea, F.K., 2018. Novel techniques to understand consumer responses towards food products: a review with a focus on meat. Meat Sci 144, 30–42. doi:10.1016/j.meatsci.2018.06.006.

Torrico, D.D., Tam, J., Fuentes, S., Viejo, C.G., Dunshea, F.R., 2020. Consumer rejection threshold, acceptability rates, physico-chemical properties, and shelf-life of strawberry flavored yogurts with reductions of sugar. J. Sci. Food Agri. 100, 3024–3035. doi:10.1002/jsfa.10333.

van Kesteren, R., Evans, A., 2020. Cooking without thinking: how understanding cooking as a practice can shed new light on inequalities in healthy eating. Appetite 147, 104503. doi:10.1016/j.appet.2019.104503.

van Ooijen, I., Fransen, M.L., Verlegh, P.W.J., Smit, E.G., 2017. Signalling product healthiness through symbolic package cues: effects of package shape and goal congruence on consumer behaviour. Appetite 109, 73–82. doi:10.1016/j.appet.2016.11.021.

van Rompay, T.J.L., Deterink, F., Fenko, A., 2016. Healthy package, healthy product? Effects of packaging design as a function of purchase setting. Food Qual and Prefer 53, 84–89. doi:10.1016/j.foodqual.2016.06.001.

Velardo, S., Drummond, M., 2018. Australian children's perceptions of discretionary foods. Appetite 120, 43–48. doi:10.1016/j.appet.2017.08.022.

Velema, E., Vyth, E.L., Steenhuis, I.H.M., 2019. I"ve worked so hard, I deserve a snack in the worksite cafeteria': a focus group study. Appetite 133, 297–304. doi:10.1016/j.appet.2018.11.027.

Verain, M.C.D., Sijtsema, S.J., Antonides, G., 2016. Consumer segmentation based on food-category attribute importance: the relation with healthiness and sustainability perceptions. Food Qual. Prefer 48, 99–106. doi:10.1016/j.foodqual.2015.08.012.

Weightman, C., Bauer, F.F., Terblanche, N.S., Valentin, D., Nieuwoudt, H.H., 2019. An exploratory study of urban South African consumers' perceptions of wine and wine consumption: focus on social, emotional, and functional factors. J. Wine Res. 30 (3), 1–25. doi:10.1080/09571264.2019.1652149.

Yarar, N., Orth, U.R., 2018. Consumer lay theories on healthy nutrition: a Q methodology application in Germany. Appetite 120, 145–157. doi:10.1016/j.appet.2017.08.026.

Younginer, N.A., Blake, C.E., Davison, K.K., Blaine, R.E., Ganter, C., Orloski, A., Fisher, J.O., 2016. What do you think of when I say the word 'snack'?" Towards a cohesive definition among low-income caregivers of preschool-age children. Appetite 98, 35–40. doi:10.1016/j.appet.2015.12.002.

Zandstra, E.H., Carvalho, Á.H.P., van Herpen, E., 2017. Effects of front-of-pack social norm messages on food choice and liking. Food Qual. Prefer 58, 85–93. doi:10.1016/j.foodqual.2017.01.007.

3. CHAPTER II
Contemporary Foods – Can They Become New Comfort Foods or Simply Mimic Them?

Highlights

- Satiety and health concern partially explained preferences from healthier to non-healthy foods;
- The familiarity either created or broke barriers in acceptance of new foods;
- Food deprivation increased comfort feeling about unhealthy foods;
- The artistic plating has great influence over ‘green’ comfort food;
- Cultural and taste barriers showed to be influential in the choices of contemporary and healthy foods.

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Contemporary foods – Can they become new comfort foods or simply mimic them?

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ABSTRACT

This paper aims to provide a broad view of how contemporary foods have altered the conception of comfort foods. Can 'green' foods be comfort foods? Moreover, are modern trends producing new comfort foods? To answer these questions, we conducted qualitative research which included semi-structured interviews with 20 Brazilian participants. It was shown that cultural predilections, health concerns, self-awareness, past experiences, familiarity, satiety, and taste may explain why comfort food preferences vary from healthy to unhealthy foods, and from traditional to modern foods. The psychological manifestation of comfort was shown to be more closely related to a sense of morality where healthier foods were concerned. A desire for novelty may explain a growing desire for contemporary foods as a way to escape a sense of routine or boredom in taste experiences. We suggest considering contemporary foods to be comfort foods mimics which elicit similar emotional effects in different contexts.

Background

Food trends are causing consumers to change their behavior to accommodate eco-conscious choices, and adapt to sustainability, health, and food waste reduction parameters (Nielsen, 2019; Mintel, 2019). This global trend is fed back by expectations and beliefs about health and wellness benefits of foods (Mai and Hoffmann, 2015), and will propel food and drink innovations worldwide in the years ahead (Aschemann-Witzel et al., 2019; Mintel, 2019; Román et al., 2017; Wendin et al., 2019).

Research has shown that our understanding of food is being reinvented, possibly in response to consumers' preferences and requests (Mintel, 2019; Sõukand et al., 2020). Indeed, consumers no longer look to eliminating certain foods from their diets, but instead aim to transform them. Take the "healthy food swaps" trend which includes transformations like rice-based pizza dough and jackfruit-infused smoothies (Mintel, 2019). Ertimur and Chen (2020) report that the speed with which each innovation enters into daily meals depends on its ability to be reinvented.

Recent food innovations have also reinvented traditional foods like fondue, paired unusual flavors and ingredients like smoked vanilla and caramel in ice cream, introduced natural/sustainable marine animals and plant ingredients, like jellyfish and seaweed, and exotic foods like cooked insects and pea sauces, provided alternative foods including vegan meat substitutes, presented unusual combinations like lavender with blackberry cake and flower juices, and promoted therapeutic and functional foods like butter with cannabidiol, organic yacon syrup, and hemp oil (ABIP, 2019; Bedin et al., 2018; Spence, 2017c).

In Brazil, traditional foods unfamiliar to Brazilian consumers, foods that are not consumed to a significant degree in the country, produced using new technologies, with new ingredients, derived from new sources and new substances, and presented in non-conventional ways (pills,

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tablets, and similar) are considered to be new or contemporary foods according to Regulation (BR) 1999/16 (ANVISA, 1999).

Contemporary foods often evolve out of ways chefs and food producers innovate with ingredients to attract customers (Frøst, 2010). Spence (2017a) affirms that modern chefs, molecular mixologists, culinary designers, food and beverage manufacturers look for ways to play with stimuli, whether it be the texture and weight of a food or its temperature and firmness. The goal is to trigger changes in our moods, emotions, and memories.

As Traylor (2019) states: "Just like in any art form, restaurant owners, chefs, and really anyone working in the foodservice industry should be keeping up with trends in the culinary world, because they are constantly shifting to reflect the needs of consumers." For Celi and Rudkin (2016), trends are "the seeds of tomorrow scattered in the overwhelming detail of the present. Following modern societal trends means going in a general direction where something is changing, developing, or veering toward, and drives adequate growth and continuous innovation." In a food context, the term "trend" applies to food fads and lifestyle or dietary choices.

Most of the foods that we eat today constitute a fusion of ingredients, flavors, components, recipes, styles, and/or food philosophies (Spence, 2018). The way food consumption influences mood and emotion has gained attention in both consumer and sensory research (Lagast et al., 2017). In the 1980s, the term 'comfort foods' was used to represent food preferences from childhood that in adulthood evoked pleasant memories. Currently, 'comfort food' refers to foods that provide consolation or a sense of well-being. They may offer a psychological appeal by stimulating positive emotions, such as nostalgia (e.g. childhood memories) (Spence, 2017a). From the physiological point of view, comfort food preference occurs when a palatable food is eaten (generally high-calorie, sugar, salt and fat foods) and trace amounts of mood-elevating opiates and serotonin are released (e.g. cookies, chocolate) (Stein, 2008).

Recently, Soffin and Batsell (2019) proposed a situational taxonomy of comfort foods that divides them into 5 categories based on emotional stimuli: Negative Emotion (stress, break-up, loneliness), Positive Emotion (celebration, cultural affiliation), Illness, Reward, and Remembrance. It remains unclear whether new food trends may lead to new comfort foods, i.e., if new, unusual, exotic, unfamiliar foods that are aligned with consumer requirements and desires may be able to comfort their psychological needs. Recently, authors have expanded the heterogeneous nature concept of comfort food to include 'green' comfort foods (Spence, 2017a), because sensory pleasure is not merely associated with enjoyment, although the rejection of novel foods in neophobic consumers has been associated to sensory characteristics (e.g. food odor) (Majid et al., 2017); it is also tied to non-sensory food characteristics (e.g. health issues) (Spence, 2017b). This is yet another way to justify the highly idiosyncratic preferences for comfort foods (Soffin and Batsell, 2019). For example, the nice smell of an environment (e.g. natural food stores) can arouse sensations of health and well-being which in turn enhances the purchasing and consumption experience as well as providing comfort. Thus, sensory and non-sensory characteristics of foods are used in combination to define the representations of comfort.

Can a bowl of salad be perceived as a reward for someone with a moral conscience? Are there differences among comfort ideals that can be explained by Brazilian consumer perceptions? Among reinvented foods (e.g. contemporary or traditional foods), why are unhealthy options more likely to be chosen over healthy foods? Although regular (healthy) eating and comfort eating are associated with well-being, there are emotional/affective associations linked to regular eating that do not necessarily infer comfort (Spence et al., 2017b). Moreover, new concepts that break with the traditional idea that the culmination of a pleasant meal involves unhealthy foods, are being developed to respond to such questions (Alija and Talens, 2012). This paper sets out to examine whether contemporary foods can become new comfort foods or simply mimic them.

Material and methods

This study is the result of a collaborative research project between the Federal University of Espírito Santo and the Federal University of Viçosa in Brazil. Twenty volunteers, between the ages of 24–61 (M = 42.5) were recruited in the city of Viçosa, Minas Gerais, Brazil. The participants' education levels ranged from 9th grade equivalent to post-doctoral candidates. The participants' racial make-up included 18 white and 2 multiracial volunteers. Apart from one low-income multiracial participant, all participants were at the established national middle-class level or above. The research was conducted according to guidelines defined by the Helsinki Declaration and all procedures involving human subjects were approved by the Committee on Ethics in Human Beings Research of the Federal University of Viçosa (n° 3.805.746). As part of the informed consent, the participants were told they had a right to withdraw from the study at any time and that their anonymity would be guaranteed. All names in the data have been carefully excluded to preserve their privacy.

Volunteers were recruited during home visits or interviews at another location after they had answered sociodemographic questionnaires. A sampling strategy was used to keep the group as diverse as possible. Eligibility was based on: (a) sociodemographic differences, (b) health concerns, (c) health and dietary needs, and (d) written, informed consent to participate in the study. Potential participants were first selected by telephone or in-person, then an interview was scheduled in an appropriate location. The informed consent was reviewed conjointly with each person. Once participants had agreed with the consent form, audio recording began. Data on participants in this study and the classification criteria for health concerns are shown in Supplementary Table 1.

Cognitive and emotional processes were examined using a semi-structured protocol that included open-ended questions and photo-elicitation, according to the procedures adopted by Lovell (2016) and Lecomte et al. (2019). The interview included questions about consumer beliefs (Supplementary Material Table 2), and photos of contemporary foods collected from social media, food trend websites, and Google Images®, using the keywords "food trends" and "contemporary foods" (Alden, 2019; Andrei and Comune, 2005; Bedin et al., 2018; Chuck-Hernández et al., 2016; FAO, 2017; Hwang et al., 2018; Karsch-Völk et al., 2014; Messias et al., 2015; Moré, 2019; Omar et al., 2012; Premoli et al., 2019; Spence, 2017b) (Supplementary Material Table 3). The 6.0 × 6.0 cm photographs were printed in color using a high-quality laser printer on A4 bond paper. Based on the premise that the development of new foods depends on how they are presented to the consumer, we believed photo-elicitation would be the most effective starting point for understanding the emotions associated with food trends both before and after they were presented in the survey.

All interviews lasted 40–60 min. Interview questions were based on previous studies that have focused on comfort foods and food trends (Soffin and Batsell, 2019; Spence, 2017b; Troisi et al., 2015). We adopted a qualitative approach of triangulating opinions from consumers (Van Kleef, Vingerhoeds, Vrijhof and van Trijp, 2016) prevenient of different locations of Brazil, with different motivations to consume contemporary foods. Verbatim interview transcripts, documentary evidence and field notes were used as supplementary materials to improve the quality of the findings. Documentary evidence consisted of relevant articles, websites, trend news (over the last two years), social media and videos (Comfortfood, 2020; Comfort Food Community, 2020; Mintel, 2019; Nielsen, 2019; Soffin, & Batsell; Spence, 2016; Spence, 2017b; Spence, 2017c; Spence et al., 2019; The Cooking Foodie, 2019). These sources were triangulated with the interview results to improve the accuracy of the findings (Lovell, 2016).

Three consumer science specialists used a traditional approach to analyze the original audio and video recording transcripts (Braun and Clarke, 2006; Greenwood et al., 2017). Open coding analysis was carried out individually in a silent environment and transcription was based on

an analysis of the twenty interviews to determine thought units, i.e., small sections of text representing a certain idea or concept. These then were used as analysis units (Lovell, 2016). Similarly to Lovell (2016) we also used theoretical sampling to add questions or probes to the semi-structured protocol for subsequent interviews, especially when gaps in the data or new areas of inquiry were observed. This procedure allowed us to compare different answers and analyze patterns from session results. Triangulation procedures between audio and video documentation were used and ultimately helped obtain emergent codes. Furthermore, each researcher conducted a thematic coding strategy to find/observe patterns in the data, grouping 'like' concepts as they related to each other and core themes generated (Greenwood et al., 2017). Following procedures by Brownbill et al. (2020), the final themes were developed for addressing the research question rather than their prevalence within the data, as is appropriate for a qualitative approach. Finally, researchers discussed results and proposed improvements in transcription and codes (Table 1). A professional translator revised the English and scientific writing. A definition of Brazilian foods has been provided in the supplementary materials.

Results and discussion

Food familiarity, personal memories and food choices

The first finding in our research was that food familiarity presents an advantage for unfamiliar products when they can be visually linked to well-accepted or preferred foods and past tasting experiences. Secondly, health concerns moderate the integration of a new food into a regular diet and can help make it acceptable (Goulart et al., 2020; Saldaña et al., 2021; Tuorila and Hartmann, 2020). Thirdly, unfamiliarity generates a need to reduce anxiety caused by suspicion of a new food. Because familiarization with a product consolidates expectations about sensory quality (Tuorila and Hartmann, 2020), our findings suggest that a similar overall appearance of a new food to a familiar product may serve as a stepping-stone for new food acceptance. In other words, consumer expectations can be guided when consumers do not yet know what to expect. Indeed, Nacef et al. (2019) were able to demonstrate that familiarity directs food choices based on beliefs about intrinsic attributes. One example would be the similarity between butter with cannabidiol and avocado. Conversely, the differences between lavender cleaner products and lavender-flavored food would be contrasted as they permeate beliefs towards odor. That said, it is not surprising that totally unfamiliar or uncommon foods have been related to negative reactions (e.g. texture of insects) and extrinsic judgments that include cultural experiences and personal memories (Myers and Pettigrew, 2018).

In keeping with these findings, the participants in this study with the greatest fear of trying new foods were those who had had bad past experiences and expressed disgust when it was suggested they could/should eat an ingredient/food again. Furthermore, food acceptance is meaningless or non-existent when a food has been forced on a participant (e.g. okra) or when he/she has had a bad experience with the way a food has been prepared (e.g. cod). Occasionally, a reasonable suggestion may alter expectations enough for a participant to reconsider a discomfort food (e.g. ideology motivation: "Give it a second chance"). In fact, Turiola and Hartmann (2020) affirmed that individual variations in disposition determine the responses to novelty and are able to dissolve old paradigms that have existed for generations.

"I began eating contemporary foods at around age 40. In general, an aversion to changes in my routine extended to new foods, but I wanted to test my palate. That changed my life quite dramatically. I was in a small restaurant and the Portuguese owner has prepared cod for us. I only ate it because everyone was eating it. I have never eaten anything as delicious that in my life. And then I realized that food preparation is essential to our food experiences. I was surprised, shocked, satisfied. I had broken through the food barrier because I had no idea that I would like something that I ordinarily dislike so much. And I thought about

Table 1
List of content codes in semi structured interview.

Emotional codes	Comments
Repulse	- "I do not eat anything with fennel. It feels like you are eating a cosmetic or a cleaning product. If it's healthy, but it makes me want to throw up (like lavender), I do not eat." (Woman, 24 y. o., HHC) [a]; "The lavender odor is gross. That is why I would not eat lavender cake." (Man, 26 y. o., high concern) - "(Ew!) The algae snack reminded me of Japanese food that I used to watch on the internet. I do not like it." (Woman, 24 y. o., HHC) - "I am disgusted when I see a fruit patch. Reminds me of pesticide, dye, preservative." (Woman, 24, y. o., HHC) - "If it is a cockroach, I feel sick, sick. If it is insects more dried (ant, grasshopper), I would take them because I am curious" (Woman, 24 y. o., HHC); "I do not think it is disgusting. I would eat larvae if it were properly prepared in a 'farofa' (typical Brazilian food made with cassava or maize flour), because I know that the amount of protein present in larvae is high." (Man, 26 y. o., MHC); "Gross! For the grasshopper, it's alright because it is not an animal that lives in the ground. The larva, on the contrary, reminds me of spoiled food, pig's food. There was a time in which I stopped eating rice because of the larvae shape." (Woman, 30 y. o., MHC); "Gross! I would not eat them (arachnids)! Because of the whitish secretion within their bodies. It reminds me cockroaches (laughs)." (Woman, 30 y. o., MHC); "Never! I would never eat larvae and grasshopper. It is not common for us. I know in India is common to eat these types of food, but I have a psychological rejection. […] But I will only eat larvae and flies if we have nothing else to eat in the world. Only if I were in a jungle, lost, in need of protein! I fell sick!" (Woman, 49 y. o., HHC); "I think people, in general, would assimilate it to spider, scorpion, and other animals that live in garbage. Would people accept this in Brazil? I think it is a challenge to convince consumers." (Man, 28 y. o., MHC); - "Repudiation. I have no interest because it reminds me marijuana. It is negative and toxic. It is not good for the body." (Woman, 49, y. o., HHC)
Agony/Fear	- "I don't eat many different foods because I'm afraid of getting sick." (Woman, 24 y. o., HHC); "Fear of disappointment, of regretting. I think: I'll risk on a food I don't know, then I'll have spent my money for nothing. This is bad. I prefer to buy what I already like." (Woman, 24 y. o., HHC) - "Maybe I should eat it because it looks like a potato, not a jellyfish. The sensation is of agony because jellyfish burns and it is the same sensation of eating the entire arachnid." (Woman, 24 y. o., HHC); "Eating arachnids reminds me of something dangerous, that makes me very scared." (Woman, 24 y. o., HHC); "It is not about being hygienic or not (grasshopper), but the texture of the chitin backbone gives me chills. The crashed insect meal would not be a problem because I cannot see the insect." (Woman, 24 y. o., high concern with health); "Disgust, repudiation, fear. It looks like you are deprived of everything you could eat. They are animals that we want to kill, stay away from, and eating insects is strange (insects)." (Woman, 27 y. o., HHC); "God forbids! Never! It scares me!" (Woman, 49, y. o., HHC); "Dear God! I do not want that (insects)." (Woman, 61 y. o., MHC) - "I would be afraid to consume it (butter with cannabidiol-hallucinogenic), but provided information on their health benefits relaxes me." (Woman, 24 y. o., HHC) [a] - "Nuisance. I'm afraid to try a very blue juice, it seems artificial." (Woman, 38, y. o., LHC)
Feeling bad/ sadness	- "When I am sad, I eat raw food, raw sausage. It is to externalize my moment of sadness. I am so sad or disappointed with someone that I do not have the strength to prepare something to eat. When I'm happy, I make spicy food with parsley to make the dish beautiful." (Woman, 30 y. o., MHC) - "If the world is ending, then you eat a 'coxinha' and it is like "Okay, everything is alright. Eating 'coxinha' gives me a warm heart feeling." (Woman, 30 y. o., MHC) - "I don't eat it even by force. It disgusts me because the pitaya reminds me of gelatin. I never liked this since childhood (gelatin). I was forced to eat it, I was scared (of gelatin). Yesterday, in an official launch of a new store, it had pitaya. Wow, I felt something bad right away (after information: I would

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Table 1 (*continued*)

Emotional codes	Comments
	make the sacrifice to eat it due to their health benefits) (Woman, 33 y. o., HHC). - "I feel uneasy, I feel a little pain, because if I arrive at the supermarket there is chocolate, cake, cookies, all I cannot eat because of dumping syndrome. I feel that if I eat them, I will be sick because they are not sugar-free." (Woman, 49 y. o., HHC)
Anxiety/bored	- "Once I went for a test. I was anxious, nervous. My mother-in-law made a chocolate ice cream pudding, called cassata. It's a candy that I love. I ate and felt happiness, pleasure. I remember the dessert more than the test." (Woman, 24, y. o., HHC) - "Since I have a lot of PMT (pre-menstrual tension) and anxiety, I cry a lot, get sad, and very angry. I eat ice cream, chocolates, candy […] it is like a compensation for these feelings. I feel the sweetness will soothe me. I feel like eating chocolate nonstop." (Woman, 24, y. o., HHC) - "I found it interesting because I suffer from anxiety and nervousness. Knowing that there are foods that can calm me down, and that those are foods that I like, I would eat them. It depends on the taste though. Even if it is relaxing, lavender no!" (Man, 24 y. o., MHC)[a] - "In a boredom situation, I need to chew something. […] And I'm happy I found something to eat. Usually it's peanuts, chocolate." (Man, 29, y. o., MHC)
Guilt	- "Sometimes I overeat when I'm nervous, anxious. Then comes the thought: Why did I eat so much? I will get fat and my problems will not pass." (Woman, 24, y. o., HHC) - "I ate healthy and it was tasty. Then I thought: I ate without guilt that day." (Woman, 30 y. o., MHC) - "I had not eaten stuffed potatoes for a long time and it is something I like. It was very good, I was with my friends, I ate without guilt." (Woman, 25, y. o., MHC) - "Yesterday I was worried about a presentation and ate six cheese rolls. First, I feel pleasure, how delicious I forgot the problem. Then comes the worry: wow, cheese bread put on weight and I ate carbohydrate before going to sleep. I need to burn it. Then I go for a run. Regret and worry about my cholesterol. I shouldn't have done that. It is a self-judgment." (Woman, 48 y. o., HHC) - "I like meat. Ecologically speaking it is not correct. My son says: Mother, poor animal. It messes with me, I feel guilty. I think: Wow, he's more aware than me." (Woman, 38, y. o., LHC) - "Wow! I could have eaten less. Barbecue makes me sick. I regret. I think: unnecessary." (Woman, 24, y. o., HHC)
Unpleasure	- "It depends on the common and unusual ingredient that is added. I would eat any food that has no ingredient that displeases me." (Woman, 24, y. o., HHC) - "Being inside the box already reminds me of something that is not vegetable, but industrialized. But meat is not plant-based. I feel disappointed, sad." (Woman, 24, y. o., HHC); "It would be like eating lettuce (vegetable meat). Not funny, because I don't think it would taste like meat." (Woman, 25, y. o., MHC); "I have already eaten it (vegetable meat). I feel indifferent. It is less pleasant than animal meat." (Man, 29 y. o., MHC); - "I feel cheated. This is because I think this product (vegetable meat) will not provide the same flavor and texture as animal meat." (Woman, 38, y. o., LHC) - "Plant juice looks like water with a dye. It reminds me of ornamental plants and something with no taste (indifference)." (Woman, 24 y. o., HHC) - "The texture would not please me (insects and arachnids' stick, grasshopper). In Brazil, it is not common to eat this kind of stuff. I would say no, if needed to." (Man, 24 y. o., MHC) - "The odor is the main one (cannabidiol). It reminds me bad memories." (Man, 29 y. o., MHC) [a] - "I think if I had eaten sweet stuff in childhood, I would probably relate these foods with pleasure. But I don't like sweets very much." (Man, 26 y. o., MHC) - "Eating arachnid bark is useless. It is like eating a leaf (texture). It doesn't look like food. Despite the amount of protein, it is useless. Why does eating it?" (Man, 26 y. o., MHC); "[…] It is a weird feeling when it comes to eat a grasshopper because it could cut my gingiva. However, I would not have problems at eating insect flour, since it was produced under Good Manufacturing Practices (GMP)." (Man, 28 y. o., MHC)

Table 1 (*continued*)

Emotional codes	Comments
	- "Feeling of impurity (Echinacea and liquorice ice cream). We think of ice cream in a soft, clear, white color." (Man, 28 y. o., MHC) - "Fat and sugar bring good sensations momentarily. To be as good as unhealthy, the healthy food would need to have more flavor. Having no taste is horrible, I feel bad. To change a hamburger for a plate of salad is a bad feeling, a frustration, because I am looking for something that gives me pleasure. Perhaps a well-seasoned salad would help to change that. Need to improve flavor, texture. Packages with teddy bear and colors also particularly appeal to me." (Woman, 32 y. o., HHC) - "I don't like the mixture of sweet and salty, the taste is strange. It seems like serum. It's like putting fruit in salty food. I don't like it. (Man, 34 y. o., HHC); "Weird! This does not make me happy. For me, bacon (salty) is not dessert." (Woman, 24 y. o., HHC); "is like eating a salty food with fruits. I do not like to mix sweet and salty foods. You think it is something salty (an egg, for instance) and, suddenly, it is a banana mixed in the food. It seems bad." (Man, 28 y. o., MHC) [a] - "I do not know if I would associate this variety (butterfly pea) to the fact that peas are salty. I think it is weird to have a salty juice." (Man, 24 y. o., MHC). - "If I don't "eat with the eyes (pleasure) […] I eat thinking: this could end soon! Leaves, raw foods, are also foods that do not make me happy. I eat it just because I have to." (Woman, 38, y. o., LHC) - "I do not have the courage to eat Japanese food (unpleasure), I prefer something more traditional. I prefer pizza, hamburger. I think it's because of my creation." (Woman, 38 y. o., LHC)
Skepticism	- "I am completely against it. I feel sick! Meat is from animals not from vegetables. It is not like animal protein." (Man, 24 y. o., MHC) - "It is possible to do something that is tasty and healthy, but we usually do not have this culture. It is usually either healthy or tasty." (Woman, 25, y. o., MHC) - "I do not believe they have food that have influence mood. I have never seen anyone who has had any benefit in mood while eating food." (Woman, 27 y. o., HHC) [a]
Neutral	- "We eat to make up for all the money spent. I pass the limit, but I don't know if I regret it, because I already got there thinking about eating a lot." (Woman, 24, y. o., HHC) - "I don't know if I regret it, because it was a day that I went out to eat. I wanted to eat. For example, on Valentine's Day I ate a lot of." (Woman, 24, y. o., HHC) - "It was distressing to eat the egg pure (past experience). I felt a taste like baking soda. But egg has protein, which is more important to me. Psychologically I feel nothing bad anymore." (Man, 26 y. o., MHC)
Arousal	- "It's a kind of celebration (eating chocolate): I'm on vacation!" (Woman, 24, y. o., HHC) - "I think I would go crazy!" (butter with cannabidiol) (man, 24 y. o., MHC) - "The intense red color attracts my desire to prove it, also it reminds me of sweetness (dragon fruit beer)." (Woman, 24 y. o., HHC). - "It sharps my appetite only by looking at it. For being rare (ruby chocolate)." (Woman, 24 y. o., HHC); "The ruby chocolate color drew my curiosity. Willingness to taste it." (Man, 28 y. o., MHC) - "On one trip I went to eat raw fish. I saw the fish and thought: Our Lady, today my day has improved. "I turned the key." I like raw fish very much and rarely eat." (Man, 26 y. o., MHC) - "The exotic appearance arouses desire ('ruby' chocolate)." (Man, 28 y. o., MHC) - "What a pleasant surprise, I did not expect it! It is a normal (familiar) and healthy chocolate muffin (chocolate muffin made with larvae flour covered with grasshopper." (Man, 28 years old (y.o.), MHC). - "Maybe in a day that I am more animated, more excited, I will be more motivated to buy a different food." (Man, 29 y. o., MHC) - "I am curious about new sensations. Fullness of good feelings for eating this new flavor. I think: if I repeat, I will taste it again." (Woman, 30 y. o., MHC). - "I feel ecstasy, disposition, happy because I feel that I am eating properly (peanut butter, whole granola, almond flour, natural red or yellow fruits yogurt)." (Woman, 48, y. o., HHC)

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Table 1 (*continued*)

Emotional codes	Comments
Feeling good	- "Especially if I have access to those beautiful, colorful salads. This greatly influences my mood. Awakens desire. I think it is beautiful. I will eat again." (Woman, 49 y. o., HHC) - "Wow! I would immediately consume it after the weight loss information, because Woman always think they are fat!"; "Wow! What an interesting thing … I would taste it because it looks like ginger (jellyfish snack)!" (Woman, 49 y. o., HHC)[a] - "Cool! I would love it (mood food)! Because it reminds me of childhood (Echinacea and liquorice ice cream). It is such a delicious time that we only value when we are adults. The delicious nostalgia of remembering childhood, climbing on the 'jabuticaba' tree. When we had no adult troubles/issues. Now, I would like to eat all these foods!" (Woman, 49, y. o., HHC)[a] - "I have already ordered salad in a restaurant while my friends ate pizza. It felt good. I did not want to eat fat." (Woman, 24, y. o., HHC) - "I feel joy eating something I like (favorite food). Obviously if it is healthy, I will not feel guilty." (Woman, 24 y. o., HHC) - "Knowing that someone has had a positive experience with that food (new food) gives me confidence. Security in buying." (Woman, 24, y. o., HHC) - "Maybe the unhealthy has more flavor. And the feeling of eating something tasty is one of happiness." (Woman, 24, y. o., HHC) - "If I am very happy, I will eat meat. It brings me to the celebration." (Woman, 24, y. o., HHC) - "When I achieve goals, have a mission accomplished, I give myself the gift of eating well. I once went to a friend's coffee shop that makes delicious things. I thought: Today I deserve to go there and spend my money on delicious (sweet) things." (Woman, 24, y. o., HHC) - "If it wasn't just a traditional lettuce salad with olive oil, but a pretty one, with varieties, I'd trade the unhealthy for the healthy." (Woman, 24, y. o., HHC) - "Previously, my perception was of people in the woods, who go to the park to meditate or listen to psychedelic music. Now, I imagine an old man who eats butter with cannabidiol because it is good for him." (Man, 26 y. o., MHC)[a] - "Cannabidiol got me scared because I associated it to drugs and narcotics. However, the possibilities of health benefits changed my concept." (Man, 28 y. o., MHC) [a] - "It seems good because I also like ice cream and bacon." (Man, 29 y. o., MHC). - "I like novelty. The curiosity to try, to know a new food, to feel the new." (Woman, 30 y. o., MHC) - "Wonderful, I have eaten it already! Bacon cannoli! It is a perfect match/wedding! (Woman, 30 y. o., MHC). - "Feeling of fresh food, well-being, colors awaken the feeling of healthy (flower juice)." (Woman, 32, HHC) - "I changed my mind about eating jellyfish, due to their benefits for cancer, and the collagen is beneficial for appearance. Because I am concerned about my body and the aging (Woman, 49 y. o., HHC)[a] - "I feel wonderfully good (from eating healthy). I have no more sleep after lunch, I have more physical disposition, I lost weight." (Woman, 49 y. o., HHC)
Pleasure/liking	- "I buy (new food) if anyone has tried it. If she says it's good (tasty), I get curious and buy."; "I was offered an apricot cookie with orange. I was curious and agreed to try it. But I did not like it. I thought, Thank God I didn't buy it. Relief." (Woman, 24, y. o., HHC) - "It gives you more pleasure to eat unhealthy foods than healthy ones. It may be because of taste, but it may also be what we are not in the habit of eating every day. For example, I eat rice and beans every day. So, I don't think, Wow! What a desire to eat rice and beans". Similarly, if I eat cheese bread, hamburger and pizza every day, I would not feel the pleasure of deprivation I feel. I think it's like having only Saturday and Sunday to rest and Monday to Friday to work. So, we like Saturday and Sunday better." (Woman, 24, y. o., HHC) - "Nowadays, we are seeing a "goumertization" of healthy foods, they are getting more beautiful. Then it makes me want to experiment. For example, I wouldn't eat fruit in salad before. I thought it was weird. Then social networks were transmitting healthy recipes that attracted the palate. They influenced me a lot to have this behavior." (Woman, 24, y. o., HHC) - "I would not stop eating a fat meat that I like just for being unhealthy. It would reduce my consumption, but I would not stop eating." (Woman, 24, y. o., HHC) - "Usually exotic foods are more expensive. It will have to be tasty. For example, bitter leaves that people often dislike can be inserted into beans, as seasoning. This may not cause the same rejection that leaves have when consumed pure." (Man, 24 y. o., MHC) - "It was dark chocolate with orange (candy bar). And the reason I bought it was the possibility of exceeding expectations. That is why you buy the unusual. It felt great after eating it." (Man, 24, y. o., MHC) - "I think taste is a factor that differentiates a lot healthy from unhealthy. The sugar in unhealthy foods causes a taste addiction, just like cocaine. A dependency. It is a pleasure and a joy that makes you want to repeat it." (Woman, 25, y. o., MHC) - "I don't know if I would be willing to choose between the one, I like and the healthiest." (Woman, 25, y. o., MHC) - "I'd trade pizza for salad if it was as yummy and satiating. Because salad is more nutritious." (Woman, 25, y. o., MHC) - "If new foods give off the same sense of pleasure and taste that unhealthy ones promote, I think they may become just as favorite." (Woman, 25, y. o., MHC) - "I would trade a protein 'brigadeiro' (Brazilian candy) for a traditional brigadeiro for its nutritional benefits. As long as the taste was similar." (Woman, 27, y. o., HHC) - "It would be good (dragon fruit beer) because the dragon fruit is tasteful. It draws my curiosity." (Man, 29 y. o., MHC) - "It is the warmth. You know you get fat, that it is more caloric. But it's tastier." (Woman, 30 y. o., MHC) - "This looks like a fig jam (echinacea and licorice ice cream). This makes it easy a good impression, because it is a food that I like." (Woman, 32, y. o., HHC) - "I would eat it because it is fried or cooked. It does not bother me because I like meatballs." (Woman, 38, y. o., LHC) - "Pizza is something I like. So, putting different ingredients on pizza doesn't affect me." (Woman, 38 y. o., LHC) - "Not so long ago no one bothered to eat granola-like things in yogurt or fruit salad. But it's been so widespread that it doesn't lose in taste. You get a lot of fiber, healthy, spread in a positive way." (Woman, 48 y. o., HHC) - "Maybe it seems cool (ruby chocolate)! I would taste it, since I once ate a chocolate (candy) with salt flower (salty) and liked it." (Woman, 49 y. o., HHC).
Relaxed/Calm	- "(Laughter) I would definitely want to because I believe it brings calmness (marijuana)." (Woman, 24, y. o., HHC)[a] - "Wow, I need many of these foods. They make me calm. If there is a bathroom odor, it is not possible, but due to the calming effect I want to consume!"; "I have concerns about the skin. Then, I believe that a jellyfish with collagen would be a medicine." (Woman, 24 y. o., MHC)[a] "I would have less resistance by eating it, because it woke me up with something preventive (jellyfish snack)." (Man, 29 y. o., MHC); "I feel calm. I already ate squid and this looks like ginger." (Woman, 30, y. o., MHC)[a] - "I have concerns about the skin. Then, I believe that a jellyfish with collagen would be a medicine." (Woman, 24 y. o., MHC)[a] - "I would make a sacrifice to eat jellyfish due to collagen and health. On learning about their health benefits, I think jellyfish could be my friend and will not burn me." (Woman, 32, y. o., HHC)[a] - "I feel fulfilled. Wow, I care about myself because I'm eating healthy. It is a care with myself. I feel calm." (Woman, 48 y. o., HHC) - "I feel wonderfully good (from eating healthy). I have no more sleep after lunch, I have more physical disposition, I lost weight." (Woman, 49 y. o., HHC)
Comfort	- "When I am very stressed, I usually look for sweeter foods. Ice cream, chocolates. They bring me tranquility." (Woman, 24, y. o., HHC) - "I think that the hot food is more comfortable, my body feels more pleasure from hot food than from ice cream. White, blue and green give me the feeling of coldness as well. If I am - seeking pleasure, then this coldness is negative." (Man, 26 y. o., MHC)

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Table 1 (*continued*)

Emotional codes	Comments
	- "I think pitaya beer will be consumed because of the alcohol and not because of pitaya, just like in the case of cannabidiol butter. […] the effect on mood." (Man, 28 y. o., MHC) [a] - "I would feel comfortable knowing that it is beneficial to health (mood food)." (Man, 29 y. o., MHC) [a] - "Frying brings me to a good thing. You are used to it. It is psychological. A Cozy feeling." (Woman, 38, y. o., LHC) - "Having spent this time outside my country and culture very recently, whenever I had opportunities to find genuine food (traditional food) of our own, I ate with all that good feeling tied to the memories of my food. Emotional comforts of remembering home." (Man, 28 y. o., MHC) - "When you are tired and eat a different (non-routine) food, you forget tiredness, come home quietly to sleep and rest. It is a physical comfort. You get out of the bean and rice routine." (Woman, 38, y. o., LHC)

[a] Photo-elicitation with information (PEI). HHC: High Health Concern; MHC: Moderated Health Concern; LHC: Low Health Concern.@

why I don't like fish. I figured the way I ate fish at meals had been displeasing me. Then, my palate changed. I have built up such a tolerance to the bitterness of beer and 'jiló'. I also discovered I didn't like okra because my father forced me to eat it. It was a war between us at home. I later realized that, actually I didn't like okra slime." (Male, 48, lower health concern).

Examining contemporary foods, unfamiliar foods, and food trends have sown the challenges that exist when disassociating preconceptions that are already culturally formed and turning exotic foods like edible insects into comfort foods. Although positive food characteristics are associated with good feelings, it remains difficult to evolve from a feeling of curiosity to a sense of comfort, because "we are used to eating foods from our culture." In Brazil, pizza and hamburgers are common comfort foods because they are often enjoyed in restaurants.

When disgust is present along with food neophobia and related sensations, the barrier to new food and alternative food acceptance is even higher (Tuorila and Hartmann, 2020). For example, it is difficult to separate a jellyfish from its sting, a cockroach from the disgust and fear it arouses, or the scent of lavender from cleaning product fragrances. Yet, some food perceptions follow an opposite trajectory and may indirectly stimulate the development of new comfort foods for certain consumers. Take for example this statement: "People will consume cannabidiol but not butter (butter with cannabidiol - relaxation effect). And, Brazilians always want to taste everything that is forbidden" (Male, 28., high health concerns). This is one nuance to the 'feel-good' effect of a comfort food where the mood effect of cannabidiol (CBD) alters a consumer's perception of it.

According to Myronenko (2020), CBD is commonly associated with hallucinogenic effects, reducing anxiety and calming properties. The concern is that consumption of CBD may become a panacea as industries take full advantage of this opportunity to produce so-called "healthy" foods, even though the effects of food and beverages that contain CBD are disputed. For example, CBD goes well with popular foods, such as tea, brownies, and foods with stronger, earthy flavors, such as chocolate and coffee (BBC, 2020), but if CBD consumption surpasses the scientific evidence about its true psychological effects? It is known that the beliefs and social representations on positive effects on health and environment strongly affect the expectations and intention of eating novel foods and persuasive information on certain foods or ingredients could be led to unconscious decisions (Bäckström et al., 2003; Menozzi et al., 2017). Doungtip et al. (2019) noted that older consumers (40+) showed a greater willingness to purchase products with pungent aromas and bitter tastes than their younger counterparts when the health benefits the pungent and bitter foods provided aligned with their health expectations. Dial and Musher-Eizenman (2019) showed that children were more likely in willing to try novel packaged foods, and indicated that the foods were "yummy" more often than other types of novel foods, and the willingness to try a novel food was higher if claimed that it "makes them strong".

It is important to remember that social criteria, such as habits, culture, and neophobia, remain a hurdle to consuming new foods, especially among the elderly (Castro and Chambers, 2019; Myers and Pettigrew, 2018). Puhakka, Valve, and Sinkkonen (2017) determined that older consumers were less likely to choose processed, convenience, and unfamiliar foods that they see as non-traditional, untrustworthy, or unnatural. However, they also pointed out the older consumers market is not homogeneous and is made up of health-conscious consumers, cautious consumers, critical consumers and natural health-oriented consumers. Myers and Pettigrew (2018) perceived that elderly consumers reflected low levels of awareness of the environmental and nutritional advantages of entomophagy practices (e.g. beliefs towards nutritional value of insects), and preferred to consume more conventional products than the processed foods with increased protein content.

Although "strange" foods and meals go against the grain of traditional western culture, they may gain appreciation and be perceived under a new look. We also believe that the quest for high-protein foods, the excessive consumption of food supplements, and a boom in healthy, eco-friendly food production practices and sustainability issues have paved the way for entomophagy, i.e., the consumption of edible insects (Spence, 2017a). Menozzi et al. (2017) perceived that attitude and intention improved after tasting the insect-based food product. In this sense, the digital revolution and growing awareness of eco-conscious practices are also driving a desire to reduce food waste and place value on different, sustainable and healthy options.

Comfort foods x health consciousness

In our qualitative research, we found different definitions of what constitutes comfort foods. Health concerns and personal origins (place of birth) were both shown to be relevant extrinsic sources of influence. While consumers with low to moderate health concerns tended to associate pasta, candies and lasagna with pleasure, those who were very concerned about health issues reported rice, beans, fruits and vegetables as their preferred foods, linking the feelings these foods evoke to happiness, joy, pleasure and satiety. On the other hand, candies, pasta, 'rice and beans' and pizza were cited by the interviewees as comfort foods, often assigning them cultural significance.

The participant responses in the present study confirm findings from previous studies on comfort food scenarios (Soffin and Batsell Jr., 2019; Spence, 2017b) (Table 1). Consumers associated certain foods with past experiences involving unhealthy foods (e.g. high-calorie foods), which turned out to be key to understanding the relationship of their food experiences to comfort foods. For example, rational decisions based on healthy eating lead to comfort foods choices with health or mental health benefits:

> "I'm fine because I am eating healthy." In other words, I am fine because I eat foods that have health benefits, help me stay in shape, and promote good health. It is worth noting that there was an opposite effect on the psychological experience of comfort which we defined as 'self-sabotage.' In the words of one participant: "For instance, people who lose control of supplement consumption and other foods linked to physical performance. Over-consumption of these foods is like tricking yourself: I can eat this because it's healthy so I'm not doing so much harm."

Because the concept of "healthy food" is ubiquitous, ambivalent and polysemic in diverse scientific areas (Gaspar et al., 2020), the understanding of 'health benefits' term remains transcendental. Brazilian consumers determine a food to be healthy according to their social, cultural, symbolic and moral status. Consumption of healthy foods that instill impressions of security and physical and moral well-being may

also explain why it is no longer hard to envisage the advent of "green comfort foods", mainly represented by cruciferous vegetables that taste bitter (Maiz et al., 2019). And De Toffoli et al. (2019) remind us that "a food that is initially disliked may become a familiar and potentially preferred product." According to the interviews we conducted, consuming healthy foods leads to a satiety effect that expresses itself in a physical comfort of "intense lightness". Self-care therefore leads to psychological comfort. 'Tranquility', 'well-being', 'a clear conscience', 'happiness' and 'self-respect' were the terms used most often to explain the sensation. These factors encourage participants to favor cruciferous vegetables over other comfort foods, especially if they are presented in an attractive manner.

> "Unhealthy foods satisfy you faster. But when you eat something light you have a feeling of calm, it's a good thing. I feel satisfied, happy about that (a salad). Especially if it is a beautiful salad, colorful, with lettuce, tomatoes, and mangoes that is a feast for the eyes. It has to be a good salad." (Female, 49, moderate health concern).

> "I love salads, I like salads more than hamburgers. I feel a lot of joy when I eat a salad. When I go to the supermarket, I love the smell of greens" (Female, 53, high health concern).

> "Salad tastes pretty good to me. It tastes fresh and healthy. If I have to choose between a salad or snack food, I prefer salad. To me, it is tastier. But 'feijoada' is better than salad. I cannot resist 'feijoada', I eat it compulsively." (Female, 36, high health concern).

Health food popularity continues to surge and consumers are increasingly yearning for new food experiences. These trends are dependent on lifestyle and background. To paraphrase Dr. Carlos Antunes dos Santos, "Feeding is a nutritional act, but eating is a social one". The 'indulge myself' choice expressed by four participants when talking about eating a hamburger represents a state of momentary psychological comfort causes by a psychological impulse (loneliness, stress, anxiety, celebration, or reward), that is quickly succeeded by negative feelings (e.g. fault, repentance, a sensation of heaviness). Generally speaking, this demonstrates a sense of comfort in special event contexts such as a party or celebration. From a qualitative Brazilian perspective, a state of comfort is dependent on the day of the week and/or the occasion (e.g. a desire for healthiness generated by having eating unhealthy food which results in a sense of well-being generated by having eaten healthy during the week).

Participants who were less concerned with health issues noted that health foods have a lack of satiety that makes it difficult for them to associate healthy foods with recreation, commemorative or comfort situations. In evaluating participants' perceptions, this study corroborates Fiszman et al. (2014) by showing that the participants associated "satiating" food more with an immediate sensation of a "full stomach" than to a sensation of satisfying hunger. Heavier foods like carbohydrates and protein-based meals including meat, pizza, and pasta were associated with copious meal choices that made participants feel full immediately, and potentially "fill" or "swell" the stomach to induce negative sensations feelings such as. Stomach discomfort, and a desire for repentance. Overall, a sense of pleasure was most often attributed to unhealthy foods. Food deprivation prior to eating also appears to increase the comfort element.

> - "I tried not to put rice, just salad and a grilled steak on the plate. I was still very hungry. I got angry." (Female, 27, high health concern)

Piqueras-Fiszman (2019) reports that recent dining experiences can influence subsequent satiation expectations. When it comes to new foods, associations between the food's sensory properties and its ability to bring about satiety are common. In general, a lower satiety will be assumed when a food is unfamiliar until a subject learns differently through experience and can modify or reconsider prior satiety expectations (Piqueras-Fiszman, 2019). According to previous studies, cognitive and sensory factors such as satiety expectations based on previous experience and salad size may influence satiety perception (Fiszman et al., 2014; Roe et al., 2012). This is directly related to oro-sensory exposure (Morell et al., 2014). Oral processing is determined by textural changes in similar foods. In one study, consumption of barley breads made with the same ingredients, same composition, and same caloric content led to different experiences of satiety (i.e. a physical feeling of fullness that allows us to stop eating for a while) and satiation (i.e. the end of desire to eat after a meal), although the samples were equally liked by participants (Nguyen et al., 2017). In the same vein, Yeomans and Boakes (2016) showed that it is possible to use satiety-associated odor cues to manipulate consumer satiety expectations. The process is separate from expressed like or dislike for a certain food. We would suggest that similar cues strategy may change satiety perceptions for healthy foods including salads and light options, and may even lead to a sense of comfort.

Spence (2017a) also states that enhancing sensory impressions likely leads to improved flavor perception and improves feelings of satiety. The heavier or fuller the bowl of salad, the greater the sense of satiety. This behavior is related to "Affective ventriloquism" concept, which occurs when a product's quality and desirability are affected by other sensory cues. These cues come from sensory hedonic attributes, such as touch, which then affect a subject's overall (multisensory) product experience. The author puts forth the argument that consumers transfer an affective response generated by the way a product feels when they touch it to their ultimate assessment of a food (Spence and Gallace, 2011). Thus, these and other tricks of the mind may be used as innovative methods for turning 'green' food experiences into established 'green' comfort foods. Future consumers may experience positive emotions associated with healthy foods and perhaps even begin to crave them as comfort foods.

Future prospects and conclusions

The research presented here supports the existence of 'mood foods' that produce psychological comfort. Information on the emotional effects of contemporary foods elicited a desire to consume them based on the emotional benefits of their calming and/or soothing effects. One way to turn trend foods into comfort foods is to associate familiar foods and unfamiliar foods in a consumer's mind, like combining echinacea with licorice to make ice cream (unfamiliar), tying this to the color of jaboticaba or açaí (familiar) and invoking a fond memory (childhood tradition - climbing a jaboticaba tree). Social context and individual food preferences have an impact on how food relates to mood (Spence, 2017b). However, finding a way to put green comfort foods and "unhealthy" comfort foods (e.g. high in sugar, fats, salt and calorie foods) on equal footing will not be an easy task because it requires overcoming cultural and sensory barriers established in the minds of many consumers (De Toffoli et al., 2019):

> "For me, it is not possible to replace unhealthy food with healthy food in any situation, because the tastes are drastically different" (Male, 28, moderated health concern).

Puhakka et al. (2017) point out that radical food innovations must be communicated and advertised before a new product enters the market. A product's sensory properties must also be taken into account to ensure consumer acceptance. Spence (2017a) showed the importance of selling the "experience" for many contemporary trends in the world of high-end dining and drinking. Cotton candy laced with Thai vegetables, herbs, spices, sprouts, nuts, and a dark brown tamarind sauce can change consumer perceptions based on taste while also evoking childhood memories of joy in an amusement park (Spence et al., 2019). In order to develop safe, exotic, healthy foods, marketers should show a greater interest in foods that benefit heart health and digestion (Troisi et al.,

2015).

Cultural preconceptions, health concerns, self-awareness, past experiences, familiarity, satiety, and taste have been shown to influence consumers preferences for healthy vs. unhealthy foods and for traditional vs. contemporary foods. The psychological manifestation of comfort was shown to be more closely related to a sense of morality in the consumption of healthier foods and a desire for novelty may explain why a desire for contemporary foods kicks into high gear as a way to escape a sense of routine or boredom in taste experiences.

Although our research did not examine food tastes or the emotional associations based on experience, pre-established perceptions based on sensory experiences (e.g. consuming smoked vanilla bean ice cream with candied bacon and caramel) allowed participants to link them to social representations and emotional sensations (eating ice cream on an unforgettable trip to Italy) rather than a physiological experience. Based on these findings and those from Spence et al. (2017b), it can be concluded that the comfort food consumption really does provide a measurable psychological benefit depending on context.

Information related to protein content and the importance of food supply and waste were not sufficient to stimulate a desire to consume insect or arachnid foods, although the information did attenuate the disgust factor. Neither curiosity nor physiological and sustainable needs could overcome the sensory and psychological comfort required to make these foods acceptable because hygienic and cultural beliefs and feelings of fear and disgust are difficult to alter.

We have determined in this study that, although a moral sense of comfort may be experienced through curiosity, mood, and emotion for new and healthy foods, these cannot be categorized as comfort foods. These foods are not consumed in the same context as comfort foods. So, we suggest considering them to be comfort foods mimics which elicit similar emotional effects in different contexts. Perhaps in the not too distant future, healthful and upscale versions of comfort foods become popular, and taboos are steadily being broken and make food experiences most thrilling.

Author contributions

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Appendix A. Supplementary data

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References

Alden, A., 2019. Smoked vanilla bean ice cream. Available at: https://www.napoleon.com/en/uk/barbecues/smoked-vanilla-bean-ice-cream. (Accessed 13 June 2019).
Alija, J., Talens, C., 2012. New concept of desserts with no added sugar. International Journal of Gastronomy and Food Science 1 (2), 116–122.
Andrei, P., Comune, A.P.D., 2005. Aromatherapy and its applications. *CADERNOS*, Centro Universitário S. Camilo, São Paulo 11 (4), 57–68.
ANVISA (Agência Nacional de Vigilância Sanitária), 1999. Ministério da Saúde. (BR) 1999/16 of 30 April 1999 establishing the technical regulation of procedures for registration of new foods and/or new ingredients. Diario Oficial Uniao 1 (11), 1–3.
Aschemann-Witzel, J., Ares, G., Thøgersen, J., Monteleone, E., 2019. A sense of sustainability? – how sensory consumer science can contribute to sustainable development of the food sector. Trends Food Sci. Technol. 90, 180–186.
Associação Brasileira da Indústria de Panificação e Confeitaria (ABIP), 2019. Tendências de alimentação para 2019. Available at: http://www.abip.org.br/site/tendencias-de-alimentacao-para-2019. (Accessed 13 June 2019).
Bäckström, A., Pirttilä-Backman, A.-M., Tuorila, H., 2003. Dimensions of novelty: a social representation approach to new foods. Appetite 40 (3), 299–307.
BBC, 2020. Why are people eating CBD and will it get me high? Available at: https://www.bbc.co.uk/food/articles/cbd_in_food. (Accessed 31 August 2020).
Bedin, E., Torricelli, C., Gigliano, S., De Leo, R., Pulvirenti, A., 2018. Vegan foods: mimic meat products in the Italian market. International Journal of Gastronomy and Food Science 13, 1–9.
Braun, V., Clarke, V., 2006. Using thematic analysis in psychology. Qual. Res. Psychol. 3 (2), 77–101.
Brownbill, A.L., Braunack-Mayer, A.J., Miller, C.L., 2020. What Makes a Beverage Healthy? A Qualitative Study of Young Adults' Conceptualisation of Sugar-Containing Beverage Healthfulness. Appetite, 104675.
Castro, M., Chambers, I.V.E., 2019. Willingness to eat an insect-based product and impact on brand equity: a global perspective. J. Sensory Stud. 34, e12486.
Celi, M., Rudkin, J., 2016. Drawing food trends: design potential in shaping food future. Futures 83, 112–121.
Chuck-Hernández, C., Parra-Saldívar, R., Sandate-Flores, L., 2016. Pitaya (stenocereus spp.). Encyclopedia of Food and Health. Academic Press, pp. 385–391.
Comforfood, 2020. Instagram Page (#comfortfood). General Publications. Available at: https://www.instagram.com/explore/tags/comfortfood/?hl=pt-br> Accessed on 05 March 2020.
De Toffoli, A., Spinelli, S., Monteleone, E., Arena, E., Di Monaco, R., Endrizzi, I., et al., 2019. Influences of psychological traits and PROP taster status on familiarity with and choice of phenol-rich foods and beverages. Nutrients 11 (6), 1329.
Dial, L.A., Musher-Eizenman, D.R., 2019. Healthy? Tasty? Children's evaluative categorization of novel foods. Cognit. Dev. 50, 36–48.
Doungtip, P., Sriwattana, S., Kim, K.T., 2019. Understanding Thai consumer attitudes and expectations of ginseng food products. J. Sensory Stud. 35 (2), e12553.
Ertimur, B., Chen, S., 2020. Adaptation and diffusion of renovations: the case of the paleo diet. J. Bus. Res. 116, 572–580.
Fiszman, S., Varela, P., Díaz, P., Linares, M.B., Garrido, M.D., 2014. What is satiating? Consumer perceptions of satiating foods and expected satiety of protein-based meals. Food Res. Int. 62, 551–560.
Food and Agriculture Organization of the United Nations (FAO), 2017. The Future of Food and Agriculture. Trends and Challenges. Rome. Available at: www.fao.org/publications> Accessed on. (Accessed 23 June 2019).
Food Community, Comfort, 2020. Facebook Page. General Publications. Available at: https://www.facebook.com/groups/comfortfoodcommunity> Accessed on 05 March 2020.
Frøst, M.B., 2010. Molecular gastronomy, chefs and food innovation: an interview with Michael Bom Frøst. In: Jaeger, S.R., MacFie, H. (Eds.), Consumer-Driven Innovation in Food and Personal Care Products. Woodhead Publishing Limited, UK, pp. 634–645.
Goulart, G.S., Viana, M.M., Lucchese-Cheung, T., 2020. Consumer perception towards familiar and innovative foods: the case of a Brazilian product. Br. Food J. ahead-of-print No. ahead-of-print.
Greenwood, M., Kendrich, T., Davies, H., Gill, F.J., 2017. Hearing voices: comparing two methods for analysis of focus group data. Appl. Nurs. Res. 35, 90–93.
Hwang, S.J., Ahn, E.-Y., Park, Y., Lee, H.-J., 2018. An aqueous extract of Nomura's jellyfish ameliorates inflammatory responses in lipopolysaccharide-stimulated RAW264.7 cells and a zebrafish model of inflammation. Biomed. Pharmacother. 100, 583–589.
Karsch-Völk, M., Barrett, B., Kiefer, D., Bauer, R., Ardjomand-Woelkart, K., Linde, K., 2014. Echinacea for preventing and treating the common cold. Cochrane Database Syst. Rev. 2, CD000530.
Lagast, S., Gellynck, X., Schouteten, J.J., De Herdt, V., De Steur, H., 2017. Consumers' emotions elicited by food: a systematic review of explicit and implicit methods. Trends Food Sci. Technol. 69, 172–189.
Lecomte, A., Zerrouk, A., Sibeoni, J., Khan, S., Revah-Levy, A., Lachal, J., 2019. The role of food in family relationships amongst adolescents with bulimia nervosa: a qualitative study using photo-elicitation. Appetite 141, 104305.
Lovell, J.L., 2016. How parents process child health and nutrition information: a grounded theory model. Appetite 97, 138–145.
Maiz, E., Urkia, I., Bereciartu, A., Urdaneta, E., Allirot, X., 2019. Introducing novel fruits and vegetables: effects of involving children in artistic plating of food. Food Qual. Prefer. 77, 172–183.
Majid, A., Speed, L., Croijmans, I., Arshamian, A., 2017. What makes a better smeller? Perception 46 (3–4), 406–430.

Menozzi, D., Sogari, G., Veneziani, M., Simoni, E., Mora, C., 2017. Eating novel foods: an application of the Theory of Planned Behaviour to predict the consumption of an insect-based product. Food Qual. Prefer. 59, 27–34.
Messias, M.C.T.B., Menegatto, M.F., Prado, A.C.C., Santos, B.R., Guimarães, M.F.M., 2015. Uso popular de plantas medicinais e perfil socioeconômico dos usuários: um estudo em área urbana em Ouro Preto, MG, Brasil. Rev. Bras. Plantas Med. 17 (1), 76–104.
Mintel, 2019. GLOBAL FOOD & DRINK TRENDS 2019. Available at: https://www.mintel.com/global-food-and-drink-trends/>. (Accessed 30 August 2020).
Moré, C.T., 2019. RUBI, O 4° SABOR de chocolate, NATURALMENTE rosa, mudará as nossas SOBREMESAS para sempre. Available at: https://followthecolours.com.br/gotas-de-cor/chocolate-rubi/>. (Accessed 13 June 2019).
Morell, P., Fiszman, S.M., Varela, P., Hernando, I., 2014. Hydrocolloids for enhancing satiety: relating oral digestion to rheology, structure and sensory perception. Food Hydrocolloids 41, 343.
Myers, G., Pettigrew, S., 2018. A qualitative exploration of the factors underlying seniors' receptiveness to entomophagy. Food Res. Int. 103, 163–169.
Myronenko, A., 2020. CBD infused food and drinks — the ultimate guide. Available at: encurtador.com.br/wxyJW. (Accessed 31 August 2020).
Nacef, M., Lelièvre-Desmas, M., Symoneaux, R., Jombart, L., Flahaut, C., Chollet, S., 2019. Consumers' expectation and liking for cheese: can familiarity effects resulting from regional differences be highlighted within a country? Food Qual. Prefer. 72, 188–197.
Nguyen, Q.C., Wahlgren, M.B., Almli, V.L., Varela, P., 2017. Understanding the role of dynamic texture perception in consumers' expectations of satiety and satiation. A case study on barley bread. Food Qual. Prefer. 62, 218.
Nielsen, 2019. WHAT'S IN our food and ON our mind. Available at: < 440. https://www.nielsen.com/wp-content/uploads/sites/3/2019/04/global-ingredient-and441 out-of-home-dining-trends-aug-2016.pdf/>. (Accessed 30 August 2020).
Omar, H.R., Komarova, I., El-Ghonemi, M., Fathy, A., Rashad, R., Abdelmalak, H.D., et al., 2012. Licorice abuse: time to send a warning message. Therapeutic Advances in Endocrinology and Metabolism 3 (4), 125–138.
Piqueras-Fiszman, B., 2019. Consumer psychology and eating behaviour. Interdisciplinary Approaches to Food Digestion 185–198.
Premoli, M., Aria, F., Bonini, S.A., Maccarinelli, G., Gianoncelli, A., Pina, S.D., Tambaro, S., Memo, M., Mastinu, A., 2019. Cannabidiol: recent advances and new insights for neuropsychiatric disorders treatment. Life Sci. 224, 120–127.
Puhakka, R., Valve, R., Sinkkonen, A., 2017. Older consumers' perceptions of functional foods and non-edible health-enhancing innovations. Int. J. Consum. Stud. 42 (1), 111–119.
Roe, L.S., Meengs, J.S., Rolls, B.J., 2012. Salad and satiety. The effect of timing of salad consumption on meal energy intake. Appetite 58 (1), 242–248.
Román, S., Sánchez-Siles, L.M., Siegrist, M., 2017. The importance of food naturalness for consumers: results of a systematic review. Trends Food Sci. Technol. 67, 44–57.
Saldaña, E., Cardoso Merlo, T., Patinho, I., Rios-Mera, J.D., Contreras-Castillo, C.J., Selani, M.M., 2021. Use of sensory science for the development of healthier processed meat products: a critical opinion. Current Opinion in Food Science 40, 13–19.
Soffin, M.T., Batsell, W.R., 2019. Towards a situational taxonomy of comfort foods: a retrospective analysis. Appetite 137, 152–162.
Sõukand, R., Stryamets, N., Fontefrancesco, M.F., Pieroni, A., 2020. The importance of tolerating interstices: babushka markets in Ukraine and Eastern Europe and their role in maintaining local food knowledge and diversity. Heliyon 6 (1), e03222.
Spence, C., 2016. Sensploration. Future of Storytelling 2016. Available at: https://www.youtube.com/watch?v=kszzJjtv2oo&t=189s/. (Accessed 5 March 2020).
Spence, C., 2017a. Gastrophysics: the New Science of Eating. Viking, New York.
Spence, C., 2017b. Comfort food: a review. International Journal of Gastronomy and Food Science 9, 105–109.
Spence, C., 2017c. Airline food that makes you happy (By Peter Basildon). Available at: https://www.finedininglovers.com/blog/news-trends/mood-food-monarch-airlines/> Picture: Oliver Dixon/Monarch/PA Wire. (Accessed 13 June 2019).
Spence, C., 2018. Contemporary fusion foods: how are they to be defined, and when do they succeed/fail? International Journal of Gastronomy and Food Science 13, 101–107.
Spence, C., Gallace, A., 2011. Multisensory design: reaching out to touch the consumer. Psychol. Market. 28 (3), 267–308.
Spence, C., Corujo, A., Youssef, J., 2019. Cotton candy: a gastrophysical investigation. International Journal of Gastronomy and Food Science 16, 100146.
Stein, K., 2008. Contemporary comfort foods: bringing back old favorites. J. Am. Diet Assoc. 108 (3), 412–414.
The Cooking Foodie, 2019. What is the best comfort food in the world? Available at: https://www.youtube.com/watch?v=5e4jhda0phk. (Accessed 5 March 2020).
Traylor, R., 2019. Top Foodservice Trends of 2019. Available at: https://www.webstaurantstore.com/blog/2214/top-foodservice-trends.html. (Accessed 23 June 2019).
Troisi, J.D., Gabriel, S., Derrick, J.L., Geisler, A., 2015. Threatened belonging and preference for comfort food among the securely attached. Appetite 90, 58–64.
Tuorila, H., Hartmann, C., 2020. Consumer responses to novel and unfamiliar foods. Current Opinion in Food Science 33, 1–8.
Van Kleef, E., Vingerhoeds, M.H., Vrijhof, M., van Trijp, H.C.M., 2016. Breakfast barriers and opportunities for children living in a Dutch disadvantaged neighbourhood. Appetite 107, 372–382.
Wendin, K., Egan, P.A., Olsson, V., Forsberg, S., Nilsson, A., Stenberg, J.A., 2019. Is there a best woodland strawberry? A consumer survey of preferred sensory properties and cultivation characteristics. International Journal of Gastronomy and Food Science 16, 100151.

Appendix A – List of Brazilian Foods

‘**Açaí**’ ‘is a typical Brazilian fruit from Amazonia that grows in the “açaizeiro. Nowadays, the fruit is also produced in other countries of the Amazon region as Equator, Venezuela, Colombia, and Guianas. Açaí became famous in Brazil in 2000, when it started to be consumed at gyms and beaches. This is because açaí is commonly associated with a healthy nutritional product and a great source of energy. The fruits are rich in fibers, proteins, vitamins, and minerals. Furthermore, it is also a highly natural energetic food. In general, Brazilian people love açaí because it is healthy, tasteful, fresh, and it can be served with other foods like chocolate or fruit sauces, candies, granola and other grains (INDIABRAZIL, 2018).

‘**Biscoito de polvilho**’ is a traditional, starchy (sour cassava starch), salted cookie from Brazil. The cookies are characterized by their round, puffy shape and a crispy outer texture. Biscoito de polvilho can be traced back to the 18th century, when it was prepared on farms in the state of Minas Gerais and served to the plantation owners along with cheese and coffee as an afternoon snack. Due to their unique flavor and airy texture, the cookies are so popular in Brazil that they can even be found at most supermarkets (Testeatlas, 2020).

‘**Bolinho de chuva**’ is a special dessert, that was commonly hand-shaped by slaves and cooked in pans over wood-burning stoves, originated in the 18th century during the colonial period in Brazil. Even though its name suggests that it can only be enjoyed on rainy days, most people know that it can be eaten at any time, regardless of the weather. When the “bolinhos de chuva” were pan-fried in hot oil, people would gather together around the stove to grab their share, which they would then cover with sugar and cinnamon. They became famous very quickly, especially thanks to the writer Monteiro Lobato and one of his character aunt Anastasia, who lived in a house of a farm called Picapau Amarelo (ARTE&SALGADOS VENEZIA, 2015).

‘**Brigadeiro**’ is a Brazilian dessert made by heating three key ingredients together - unsalted butter, cocoa powder, and condensed milk, which are then rolled into a small ball, similar in shape to a truffle. The candy called Brigadeiro is sweet, with a rich chocolate flavor, and is usually topped with chocolate sprinkles. Today, the Brigadeiro is marketed as a gourmet delicacy, made in many different flavors such as almond, mint, hazelnut, coffee, and coconut. It is impossible to find a birthday party in Brazil without this chocolate sweet (Testeatlas, 2020).

‘Broa’ is a Portuguese bread made from yellow cornmeal, yeast, and a combination of wheat and rye flours. It is characterized by a thick crust on the exterior, and a tender, moist texture in

the interior. Broa is also quite popular in Galicia and Brazil, where it is typically seasoned with fennel seeds. It was first baked by peasants in the mountainous regions of northern Portugal, who made their living by cultivating corn. Although broa is an integral part of a traditional Portuguese breakfast, it is also often served at the beginning of the meal with a traditional Portuguese soup called caldo verde (Testeatlas, 2020).

'Cabidela' or 'Frango ao molho pardo': Galinha cabidela is a traditional Portuguese dish that can be traced back to the 16th Century (the Golden Age of Portuguese navigation and exploration). The dish called galinha cabidela has come to mean a braised chicken (or other meat) cooked in a sauce made of its own blood. In a nod to African tradition, the dish is given a hit of spice by the inclusion of an African hot sauce called piri-piri. In Brazil, the galinha cabidela is considered a typical dish of the city of Recife. It is also very common and a typical dish in the state of Minas Gerais, where it has the name 'galinha ao molho pardo' or 'frango ao molho pardo' (FLAVORS OF BRAZIL, 2011).

'Coxinha' is a crispy croquette filled with chicken breast meat and cream cheese that is cleverly shaped into a chicken drumstick, then breaded and deep-fried. Coxinha originated in the state of São Paulo in the 19th century, and by the 1950s it had spread to Rio de Janeiro and Paraná, having now become one of the most popular 'salgados' (savory appetizers) across the country. Nowadays, coxinhas can be found anywhere in Brazilian cafés, buffets and even bakeries to numerous stand-up lunch counters and street food stalls. It is typically flavored with onion, garlic, cilantro, and lime (Testeatlas, 2020).

'Feijoada' or 'feijoada completa' is Brazilian national dish, a hearty stew featuring pork and black beans. The dish is consumed throughout the country, and every family in Brazil has their own, special recipe. Traditionally, it is prepared for Saturday lunch, so that the consumers may sleep it off. The beans are flavored with onions, tomatoes, coriander, and garlic, while pork meat can be additionally enriched with dried beef and smoked pork sausages. The Brazilian version usually uses black beans, while the Portuguese one typically uses white or kidney beans. The accompaniments include Brazilian rice, kale, cassava with butter or hard-boiled eggs, sliced oranges, and hot pepper-lime sauce. During the meal, cachaca, a sugarcane brandy and Brazil's most popular liquor, is served as a traditional accompaniment to feijoada (Culture Trip, 2017).

'Jaboticaba or Jabuticaba' 'Jabuticaba' or 'Jaboticaba' tree is a Brazilian fruit tree native from Minas Gerais, Goias and São Paulo states. It produces perfumed and sweet flowers that

result in rounded, black, tasty and sweet fruits, grouped on the trunk and on the branches of the tree. The name of Tupi origin Iapoti'kaba, refers to the "fruit-in-bud" because of its rounded shape (Da Silva et al., 2019).

'Jiló' (*Solanum gilo* Raddi) (Solanaceae) is native from India and was introduced in Brazil by slaves. Its edible fruits may be light green, dark green, or reddish orange when ripe. However, the jiló is usually picked and cooked while it is still green. Furthermore, jiló is known as Scarlet eggplant or Brazilian red eggplant, a vegetable with good acceptance in the market, especially in the Southeast region of Brazil. Widely grown in Brazil, it is normally cooked as a vegetable for meals (Alves et al., 2018).

'Maria-mole': Maria-mole, literally translated as soft Mary, is a popular Brazilian dessert made with sugar, gelatin, coconut, and egg whites. It is similar, in appearance, to a marshmallow, but even softer. Maria-mole was invented in São Paulo by Antonio Bergamo, a candy producer who wanted to use all of the egg white leftovers from making other types of candy. Today, the dessert is traditionally served during the Catholic festivals in June, called Festas Juninas (Testeatlas, 2020).

'Pé-de-moleque' ('Peanut candy') One of the most traditional and common sweets in Brazil is called "pé-de-moleque". Moleque is pronounced mo-LEH-key, and the word originally came from the African language Kimbundu where it meant simply "boy". In colonial Brazil, it took on the meaning of "black boy" or "slave boy", and was used to designate child-slaves who worked in the kitchens and laundries of the owner's mansions on sugar cane plantations. In most of Brazil, the south, southeast and middle-west, pé-de-moleque is a mixture of melted rapadura or brown sugar with peanuts - kind of like peanut brittle. Hard, chewy, sticky and very sweet. In the northeastern region of Brazil, however, pé-de-moleque is a dense cake made with rapadura, cassava flour and nuts, similar to a molasses cake. What both versions have in common is the dark, rich raw sugar and the presence of nuts. They differ in whether flour is added to make a cake or not (FLAVORS OF BRAZIL, 2010).

'Pirulito chupetinha' is a candy made by heating sugar, water and corn syrup to a temperature close to 140 °C to obtain a syrup which is then placed into shapes and then refrigerated to obtain the lollipop (Elaborated by the authors).

'Rapadura' comes from scrapings of the layers (crust) of sugar that were stuck to the walls of the cooking devices used in the manufacture of sugar. The resulting syrup is heated and placed

into brick-like forms. Even though the market of rapadura has declined, the consumption of this type of candy is common in the Northeast region of Brazil, especially in the semi-arid regions. In the region's large port cities, rapadura is mainly sold at public markets and, to a lesser extent, in large supermarket chains. São Paulo and Minas Gerais have also become large consumers, due to migrants from the Northeast (GASPAR & LIBRARIAN, 2011).

'Tareco' The tareco (Brazilian Portuguese: [ta'ɾɛku]) is a simple cookie consisting of wheat or corn flour, eggs, vanilla, and sugar. They originated in the Brazilian state of Pernambuco, but have since spread and gained so much popularity throughout Brazil that a Brazilian singer, Flávio José titled one of his songs Tareco e Mariola (Testeatlas, 2020).

References Supplementary Material A

Alves, M. V. P., Von Pinho, E. V. R., Dos Santos, H. O., Alves, G. C. P., De Carvalho, M. L. M., & Bustamante, F. O. (2018). Image analysis, quality and maturation of jiló (Solanum gilo) seeds. *Agrociencia*, *52*(2), 267–278.

ARTE&SALGADOS VENEZIA. (2015). BOLINHO DE CHUVA. Available at: <https:// www.encurtador.com.br/gisH9> Accessed on 31 August 2020.

Da Silva, J. A. A., Teixeira, G. .H A., Martins, A. B. G., Citadin, I., Júnior, A. W., Danner, M. A. (2019). Advances in the propagation of Jabuticaba tree. *Revista Brasileira de Fruticultura*, *41*(3), e-024.

FLAVORS OF BRAZIL (2010). PÉ-DE-MOLEQUE. Available at: <https:// www.encurtador.com.br/bhrsw> Accessed on 31 August 2020.

FLAVORS OF BRAZIL. (2011). CABIDELA. Available at: < https://www.encurtador.com.br/DNR78> Accessed on 31 August 2020.

GASPAR, L., & LIBRARIAN, J. N. F. (2011). RAPADURA. Available at: <https:// www.encurtador.com.br/mpuwV> Accessed on 31 August 2020.

INDIABRAZIL. (2018). AÇAÍ. Available at: <https:// www.encurtador.com.br/jAKZ2 > Accessed on 31 August 2020.

Testeatlas. (2020). BISCOITO DE POLVILHO. Available at: <https://www.tasteatlas.com/biscoito-de-polvilho > Accessed on 31 August 2020.

Testeatlas. (2020). BRIGADEIRO. Available at: <https://www.tasteatlas.com/brigadeiro> Accessed on 31 August 2020.

Testeatlas. (2020). BROA. Available at: <https:// https://www.tasteatlas.com/broa> Accessed on 31 August 2020.

Testeatlas. (2020). COXINHA. Available at: <https://www.tasteatlas.com/coxinha> Accessed on 31 August 2020.

Testeatlas. (2020). FEIJOADA. Available at: <https://www.tasteatlas.com/feijoada> Accessed on 31 August 2020.

Testeatlas. (2020). MARIA MOLE. Available at: <https://www.tasteatlas.com/mariamole> Accessed on 31 August 2020.

Testeatlas. (2020). TARECO. Available at: <https://www.tasteatlas.com/tareco> Accessed on 31 August 2020.

Supplementary Table 1. Summary of participant characteristics in Brazil (n=20).

Participant characteristic	(%)
Gender	
Female	65
Male	35
Age	
18-30 years old	55
31-45 years old	20
46-61 years old	25
Marital status	
Single	65
Married/civil partnership	30
Divorced/separated	5
Education level	
Complete/incomplete secondary school	10

University degree	50
Postgraduate studies	40
Socio-economic status	
Low	5
Middle	75
High	20
Health Consciousness Scale (HCS)[a]	
High health concern	25
Moderated health concern	70
Less health concern	5

[a] HCS based on Pinto et al. (2017). The sum of the individual values of each item of the questionnaire of health consciousness was ranged from 0 to 9. In order for the highest values to correspond to high health consciousness, items 7, 8, 9 and 10 were reversed, subtracting 9 from the score given by the participants. The consumers were assigned to three segments, representing low (0 to 50.6), average (50.7 to 74.4) and high (74.5 to 84.7) concern for health. The ranges for each segment were obtained from the sum of the values of all questions (62.5), plus or minus one standard deviation (SD = 11.9).

Supplementary Table 2. Interview script.

Questions
1. When you go out to the grocery store, do you have any interest in foods that are uncommon in your daily basis? For instance, foods with variable flavors, textures, with combinations between salty and sweet… Have you ever bought foods with features different from those that you are used to? Why? 2. What do you understand by "eating as healthy as possible"? Do you think you would be happy by "eating as healthy as possible"? 3. Do you think that the so-called contemporary foods (healthy, exotic, uncommon, and so on), which are being required by consumers, may become as much preferred as those considered non-healthy? Why? ***Photo-elicitation (PE)*** 4. What would you say if we were told that we need to consume foods that we are not used to eat (such as those shown in the sheet)?

Photo-elicitation with information (RE) - Re-exposure of pictures

5. Would it make you change your opinion in regards to any of these foods? Why?

4. CHAPTER III

Health beliefs towards kefir correlate with emotion and attitude: a study using an emoji scale in Brazil

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Health beliefs towards kefir correlate with emotion and attitude: A study using an emoji scale in Brazil

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ABSTRACT

Emojis can be used to explore food-evoked emotions in order to provide information that can support the product development and marketing decisions. This study aimed to evaluate consumers' acceptance, purchase intent and emotional responses to milk beverages, with and without kefir added, before and after these consumers were informed about the products' composition (0%, 15%, 30% and 50% m/v) and health claims toward kefir (blind and informed tests, respectively). Emotional responses were assessed by emoji use within a RATA questionnaire in order quantify the perceived significance of the emojis chosen. In the informed test, the consumers' perception of the sensory attributes of the milk beverages, such as their perception of an acid taste in added kefir beverages was shown to have changed. Overall, participants attributed significantly higher acceptance and purchase intent scores to added kefir beverages after they had been informed on its health benefits. In addition, expressions of positive emotion increased when participants were exposed to stimuli related to health benefits of kefir (15%, 30% and 50% m/v), while negative expressions of emotion decreased. The provided information of kefir modified valence and arousal in subjects, and it can be said that to 30% of kefir can be added to yogurt without compromising its sensory acceptability. Thus, health benefits alone cannot improve product acceptance, since participants found a 50% addition of kefir to be unpleasant when tasted during a blind test. Mixed beverages may present a probiotic beverage alternative for consumers who dislike kefir milk, but want to include it in their diets. The implications of liking and purchase intent and how they are linked to emotions are discussed in this paper as well.

1. Introduction

1.1. Kefir: a versatile product with unique microbiota

Kefir is a fermented milk beverage made using the unique microbiota found in kefir grains to produce an acid-alcoholic fermented product (Kesenkaş, Gürsoy, & Özbaş, 2017, chap. 14). It owes its versatility to the symbiotic association of lactic acid bacteria, acetic acid bacteria and yeasts, which gives the beverage complex sensory properties and makes it a probiotic beverage (Kesenkaş et al., 2017, chap. 14).

Recent findings highlight bioactive properties of kefir and a growing popularity due to its nutritional attributes. Its anticarcinogenic, antimutagenic, anti-inflammatory, antihypertensive, antimicrobial and antidiabetic properties, as well as its beneficial effects on osteoporosis, lactose intolerance, hypercholesterolemia and immune system function conditions have been previously discussed, although these benefits have not all been proven (Dertli & Çon, 2017; Dos Reis et al., 2019; Erdogan, Ozarslan, Guzel Seydim, & Tas, 2019; Hatmal, Nuirat, Zihlif, & Taha, 2018; Kesenkaş et al., 2017, chap. 14; Lima et al., 2017; Rodrigues, Caputo, Carvalho, Evangelista, & Schneedorf, 2005).

Kefir grains are small irregular-shaped granules with a cauliflower-like appearance. They produce a single, self-carbonated beverage with a specific taste; the beverage has similar nutritional properties to yogurt (Dertli & Çon, 2017). The flavor of kefir is primarily determined by the microbial community present and the microorganism count found in the grains (Dertli & Çon, 2017; Miguel, Cardoso, Lago, & Schwan, 2010). However, the sensory properties of kefir remain poorly

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documented (Glibowski & Kowalska, 2012).

Kefir has shown strong potential as a functional food. Although consumer studies have not been exhaustive, the potential for industrial-scale kefir production, its sale as a powdered product, and its inclusion in beverages to improve sensory acceptability and reduce manufacturing costs make it a highly versatile product (Nale, Tontul, Aşçi Arslan, Sahin Nadeem, & Kucukcetin, 2017; Singh & Shah, 2017).

Recent studies have covered many of the challenges to introducing kefir on the dairy beverage market. These challenges include pinpointing suitable strains that compete with pathogenic bacteria present in the matrix and finding resistant strains and viable cells that adapt to sub-lethal stresses caused by industrial processing conditions, including pasteurization. Recently, dairy companies have begun to market the first kefir-quark cheese in the United Kingdom and the first line of flavored kefir beverages in Brazil. These developments have paved the way for new beverage mixtures that include lacto-fermentative bacteria with bioactive potential and high functional capacities (Castro, 2018; Milkpoint, 2018).

1.2. Beyond sensory acceptability and purchase intent: the potential of emotional responses in food studies

The sensorial and hedonic properties of foods/beverages are precursors to the emotional associations that consumers will have to products (Jaeger, Lee, & Ares, 2018; Thomson, Crocker, & Marketo, 2010). These emotional associations and their underlying motivations occur when individuals find relevant stimuli (Lemos et al., 2020) (e.g. effect of red color on sweetness or effect of information on type of product on proudness) (Fibri & Frøst, 2020; Lemos et al., 2020). Emotional associations in various demographics and subjects with different psychosocial characteristics throughout the world have been studied using a wide range of stimuli (Jaeger, Roigard, Jin, Vidal, & Ares, 2018).

Emotional eating may be more related to preconceived notions and emotions and less dependent on actual sensations experienced when eating (Jones & Herr, 2018). Evers, Dingemans, Junghans, and Boevé (2018) argue that consumers with specific health issues (e.g., overweight or obese) are more vulnerable to negative emotional eating and tend to eat more than people who are considered “healthy”. By examining context emotion regulation, negative emotion levels, eating environments, moods, and consumer socioeconomic statuses, previous studies have identified additional positive and negative emotions that result from unhealthy eating habits that include calorie intake and food addictions (Giboreau & Meiselman, 2018; Jones & Herr, 2018).

Miccoli et al. (2018) investigated whether poor health habits could be associated with a higher risk of developing eating disorders, and if obesity could modify adolescents’ emotions toward sweet food cues. The presence of significant two-way interactions between habits (healthy vs. risky) and image content (sweet vs. savory) was tested. Researchers concluded that risk habits had no effect on adolescents’ feelings during the emotional stimuli tests. The intensity of the feelings toward sweet food cues was mostly due to an indistinct correlation of emotional processing and activation was barely affected by the presence of risk habits.

Consumers’ emotions are determined by the context in which they are evoked (Piqueras-Fiszman & Jaeger, 2014). Recent studies have shown that the quality of negative emotions evoked pre- and post-meal depended on meal type (e.g. dinner) (Giboreau & Meiselman, 2018), gender and age of the participants, and whether people were eating alone or with others (Edwards, Hartwell, & Brown, 2013). High-end foods and meals also turned out to be biased facilitators of increased expression of positive emotions (Giboreau & Meiselman, 2018). Based on these assumptions, it can be said that health expectations and prior health information for certain foods may strongly affect consumer emotions, acceptance and purchase intent.

The effects of non-sensory criteria such as health information on sensory acceptability has been established in previous studies (Bimbo et al., 2017; De Beukelaar, Zeinstra, Mes, & Fischer, 2019; Oliveira, Ares, & Deliza, 2018; Russell, Burke, Waller, & Wei, 2017). Blind and informed tests influence not only hedonic responses, but also sensory property perception, as well as emotional responses (Fibri & Frøst, 2020; Spinelli, Masi, Zoboli, Prescott, & Monteleone, 2015). Personal taste, personal beliefs, and psychological factors (moral, ethical and/or health) are among the influences on consumers’ perception of food products (Giraldo, Buodo, & Sarlo, 2019). Some studies emphasize that additional information for a product that a consumer is already familiar with has a greater effect and generates a ‘confirmation bias’ (Waldman & Kerr, 2018).

Since healthy eating has been shown to result in a feeling of well-being (Spence, 2017), “food comfort” may be one reason why health claims positively alter consumers' perceptions of healthier products (e.g. yogurt). Health concerns have been shown to be one of the primary influences on sensations (or lack thereof) of well-being (Pinto et al., 2017). For example, negative feelings toward healthy products may be reduced when clear information about high and low nutrient content (e.g. using a traffic-light system) is provided (Lima, De Alcantara, Martins, Ares, & Deliza, 2019). Zhou, van Tilburg, Mei, Wildschut, and Sedikides (2019), studied nostalgic labels and perceived that they also cause a sense of food comfort (i.e., safety and security). According to the authors, nostalgic labels may make food seem healthier, which could in turn boosts purchase intent. Despite these findings, understanding consumer motivation behind food choices remains a challenge.

It is widely accepted that nutrition, health, and functional food information can affect consumers’ hedonic and emotional responses to yogurt. However, studies on foods’ emotional profiles have primarily focused on unhealthy foods. Further research has been needed on foods that evoke fewer emotions, such as dairy products (Ares, Giménez, & Gámbaro, 2008; Jiang, King, & Prinyawiwatkul, 2014; Schouteten, De Steur, Sas, De Bourdeaudhuij, & Gellynck, 2017).

1.3. The role of emojis

Previous studies have contributed to the evolution of word questionnaires that use emojis to obtain emotional responses which reinforce data obtained through CATA and RATA questionnaires without extra effort or risk of boredom (Ares & Jaeger, 2017; Jaeger, Lee, & Ares, 2018). CATA emoji-questions are recommended for samples that have distinct emotional associations, while RATA emoji-questions have been used to distinguish between samples with more similar emotional profiles (Jaeger, Lee, & Ares, 2018). Future studies will focus on developing and testing circumplex-inspired questionnaires, beyond the valence and arousal factors that are currently studied (Jaeger et al., 2019; Spinelli, 2017).

Emojis have become a popular form of non-verbal expression in digital and personal communications (Luangrath, Peck, & Barger, 2017); expressing emotion has been reported as the main reason for using these pictograms (Riordan, 2017; Vidal, Ares, Hedderley, Meyners, & Jaeger, 2018). Emojis and emoticons can be used in addition to or in place of verbal communication to evaluate food and beverages via emotional associations and attitudes that transcend hedonic responses and reveal consumers’ subjective experiences (Jaeger, Xia, & lee, 2018; Meiselman, 2015; Vidal, Ares, & Jaeger, 2016).

Emojis are pictograms that enrich meaning because of their resemblance to real features (e.g., facial expressions, body gestures, etc.) (Jaeger, Roigard, & Ares, 2018), and have been shown to be a preferred method for expressing emotions about food (Evans, 2015).

Because emojis are very effective in evoking emotions and attitudes, their use may contribute to food acceptability and choice in emotional purchase settings (Das, Wiener, & Kareklas, 2019; Schouteten, Verwaeren, Lagast, Gellynck, & De Steur, 2018). Food companies may be able to use them as an effective means to access consumers’ attitudes and behaviors (Jaeger, Lee, & Ares, 2018). When Das et al. (2019)

examined the influence of emojis on consumer reactions to advertising, they observed that emojis can effectively increase positive impressions and purchase intent for hedonic products, but that emojis are not an effective measurement of evaluation on utilitarian products.

Previous emotion studies on American and Canadian children have shown a high positive correlation between emotional responses and liked foods. Favorite foods typically elicited positive or happy emotions, while least favorite foods evoked emotions such as anger, sadness, or disappointment (Gallo, Swaney-Stueve, & Chambers, 2017; Swaney-Stueve, Jepsen, & Deubler, 2018). Although liking and emotional scales in these studies were measured differently, their response patterns were similar: positive emojis were used when liking scores were high, while negative emojis were used when liking scores were low (Swaney-Stueve et al., 2018).

Emojis have also been used to evaluate social media posts (Vidal et al., 2016), as verbal and nonverbal pictograms on CATA and RATA online questionnaires, and to assess emotional and hedonic responses to seafood products in order to develop emoji evaluation methodology guidelines (Ares & Jaeger, 2017). In addition, these pictograms were used to access children's willingness to try and accept unfamiliar foods and to decipher nuances in unhealthy eating habits of children and teenagers (Lima et al., 2019). Emoji inclusion in these studies has helped predict actual food choices compared to solely studying overall liking measurements. However, when emojis are used to distinguish between hedonically similar samples, they were not shown to be good predictors among children (Schouteten et al., 2018).

A number of studies have reported difficulties with emoji use due to multiple emoji meanings, existing cultural differences, and the lack of a single verbal definition (Jaeger, Roigard, & Ares, 2018). In light of the various emotional meanings attributed to emojis researchers have attempted to determine pictogram drivers that predict hedonic acceptance in order to create an accurate food evaluation emoji scale (Ares & Jaeger, 2017; Jaeger et al., 2017). In food-related consumer research today, emojis allow for a more in-depth understanding of consumer perception of products and services. It can be used to understand consumer choices and experiences and thus provide insights for optimization and development of new products/services (Jaeger, Roigard, & Jin, 2018) as well as changes in formulation (Emotional responses can identify whether the changes will result in a positive or negative outcome for the test product.) (Spinelli & Jaeger, 2019).

There are few studies on the joint effect of sensory and non-sensory food characteristics on emotions, but findings to date have shown advances in emoji use in the sensory analysis of milk chocolate, nuts, wafers, coffee, honey, cheese, juice, yogurt and fruit. All of these products showed links between high acceptability/positive emotions and low acceptability/negative or indifferent emotions (Carabante et al., 2018; Hu & Lee, 2018; Juodeikiene et al., 2018).

The emoji and emotional terms that are most appropriate and effective as evaluation tools and the emojis that stimulate cross-cultural associations should be selected as part of specific and well-informed decisions (Jaeger, Roigard, & Ares, 2018). According to Spinelli et al. (2015), the main features of emotion domains are valence (positive/negative) and arousal (active/passive). These allow for increased understanding when emojis are used to determine differences between various stimuli.

Based on these premises, this study aimed to evaluate consumers' acceptance, purchase intent and emotional responses to milk beverages, with and without kefir added, before and after these consumers were informed about the products' composition (0%, 15%, 30% and 50% m/v) and health claims toward kefir (blind and informed tests, respectively). The emotional responses were assessed using emojis and a RATA questionnaire to evaluate the perceived intensity of emoji significance based on the findings of Ares and Jaeger (2017).

Emoji use may provide additional data for non-sensory subjective emotional experiences beyond just liking (Schouteten et al., 2018). Our study examines emoji use as a predictor of sensory acceptability and purchase intent. The research may reveal important areas for new product evaluation protocols, as well as marketing potential for encouraging the consumption of healthier foods by using emotional responses as purchase drivers. The findings of this study are expected to corroborate previous works on the suitability of emoji scales for measuring emotional responses in sensory research.

2. Materials and methods

2.1. Sample formulation

Four mixed beverages including traditional strawberry yogurt and added kefir yoghurt (0% volume/volume ($v.v^{-1}$), 15% $v.v^{-1}$, 30% $v.v^{-1}$ and 50% $v.v^{-1}$ of kefir) were formulated to use as sensory stimuli (See Supplementary Table 1).

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.foodres.2019.108833.

A strawberry flavored beverage was chosen because strawberry is a familiar flavor that is generally liked by all (inclusion criteria) and strawberry-flavored milk products represent the largest number of products available on the Brazilian market (Janiaski, Pimentel, Cruz, & Prudencio, 2016). Strawberry is also a popular and preferred yogurt flavor (Lesme et al., 2019; Thompson, Lopetcharat, & Drake, 2007). Moreover, the sensory complexity of strawberry flavoring represents a positive feature for consumer acceptance of strawberry-flavored products (Palczak, Blumenthal, Rogeaux, & Delarue, 2019).

2.2. Recruitment of participants

Participants for the current study were recruited through advertisements posted in locations such as the Universidade Federal de Viçosa and social media. The study was carried out on 100 milk beverage drinkers to comprise the sensorial team, which consisted of residents of the city of Viçosa (Minas Gerais State, Brazil). Prior to the survey, a written questionnaire was given to participants in a quiet room. Our research protocol followed the guidelines of the Helsinki Declaration and all procedures involving human subjects were approved by the Committee on Ethics in Human Beings Research of the Universidade Federal de Viçosa (n° 3.516.953).

Participants were considered eligible for the survey when they stated they read food labels, consume fermented and dairy beverages, and were willing to participate in the study. They were also asked about their willingness to try new probiotics beverages using a simple Yes/No question. Use of a hand-held mobile device to demonstrate familiarity with emoji use was also a criterion for eligibility (Ares & Jaeger, 2017). For reliability, Frequency of WhatsApp uses for social connections and emoji use in text and online communications were assessed in order to demonstrate participants' familiarity with emojis. "Never or very infrequently" WhatsApp or emoji use did not constitute exclusion criteria, but "sometimes" (10–35% of the time) was preferred to "never or very infrequently" responses (Supplementary Table 2). Lactose intolerance was considered to be exclusion criteria. See Supplementary Table 2 for further information about participants in this study.

2.3. Procedure

The experiment was divided in two sessions. In the first session (blind test), participants evaluated milk beverages samples without any information about their nature. In the second session (informed test), participants evaluated the same samples after they were informed about their composition and health benefits of kefir. In both sessions, product acceptability, purchase intent, and emotional responses towards the milk beverages were assessed using three separate response sheets for each sample.

The tests were performed at the Product Development and Innovation Laboratory at the Universidade Federal de Viçosa. In each

session, four samples were presented monadically and randomized according to a balanced experimental design (each sample appearing in each position the same number of times). Sensory analysis was performed in standard cabins and under controlled sample temperatures (7 °C). Participants tasted samples served in transparent, odorless plastic cups encoded with three random digits, and were instructed to drink water to cleanse their palates between samples. Each subject represented one repetition.

For each sample, hedonic responses were assessed using a 9-point scale (1 = dislike extremely, 5 = neither like nor dislike, 9 = like extremely). Next, participants were then asked to evaluate purchase intent on a 9-centimeter unstructured scale (0 cm = 'definitely would not buy, 9 cm = 'definitely would buy) (Carneiro, Silva, Della Lucia, & Minim, 2018). Finally, participants' emotional responses towards each milk beverage were assessed using a RATA (Rate-All-That-Apply) emoji questionnaire adapted from Ares and Jaeger (2017). For each emoji selected, participants were asked to rate its intensity of significance using a 3-point scale (Low, Medium or High). Emojis were shown as 1.0 × 1.0 cm images for clear visibility and their presentation order was randomized.

The second session was conducted two days after the first. In this session (informed test), a non-sensory description of each sample was given to participants (beverage type and amount of kefir added in the sample composition). Additionally, health benefits of kefir were given as follows: "Kefir is a low-calorie, high-protein food with beneficial health properties. It contains bacteria that help maintain intestinal flora, which aids digestion and toxin elimination, while reducing pathogenic bacteria activity in the intestine". For the standard, yogurt-only sample, information of kefir was not provided, and consumers were simply told it was 'strawberry yogurt'. At the end of the second session, participants filled out a Health Consciousness Scale questionnaire (HCS), previously validated for the Brazilian population (Dantas, Minim, & Deliza, 2003).

2.4. Emoji questionnaire used to measure emotional responses to stimuli

A 5-member expert panel operating in food science and technology, with degrees at a masters/doctoral level determined the number and type of emojis to be used in this study. Following a comprehensive review of the literature, a total of 41 emojis were included (See Supplementary Table 3 for further information about emojis used); the emojis selected were similar to those used by Jaeger et al. (2017) and Ares and Jaeger (2017). Lists with up to 50 emojis have been used to successfully create emotional assessment instruments for both adults and children (Schouteten et al., 2018).

The WhatsApp Emoji package (Emoji 11.0 for Android) was used to build the emotional response questionnaire, as shown in Table 3 (Emojipedia, 2018).

2.5. Data analysis

2.5.1. Overall liking and purchase intent data

Data from the 9-point hedonic scale were converted to numerical scores (scores were between 6 - "like slightly" and 9 - "like extremely", indicating that consumers liked the sample and scores between 1 - "dislike extremely" to 5 - "indifferent", indicating that consumers disliked the sample) (Pinto et al., 2017). For the unstructured line scales used to determine purchase intent, a millimeter ruler was used to measure the scores.

Liking and purchase intent data obtained from both sessions were analyzed using a mixed model analysis of variance (ANOVA), with stimuli type and session as fixed factors, and the consumer as a random factor. Statistical analysis was performed using R® version 3.4.2 (R Core Team, 2014) and its lme4 package (Bates, Maechler, & Bolker, 2014).

In order to examine the relationship between stimuli type and text data from comments on acceptance test (9-point scale followed by comment field), correspondence analysis (CA) was carried out. The CA analysis showed relative similarities and differences between responses to stimuli and was performed on a frequency table that showed the samples in rows and total frequency of descriptive terms in columns. Principal Component Analysis (PCA) was carried out to account for individual differences in participant attitudes and acceptance levels between sessions, as well as the relationship between emotional responses and stimuli types in both sessions. PCA was performed on individual participant data in relation to average scores for each emoji and each sample (0 values for emoji that were not selected according to procedures adopted by Ares and Jaeger (2017). Data was processed using Microsoft Excel® 2016, and the Statistical Analysis System (SAS®) University Edition 2019.

2.5.2. Emotional responses

To evaluate how participants used emojis to differentiate between samples, the data were analyzed using RATA procedures (Ares & Jaeger, 2017; Meyners, Jaeger, & Ares, 2016). Data obtained from the 3-point scale used to rate the intensity and significance of each emoji in the RATA question (Low, Medium or High) were converted to numerical scores. Emojis that were not selected were scored as 0 and selected emojis received 1, 2 or 3 values according to their significance rates (Meyners et al., 2016). Statistical analyses of RATA scores were carried out using ANOVA and Fisher's LSD for post-hoc mean comparisons ($p < 0.05$) (SAS®, 2019).

Pearson correlation coefficients were computed to examine the relationship between overall liking/purchase intent scores and emotional responses (emoji frequency and average significance scores) ($p < 0.05$) from both sessions (blind and informed tests). The continuous data obtained from the purchase intent scores were discretized into 9 categories according to discretization procedures proposed by Kim and Frisby (2019). In this case, discretization was an advantage for data analysis because it kept 'liking' and 'purchase intent' responses on the same scale.

2.5.3. Lexical analysis of terms related to stimuli

A quantitative analysis of text data from comments on acceptance test sheets was carried out by lexical analysis, as described by Andrade and Andrade (2016). This assumes that words used in similar contexts (sensory analysis of four stimuli) are associated with a single lexical world. Iramuteq software (*Interface de R pour analyses Multidimensionnelles de Textes et de Questionneires*), version 0.7, alpha 02, designed for text analysis generated by multiple responses (e.g. open-ended responses), was used in the text analyses, with enhanced representation of graphs related to Factorial Matching Analysis (AFC) (Vocabulary, overlap, frequency of words and word classes, graphical representations on a Cartesian plane). In the AFC, two-dimensional solutions were maintained when the explanation was greater than 70% of the data inertia.

To explain the occurrence of health-related terms, consumers' health concern scores (obtained from the HCS) were categorized using procedures adopted by Pinto et al. (2017). Individual values ranging from 0 to 9 were tallied. Participants' health awareness levels and concern were then classified into three categories according to their scores: low (0–38.24), medium (38.25–69.66) and high (69.67–88.2).

3. Results

3.1. Influence of information of kefir on the overall liking and purchase intent

The results of the mixed model analysis are shown in Table 4. Significant main effects of consumer, stimuli and session on liking and purchase intent were observed ($p < 0.001$). However, it is very likely that this was due to the confounded effect of 'stimuli*session' interaction (like: $p < 0.001$; purchase intent: $p = 0.006$). Results also

Table 4
Results of ANOVA mixed model on the effects of the conjoint factors on liking and purchase intent performed by 100 consumers that evaluated yogurt and mixed beverage with kefir added, in the session 1 (blind test) (a) and session 2 (informed test) (b).

Stimulus	Mean scores ± SD			
	Liking[1]		Purchase intent[2]	
	Session 1	Session 2	Session 1	Session 2
SY	$7.3^{a*} \pm 1.6$	$6.8^{b} \pm 2.1$	$6.4^{a} \pm 2.3$	$6.1^{a} \pm 2.5$
MB15	$6.9^{a,b*} \pm 1.6$	$7.4^{a} \pm 1.3$	$6.1^{a*} \pm 2.2$	$6.7^{a} \pm 2.1$
MB30	$6.8^{b*} \pm 1.6$	$7.3^{a} \pm 1.4$	$5.8^{a,b*} \pm 2.4$	$6.6^{a} \pm 2.1$
MB50	$6.3^{c*} \pm 1.9$	$6.9^{a,b} \pm 1.5$	$5.2^{b*} \pm 2.6$	$6.1^{a} \pm 2.1$

Effect	Liking	Purchase intent
Consumer (Random)	$< 0.001^{***}$	$< 0.001^{***}$
Session	0.015^{*}	$< 0.001^{***}$
Stimulus	$< 0.001^{***}$	$< 0.001^{***}$
Stimulus*Session	$< 0.001^{***}$	0.006^{**}
Consumer*Stimulus	$< 0.001^{***}$	$< 0.001^{***}$
Consumer*Session	$< 0.001^{***}$	$< 0.001^{***}$

* Significant difference between sessions by stimulus ($p < 0.05$) *Significant difference ($p < 0.05$); **Significant difference ($p < 0.01$); ***Significant difference ($p < 0.001$). Averages of liking and purchase intent of the stimuli evaluated by two sessions (blind and informed tests) (n = 100). Within the same effect and group ('Stimuli*Session'), mean values with different letters are significantly different by the Bonferroni test in the columns ($p > 0.05$). Liking evaluated in a 9-point hedonic scale and a non-structured scale of nine centimeters was used to assess the purchase intent. Note: SY – Strawberry Yogurt, MB15 – Mixed Beverage with 15% added Kefir, MB30 – Mixed Beverage with 30% added Kefir, MB50 – Mixed Beverage with 50% added Kefir.

[1] Scores assessed on a 9-point hedonic scale.

[2] Scores assessed on a non-structured scale of 9 cm.

indicate that consumers' health expectations exert influence on liking and purchase intent scores, as 36% and 40% of the variability for liking and purchase intent scores, were attributed to the random effect (consumer).

In the blind test, results indicate that both overall acceptance and purchase intent scores were inversely proportional to the amount of kefir added to the milk beverages. The lowest overall acceptance and purchase intent scores were attributed to milk beverages with 50% added kefir (mean overall like = 6.3, S.D. = 1.9; mean purchase intent = 5.2, S.D. = 2.6). By contrast, in the second session (informed session) mean acceptance and purchase intent levels for traditional yogurt (0% added kefir) decreased compared to the blind test (mean overall like = 6.8, S.D. = 2.1; mean purchase intent = 6.1, S.D. = 2.5) and acceptance scores ended up being lower than those for milk beverages with 15% and 30% added kefir. These results point out the impact that health expectations exert on participants' hedonic responses.

The mixed model analysis also revealed significant effects from Consumer*Session and Consumer*Stimuli interactions ($p < 0.001$). These observations suggest that, in the second session, participants' hedonic responses to the health benefits provided and to the different stimuli, vary between individuals (e.g. due to health concerns and taste preferences). Nevertheless, moderate to high scores were prevalent amongst the participants (83%) for the HCS. This suggests that, in general, health benefits of kefir induced a significant increase on liking, despite different hedonic responses between stimuli and sessions. These increases were enough to increase the overall acceptance level of the least preferred beverage (50% added kefir) up to the acceptance level of the other mixed beverages tasted in the blind test (Fig. 1).

Additionally, corresponding analysis results corroborate the positive impact of participants' health expectations on their hedonic responses. It has been shown that providing information of kefir increased frequency of positive sensorial terms for the mixed beverages (e.g. "nice", "good", "tasty") (Fig. 2). These terms that initially (blind test) were more common for zero stimulus samples (i.e., "nice", "tasty"), became more prevalent to describe stimuli with added kefir (informed test). Also, negative term frequency decreased in the second session as can be shown by an absence of terms related to product acidity (e.g. "very acidic", "bitter") (Fig. 2b). A significant improvement in acceptability and purchase intent for added kefir stimuli lead us to believe that the terms used for these stimuli in the correspondence analysis (Fig. 2) become positive terms and justify an increase in acceptability and purchase intent. In the same way, terms associated with added kefir stimuli in the blind taste test that disappeared (e.g. "very acidic") or moved closer to zero stimulus in the informed test were considered to be negative association terms (e.g. "bitter", "very sweet"). These results concur with previous studies that have identified 'sweet' and 'sour/acidity" to be perceived as opposite poles on a sensory continuum that are seen as attributes with significant sensory-emotion effects on food acceptability (Jaeger et al., 2019; Pohjanheimo & Sandell, 2009).

3.1.1. Individual preferences and emojis used: emotional associations

Principal component analysis (PCA) of acceptance and purchase intent test results also revealed that providing information of kefir positively influenced participants' sensory acceptability and purchase intent for mixed beverages (added kefir). As can be seen on liking in the blind test (Fig. 3a), traditional strawberry yogurt (0% added kefir) and

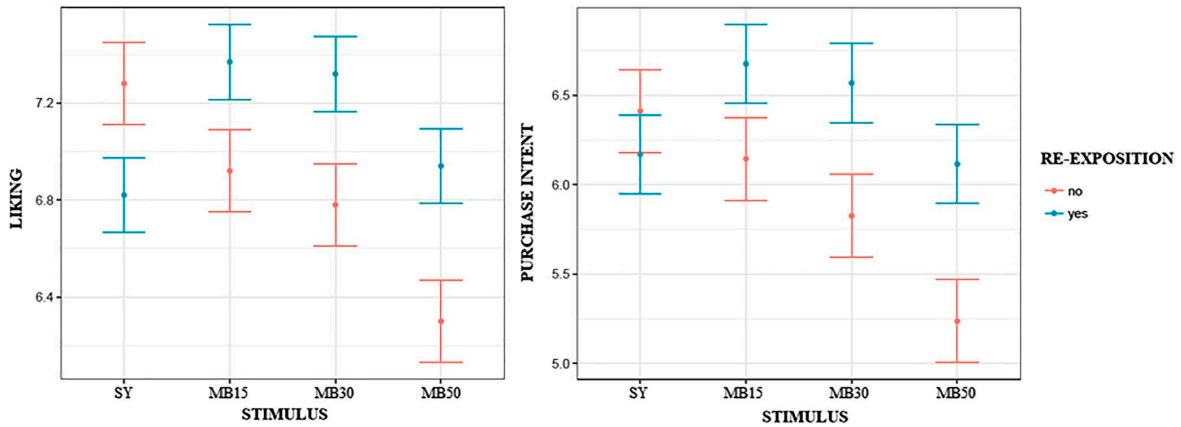

Fig. 1. Plot of the interaction stimuli*session were done (n = 100). Note: SY – Strawberry Yogurt, MB15 – Mixed Beverage with 15% added Kefir, MB30 – Mixed Beverage with 30% added Kefir, MB50 – Mixed Beverage with 50% added Kefir. Re-exposition of stimuli: No – blind test; Yes – informed test.

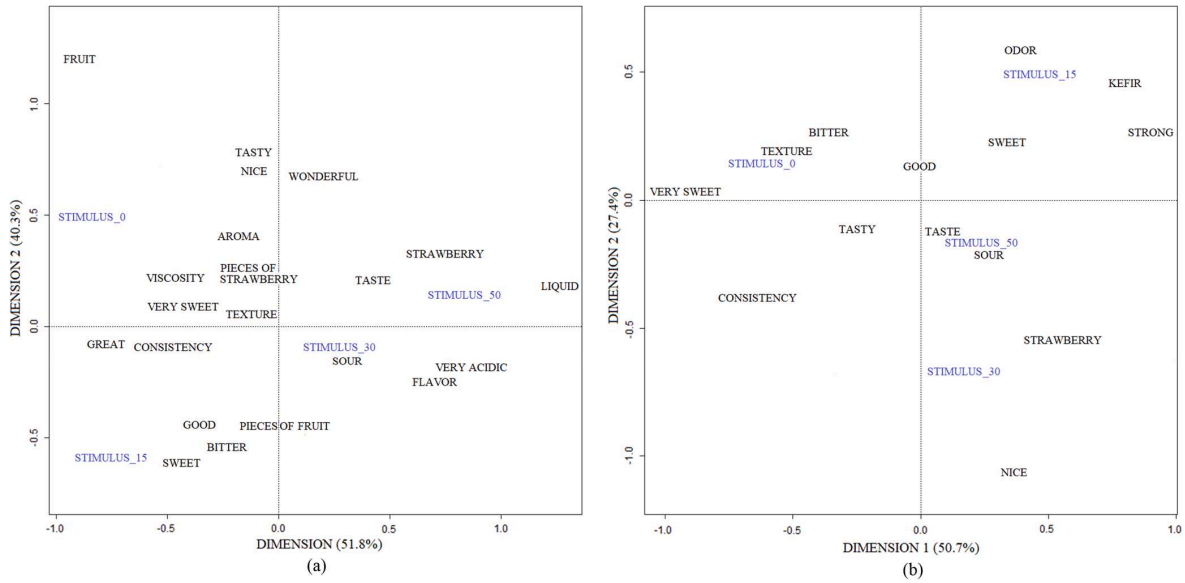

Fig. 2. Correspondence analysis of the most significant words for the stimuli assessed in the blind (a) and informed (b) tests.

the mixed beverage with 15% added kefir were found closer together on the dispersion map, with a greater number or participants around them, indicating a higher acceptance of these samples in this session. However, in the second session (informed taste test) the mixed beverages (15%, 30% and 50% added kefir) were grouped closer on the dispersion map, and the opposite occurred for the traditional strawberry yogurt (Fig. 3a).

PCA for emotional responses resulted in two principal components that explain over 80% of data variability (Fig. 3b). In the blind test, emojis that relate to negative feelings are clearly grouped closer to the mixed beverage with 50% added kefir (least accepted sample). However, in the second session results (informed test) these same emoji are grouped closer to the traditional yogurt beverage. In general, the PCA analysis plainly demonstrates an improvement in positive emotional response towards all added kefir beverages in the second session. The correspondence analysis (Fig. 2) corroborates these findings by showing that negative comments related to product acidity and texture became less frequent in the second session. Emoji frequency analysis (Fig. 4) also supports this assertion.

Participant's emoji choices to express emotional responses to stimuli in the RATA questionnaire indicate that: 'beaming face with smiling eyes' 😁 and 'smiling face with open mouth' 😃 were most commonly used to express sensory acceptability and 'nauseated face' 🤢 and 'face vomiting' 🤮 to express sensory rejection. Other frequently used emojis included 'smiling face with heart eyes' 😍, 'Face savoring food' 😋 and 'drooling face' 🤤 to indicate high liking, while 'neutral face' 😐 and 'face without mouth' 😶 were used to indicate indifference and 'frowning face' ☹️ and 'confounded face' 😖 to convey a bad taste or an unpleasant texture.

Additionally, our results revealed that these emotional associations were more prevalent among participants who used a greater number of emojis in their evaluations (7–12 emojis). Differences in emoji frequency were found for 3 of the 41 emojis (Fig. 4) in both the blind and informed taste tests. In general, older participants, especially males, used fewer emojis than average (1 or 2 versus the 5.7 average emoji use) to express emotional responses. Participants who said they use emojis more frequently in WhatsApp also used significantly more emojis in this study ($p < 0.05$) compared to those who said they used emojis less often (average 7.3 vs. 2.1 emoji use, respectively).

For the most part, the same emojis associated with acceptance were also used to express purchase intent. Emoji like 'thinking face' 🤔, 'face with one eyebrow raised' 🤨 and 'face with monocle' 🧐 were linked more frequently to sensorial rejection and low purchase intent than indifference. Emojis that express surprise such as 'astonished face' 😲, 'face with open mouth' 😮 and 'face screaming in fear' 😱 were more often associated with the pleasant discovery of something unexpected rather than a bad surprise. Additionally, a tighter correlation between the 'money-mouth face' emoji 🤑 and purchase intent scores was observed, suggesting that this pictogram could be useful in determining an individual's value perception.

Emoji associated with positive feelings (e.g. beaming face with smiling eyes '😁') were significantly and positively correlated with liking and purchase intent, while emojis associated with negative emotions (e.g. nauseated face '🤢') were negatively correlated to both parameters in terms of frequency (Table 5) and intensity (Table 6).

As shown in Tables 5 and 6, the correlation analysis from the RATA test results (individual emoji intensity of significance rates) indicates the pictograms that best correlate to overall like and purchase intent scores, suggesting that participants' emotional responses were suitably represented by these emojis. These results corroborate the study of Shoutteten et al. (2018). Also, correlation differences between purchase intent and liking show that participants' sensory acceptance do not perfectly match their purchase intent, which indicates that participants interpreted scores somewhat differently.

The higher positive correlations between optimistic emojis (😁, 😃, 😌, 😋, 😊, 😍, 😘, 😏, 🙂, 😝) and liking and purchase intent scores suggests that these emojis are good indicators. In addition, surprise emojis (😮, 😱) were shown to correlate more closely with liking in the second session (informed test), indicating that emotions evoked by the discovery of new information were indicated by these emojis. It appears that the 'drooling face' emoji (🤤) was also used to express emotions associated with liking, since a high correlation between this pictogram and liking scores could be found in this study. Results from the correlation analysis (Tables 5 and 6) can be used to evaluate participants' emotional responses based on valence and arousal emotion dimensions (Spinelli et al., 2015). Scatter maps were generated by plotting correlation coefficients obtained from emoji frequency and liking/purchase

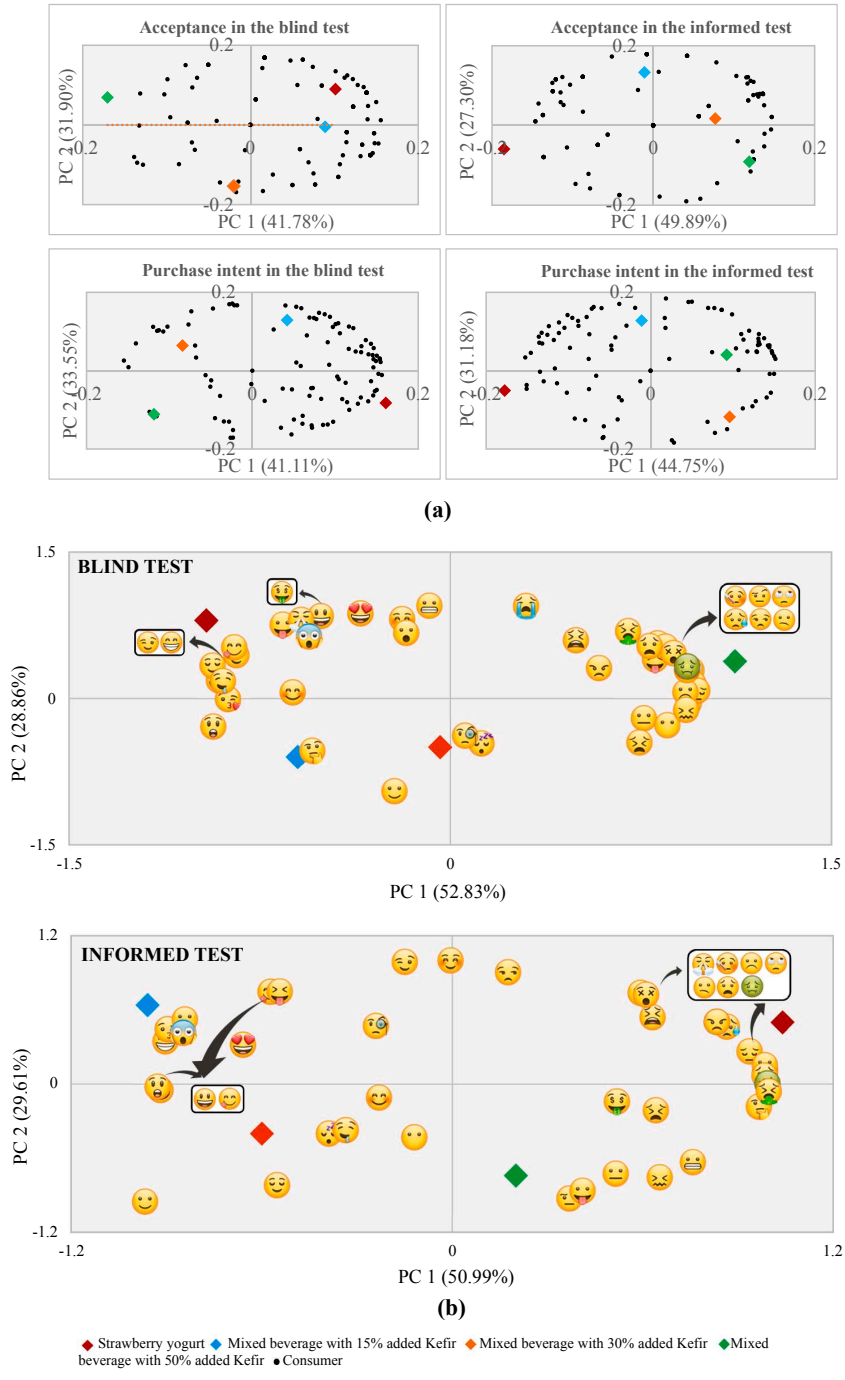

Fig. 3. Principal Component Analysis (PCA) for the liking and purchase intention of the four stimuli (mixed beverage added kefir or strawberry yogurt) in the blind and informed tests (a), and the emotional responses associated to the sessions (b). Note: Size reduction and highlighting of some Emoji were done to improve the visualization. PC 1: First Principal Component; PC 2: Second Principal Component.

intent scores (x-axis) and correlation coefficients obtained from emoji mean intensity of significance and like/purchase intent scores (y-axis) (Fig. 5). The arousal dimension is perpendicular to the valence dimension and was based on the intensity of the selected emojis.

Emoji associated with positive feelings (e.g. '😁') can be found on the left side of the scatter plot (positive acceptance or purchase intent) while emojis associated with negative emotions (e.g. '😠') can be found on the right side (negative acceptance or purchase intent), indicating that the x-axis of the scatter plot relates to emoji valence. Moreover, the location on the y-axis of the scatter plot denotes the level of arousal

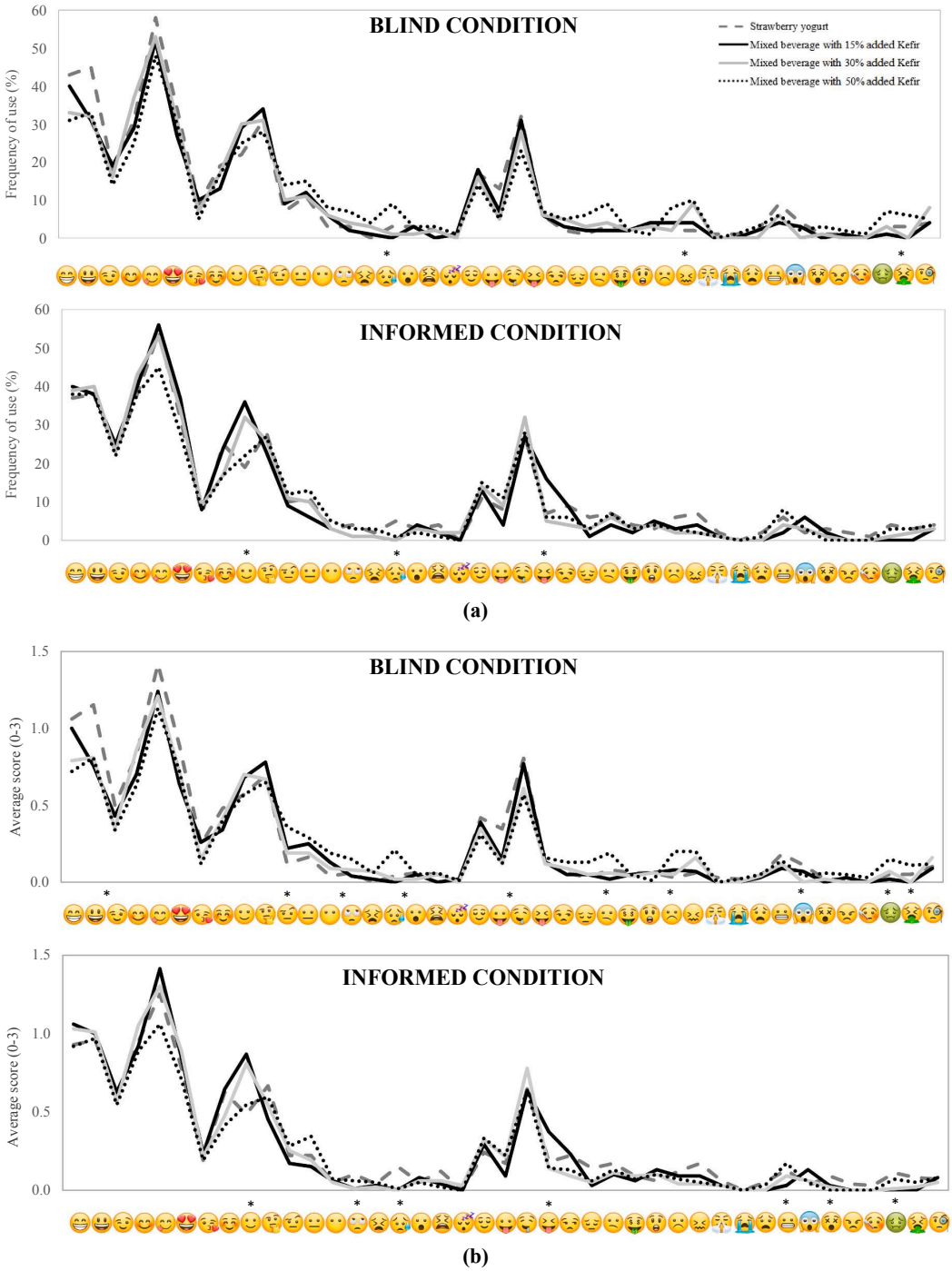

Fig. 4. Line plots show values for frequency of use (a) and average scores (b) for each Emoji presented in a RATA question with a 3-point scale (1: 'low'; 2: 'medium'; 3: 'high') to describe emotional associations with four samples (mixed beverage added kefir or strawberry yogurt) during a blind test and an informed test. Emoji are shown in alphabetical order according to their Unicode name in the WhatsApp package. Significant differences in Emoji use frequency and average scores between stimuli are indicated by * ($p < 0.05$).

elicited by a given emoji, e.g. the '😍' emoji elicited positive valence and high emotional arousal, while '😭' and '😬' emojis were both attributed to negative valence and high emotional arousal.

The results of this study show that this type of analysis provides an intuitive scheme for indicating the various meanings individuals attribute to emojis to express emotional responses. It can be seen that in

Table 5
Correlation coefficient between emotional responses and liking ratings in the two sessions: blind test (session 1) and informed test (n = 100). Values written in bold are significant.

Pearson' correlation between overall liking scores and Emoji frequency score						Pearson' correlation between overall liking scores and Emoji average score					
Emoji	Liking		Emoji	Liking		Emoji	Liking		Emoji	Liking	
	Session 1	Session 2		Session 1	Session 2		Session 1	Session 2		Session 1	Session 2
😁	0.698*	**0.918****	😝	0.869**	**0.875****	😁	**0.777***	**0.978****	😝	**0.840****	**0.915****
😀	0.666ns	**0.917****	😌	-0.281ns	**0.850****	😀	**0.796****	**0.863****	😌	-0.116ns	**0.915****
😏	0.675*	**0.883****	😒	**-0.748***	-0.230ns	😏	**0.769***	**0.905****	😒	**-0.691***	0.604ns
😊	0.564ns	**0.919****	😔	**-0.732***	-0.347ns	😊	**0.754***	**0.918****	😔	**-0.722***	0.380ns
😁	0.812**	**0.877****	😕	-0.582ns	-0.517ns	😁	**0.851****	**0.897****	😕	-0.578ns	0.549ns
😍	0.621ns	**0.848****	🤑	**0.768***	0.641ns	😍	**0.695***	**0.912****	🤑	**0.760***	**0.694***
😘	0.394ns	**0.728***	😲	0.591ns	0.581ns	😘	0.588ns	**0.909****	😲	0.625ns	**0.786***
☺️	0.322ns	**0.829****	☹️	-0.563ns	-0.443ns	☺️	0.645ns	**0.875****	☹️	-0.571ns	0.327ns
🙂	0.470ns	**0.823****	😖	**-0.855****	**-0.742****	🙂	**0.695***	**0.975****	😖	**-0.765***	0.111ns
🤔	-0.149ns	0.136ns	😤	-0.137ns	0.600ns	🤔	-0.097ns	0.179ns	😤	-0.137ns	**0.725***
😉	-0.531ns	-0.349ns	😭	-0.401ns	-	😉	-0.489ns	0.463ns	😭	-0.371ns	-
😐	-0.379ns	-0.296ns	😢	-0.566ns	-0.385ns	😐	-0.316ns	0.417ns	😢	-0.548ns	0.100ns
😶	-0.495ns	-0.426ns	😬	-0.430ns	-0.435ns	😶	-0.491ns	-0.470ns	😬	-0.277ns	0.541ns
🙄	-0.443ns	-0.287ns	😱	-0.506ns	0.639ns	🙄	-0.392ns	0.142ns	😱	-0.433ns	**0.874****
😣	-0.573ns	-0.434ns	😯	**-0.732***	-0.494ns	😣	-0.536ns	-0.310ns	😯	**-0.701***	0.249ns
😥	**-0.824****	**-0.727***	😠	-0.475ns	-0.540ns	😥	**-0.764***	-0.212ns	😠	-0.502ns	0.225ns
😮	**0.753***	**0.878****	😪	-0.548ns	-0.548ns	😮	**0.696***	**0.874****	😪	-0.548ns	-0.548ns
😫	-0.508ns	**-0.771***	🤢	**-0.831****	**-0.774***	😫	-0.507ns	-0.123ns	🤢	**-0.772***	-0.289ns
🥳	-0.089ns	0.037ns	🤮	**-0.750***	**-0.774***	🥳	-0.114ns	0.387ns	🤮	**-0.645ns**	-0.335ns
😌	**0.869****	**0.811****	🧐	-0.022ns	-0.118ns	😌	**0.934****	**0.709***	🧐	-0.100ns	-0.527ns
😛	**0.912****	**0.702***				😛	**0.904****	**0.926****			

Table 6
Correlation coefficient between emotional responses and purchase intent ratings in the two sessions: blind test (session 1) and informed test (n = 100). Values written in bold are significant.

Pearson' correlation between purchase intent scores and Emoji frequency score						Pearson' correlation between purchase intent scores and Emoji average score					
Emoji	Purchase Intent		Emoji	Purchase Intent		Emoji	Purchase Intent		Emoji	Purchase Intent	
	Session 1	Session 2		Session 1	Session 2		Session 1	Session 2		Session 1	Session 2
😁	0.593ns	0.052ns	😝	**0.819****	0.485ns	😁	**0.916****	**0.972****	😝	0.235ns	**0.854****
😀	**0.792***	0.553ns	😌	0.025ns	0.244ns	😀	0.399ns	**0.949****	😌	0.202ns	0.593ns
😏	**0.763***	**0.800****	😒	**-0.722***	-0.289ns	😏	0.408ns	**0.936****	😒	-0.549ns	-0.112ns
😊	**0.808***	**0.968****	😔	**-0.689***	**-0.762***	😊	0.654ns	**0.934****	😔	-0.648ns	**-0.713***
😁	**0.848****	0.564ns	😕	**-0.818****	**-0.930****	😁	**0.951****	**0.881****	😕	**-0.846****	0.649ns
😍	**0.816****	0.661ns	🤑	**0.770***	-0.394ns	😍	**0.812****	**0.827****	🤑	**0.770***	0.477ns
😘	**0.854****	**0.683***	😲	**0.744***	-0.191ns	😘	0.492ns	**0.808***	😲	0.525ns	0.367ns
☺️	**0.757***	0.565ns	☹️	**-0.678***	-0.581ns	☺️	**0.742***	**0.975****	☹️	**-0.679****	-0.555ns
🙂	0.440ns	0.496ns	😖	**-0.822****	**-0.822****	🙂	0.310ns	0.499ns	😖	-0.618ns	**-0.842****
🤔	-0.244ns	0.173ns	😤	-0.548ns	0.437ns	🤔	-0.541ns	-0.500ns	😤	-0.548ns	0.437ns
😉	-0.587ns	-0.596ns	😭	-0.405ns	-	😉	-0.530ns	**-0.807****	😭	-0.338ns	-
😐	-0.473ns	**-0.729***	😢	**-0.730***	-0.504ns	😐	**-0.725***	**-0.804****	😢	-0.794*	-0.513ns
😶	-0.650ns	**-0.895****	😬	-0.602ns	-0.345ns	😶	**-0.754***	**-0.853****	😬	-0.602ns	-0.200ns
🙄	-0.517ns	**-0.712***	😱	0.221ns	0.274ns	🙄	-0.592ns	**-0.699***	😱	0.610ns	0.414ns
😣	-0.647ns	**-0.886****	😯	**-0.710***	-0.381ns	😣	-0.641ns	**-0.908****	😯	-0.615ns	-0.370ns
😥	-0.571ns	**-0.817****	😠	**-0.712***	-0.398ns	😥	**-0.752***	**-0.829****	😠	**-0.688***	-0.276ns
😮	**0.709***	0.566ns	😪	-0.548ns	-0.548ns	😮	**0.714***	0.533ns	😪	-0.548ns	-0.548ns
😫	-0.614ns	**-0.809****	🤢	**-0.703***	**-0.672***	😫	-0.531ns	-0.536ns	🤢	**-0.673***	-0.592ns
🥳	-	0.009ns	🤮	-0.643ns	-0.642ns	🥳	-0.137ns	0.202ns	🤮	-0.637ns	-0.590ns
😌	0.663ns	0.638ns	🧐	-0.002ns	0.117ns	😌	**0.701***	0.514ns	🧐	-0.076ns	**0.694***
😛	0.499ns	0.065ns				😛	0.417ns	0.242ns			

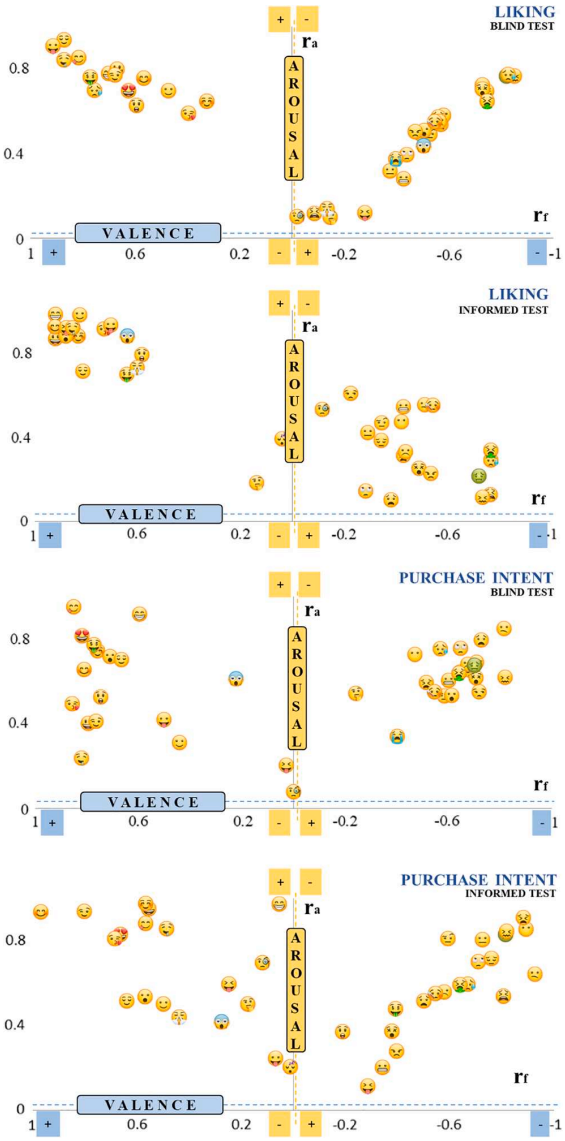

Fig. 5. Representation of the emotional dimensions of valence and arousal attributed to Emoji in relation to products acceptance and purchase intent evaluation (adapted from Spinelli et al., 2015). The arousal dimension is perpendicular to the valence dimension and was based on intensity of the emoji selected. Note: r_f = Pearson' correlation between overall liking/purchase intent and Emoji frequency score; r_a = Pearson' correlation between overall liking scores/purchase intent and Emoji intensity of significance scores.

both circumstances (blind and informed taste tests), individuals attributed different meanings to certain pictograms. For example, the valence for some emojis (😱, 😲, 😮, 😤) changed from negative to positive after individuals were given kefir health information (acceptance test results). These emojis may have been primarily used in the blind test to represent participants' emotional responses to non-accepted beverage sensory attributes, whereas, after they learned about the health benefits of kefir, some participants used these same pictograms to express surprise or another emotion.

4. Discussion

4.1. Effects of health benefits on liking, purchase intent and emotions

An overall evaluation of the qualitative and quantitative data obtained from acceptance and purchase intent tests demonstrate that participants' hedonic responses were strongly influenced by health expectations, even though this influence may be limited by taste preferences. In this study, participants generally attributed significantly higher acceptance and purchase intent scores to the mixed beverage with 50% added kefir in the second session (informed taste test), but the scores were not sufficient to establish this sample as a favorite.

Based on literature on the effect of health information on sensory and hedonic evaluations, a majority of studies have shown that this effect depends on the type of product tested and is not directly related to actual hedonic liking responses (Piqueras-Fiszman & Spence, 2015). In this study, the effects on like scores for the stimuli tested may have depended on health beliefs and concerns, attitudes towards diet, as well as an interest in increasing consumption of healthy foods. These in turn may have interfered with emotional responses and purchase intent. In this sense, information that demonstrates a self-directed benefit may have potential for study (Pinto et al., 2017).

Carabante et al. (2018) reported that offering information on healthier fatty acids increased overall liking and purchase intent for steaks. Some authors have highlighted that packaged products with distinct brands and product information elicit different emotional associations compared to their blind counterparts, and distinctly impact consumers with increasingly high levels of involvement (Jaeger, Lee, & Ares, 2018; Kytö, Järveläinen, & Mustonen, 2018; Spinelli et al., 2015). On the other hand, the findings of Schouteten et al. (2017) where brand information was as an extrinsic source, i.e. non-related to health, indicate that overall liking and emotional profiling could not be observed when information was provided in a home-use test for strawberry yogurt. These results indicate that the validity of the results of this study may be compromised if the non-sensory characteristics of mixed beverages made with yogurt and kefir (e.g. color, brand, nutritional information) were not in keeping with health information labels because they may provide positive emotional reactions to the label.

As expected, sensory attributes governed acceptability and purchase intent levels of participants when composition and health claims for the probiotic beverages were absent (blind test). Moreover, health concerns seem to have played an important role in individuals' emotional responses, enough to raise the acceptance level and purchase intent of all kefir-based beverages, including the least preferred product (50% added kefir). The influence that health expectations play on food sensory acceptability and their ability to drive purchase intent among consumers are remarkable, and can be especially important in situations that require the sacrifice of sensory enjoyments for health benefits. Previous findings have discussed how the ability of non-sensory attributes to influence consumer preferences, and can elevate non-accepted products to higher acceptability levels while decreasing the acceptability of foods considered unsuitable or unhealthy (De Beukelaar et al., 2019; Demartini et al., 2019).

Nevertheless, in this study, acceptability and purchase intent levels were determined by the interaction between sensory performance and health expectations. Clearly, the milk beverages with 15% and 30% added kefir performed better than the beverage with 50% added kefir, possibly because sensory attributes such as texture and acidity overrode participants' tolerance levels. Pronounced, fermented and acidic taste of kefir was the main negative attribute cited in participants' comments. These findings reinforce the need for a fine balance between desired sensory characteristics and health attributes to optimize a product's commercial performance (Pinto et al., 2017).

Participants' rated samples more similarly for sensory attributes when given direct information. A beverage with kefir or without was what was at stake, and in this situation non-sensory characteristics

modified sensory perception. This may be one reason participants rated the added kefir stimuli more similarly for sensory attributes. In the blind test, it was easier to use individual criteria for each sample (e.g., color, flavor, texture), because participants were expecting to taste four different stimuli. When health information was provided, it was not difficult to evaluate the added kefir samples (15%, 30%, 50%) in one way and the control stimulus (0%) in another. Therefore, it is possible to add up to 30% kefir to a yogurt formulation without compromising its sensory acceptability, as long as consumers believe it has potential health benefits.

Emotions evoked were correlated to purchase intent, which led us to corroborate the conclusions that measurement of food-evoked emotions conveys new information beyond acceptance (Gutjar et al., 2015; Swaney-Stueve et al., 2018). Peltier, Visalli, and Thomas (2019) studied the impact of coffee advertisements on consumer behavior have shown that purchase intent and brand image improved when specific emotional responses were identified for different advertisement stimuli.

According to Guo, Wang, and Wu (2020), pleasant feedback for a product/service leads to higher purchase likelihood. Perceived credibility is a factor that has a significant influence on purchase decisions. Emotions evoked by credible health information and the desire for good health also determine preferences for individuals concerned with holistic, nutritional, enjoyment, or purity health choices (Apaolaza, Hartmann, D'Souza, & López, 2018; Chrysochou & Grunert, 2014; Ditlevsen, Sandøe, & Lassen, 2019; Evers, Dingemans, Junghans, & Boevé). Sukkwai et al. (2018) noted that positive (good, interested, satisfied) emotions decreased while negative (guilty, unsafe, worried) emotions increased when dye content in products was increased; statements of "natural dye" and "sodium content" had minimal effects on elicited emotions and on purchase intent. Kim, Song, and Youn (2019) also highlighted that the perceived authenticity of a product/service influences purchase intent both directly and indirectly through positive emotional responses.

This study also pursues the findings of Kytö et al. (2018). These authors realized that emotional responses can predict consumer attitudes, even though low association levels have also been found (Tables 5 and 6). The authors concluded that consumer behavior prediction was poor following a blind test and could only be improved by revealing the information (brand) about the fermented dairy products tested. In this study, prediction levels were better following the blind test and health benefits reduced the sensory pleasure of the control stimulus after the health information was provided.

According to Jiang et al. (2014), health claims can be regarded as rational thinking based on judgment at the time of purchase, but external factors such as purchase environment, mood, packaging, and past experiences can modify emotions and attitudes towards foods and ultimately lead to an impulse or intuitive purchase. In some situations, emotions override food sensory pleasures and decisively dominate repurchase decisions. Despite the link between emotions and purchase intent for foods in this study, few studies have analyzed this association and it is necessary to validate our findings with future studies that focus on emotions and purchase intent.

4.2. Conveying emotional responses with emojis

According to Swaney-Stueve et al. (2018), emotions that weakly correlate with liking a product are of special interest, as they convey information not revealed by acceptance tests. In the present study, emojis were used in a RATA response questionnaire to explore participants' emotional responses to different stimuli (milk beverages). This approach made it possible to distinguish the valence and activation emotion dimensions evoked by participants when choosing emojis. Results of this analysis highlight the presence of emotional responses that extrapolate sensory acceptance of the products.

The 'sleeping face' emoji 😴 may have indicated emotional disconnection and reduced interest during sample tasting. The 'sad but relieved face' emoji 😥 was initially used to express negative feelings towards samples with higher proportions of kefir (blind test). However, in the second session, the same pictogram was primarily used to express discontent for the sample with no added kefir (once participants had been informed of the contents of kefir in the samples composition). Different contexts significantly affected emoji meanings and how these meanings are used to express food emotions (Hu & Lee, 2018; Schouteten et al., 2018).

This study has identified certain differences in emoji meanings for Brazilian consumers compared to meanings found in previous studies (Jaeger, Lee, & Ares, 2018; Jaeger, Roigard, & Jin, 2018; Jaeger, Xia, & lee, 2018). For example, 'face with steam from nose' 😤, 'face with raised eyebrow raised' 🤨, 'grimacing face' 😬 and 'thinking face' 🤔 characterized both good and bad emotions with varying (low, medium and high) degrees of intensity. Some emojis that reflected negative acceptance or purchase intent were insignificant after health benefits of kefir were provided (e.g. '😥', '🤢', '😭'). In some cases, this effect was greater in the activation dimension (degree of emotion felt) than in the valence dimension.

Munoz-de-Escalon and Canas (2017) describes "fear" as a high-activation level/negative valence emotion, while "calm" is a low-activation/positive-valence emotion. In this sense, and in keeping with previous studies (Spinelli et al., 2015), our study showed that positive emotions characterized by a higher degree of arousal were more prevalent when participants had health expectations for the probiotic beverages. Cognitive dissonance was pronounced after consumers were given health information about the beverages and tried to minimize discomfort by modifying beliefs about the samples. Cognitive dissonance refers to a feeling of mental discomfort leading to a change in attitudes, beliefs or behaviors to alleviate this discomfort and to restore balance (McLeod, 2018).

The findings of this study are in keeping with previous studies which show that hedonic judgment is based on both extrinsic and intrinsic signals from food products (Conti-Silva & de Souza-Borges, 2018; Nacef et al., 2019). The effects of these signals and how they are received and valued by consumers can make food and beverage product acceptability less dependent on sensory attributes (Carvalho & Spence, 2019; Claret, Guerrero, Gartzia, Garcia-Quiroga, & Ginés, 2016; Hubbard, Jervis, & Drake, 2016). This study reinforces the need for a careful approach in the association of emojis with acceptance and attitude measurements. Future studies should be carried out to determine controversial emojis, i.e. those that have both positive and negative connotations, and how to implement them in evaluations.

4.3. Limitations and future prospects

Some limitations in the present study should be mentioned. The team was made up of health-conscious consumers to facilitate analysis of the influence of health information. The second limitation is the age factor, as more than 64% of the participants were 18–25. Older people might present different attitudes, hedonic and emotional responses as they are more concerned with health. Therefore, future studies on individuals with low health concerns may counter or corroborate our findings.

Third, as has been shown in similar studies (Jaeger et al., 2017; Schouteten et al., 2018), average emoji frequency was around 14%. Using four stimuli and an emotional survey based on a 3-page evaluation where emotion was evaluated last (acceptance, purchase intent and emotion), evaluation saturation (categorical scale, unstructured scale and 41 emoji in RATA scale) for each sample served could be a factor in determining emotional responses. The saturation levels may have influenced the results, but participants first assessed overall liking potential to reduce bias, as past procedures have recommended (Schouteten et al., 2018). Moreover, because Brazil has had fewer studies involving emojis and perception, a large number of emojis were used to try to meet a set emotional profile for Brazil. Our research can

contribute to methods which may be used for other products and consumer populations from different countries because it presented new insights regarding Brazilian consumers. For future investigation, it is important to describe facial features and emoji meanings/uses and define the sensory terms and emotion words that are not readily understood by the general public.

Finally, in future research with emoji surveys, it could also be useful to have more detail regarding package of the samples (e.g. colors, nutritional labelling, brand). It would be interesting to study assimilation theory, expectation confirmation and disconfirmation, and different food matrices in order to determine if flavors other than strawberry present the same results and have the same prominent flavor of kefir. In keeping with the work of Schouteten et al. (2017), this study provides new findings about the emotional profile of strawberry yogurt beverages, and highlights nuances and gaps for the beverage as well.

5. Conclusion

This study demonstrates the impact that health expectations exert on consumers‘ acceptance, purchase intent and emotional responses toward food and beverages. Providing information on health benefits of kefir affected survey participants' perception of sensory attributes such as the acid taste and texture of milk beverages added kefir. Overall, consumer acceptance and emotional responses for yogurt formulation with an addition of up to 30% kefir did not compromise sensory acceptability, when consumers were led to believe in its potential health benefits. This emphasizes that the addition of an ingredient, even one with health benefits such as kefir, should be investigated further. Health benefit information can have a positive effect on product acceptance when it does not compromise sensory quality.

Valence and arousal were moderated by health benefits of kefir. Positive emotions increased when participants were re-exposed to milk beverages with information (0%, 15%, 30% and 50% m/v), while negative emotions decreased. Mixed beverages may be a probiotic beverage alternative for consumers who dislike kefir, but otherwise wish to consume it. In this sense, exploring food-evoked emotions may provide additional information beyond hedonic and attitude measurements and enhance product development and marketing decision making.

Declaration of Competing Interest

The authors declared no conflict of interest.

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References

Andrade, E. de O., Jr., & Andrade, E. de O. (2016). Lexical analysis of the code of medical ethics of the Federal Council of Medicine. *Revista Da Associacao Medica Brasileira, 62*, 123–130.

Apaolaza, V., Hartmann, P., D'Souza, C., & López, C. M. (2018). Eat organic – Feel good? The relationship between organic food consumption, health concern and subjective wellbeing. *Food Quality and Preference, 63*, 51–62.

Ares, G., Giménez, A., & Gámbaro, A. (2008). Understanding consumers' perception of conventional and functional yogurts using hard laddering and word association. *Food Quality and Preference, 19*(7), 636–643.

Ares, G., & Jaeger, S. R. (2017). A comparison of five methodological variants of Emoji questionnaires for measuring product elicited emotional associations: An application with seafood among Chinese consumers. *Food Research International, 99*, 216–228.

Bates, D.M., Maechler, M., & Bolker, B. (2014). lme4: Linear mixed-effects models using S4 classes. R package version 0.999999-0.

Bimbo, F., Bonanno, A., Nocella, G., Viscecchia, R., Nardone, G., De Devitiis, B., & Carlucci, D. (2017). Consumers' acceptability and preferences for nutrition-modified and functional dairy products: A systematic review. *Appetite, 113*, 141–154.

Carabante, K. M., Ardoin, R., Scaglia, G., Malekian, F., Khachaturyan, M., Janes, M. E., & Prinyawiwatkul, W. (2018). Consumer Acceptability, emotional response, and purchase intent of rib-eye steaks from grass-fed steers, and effects of health benefit information on consumer perception. *Journal of Food Science, 83*(10), 2560–2570.

Carneiro, J. D. S., Silva, C. H. O., Della Lucia, S. M., & Minim, V. P. R. (2018). Análise Conjunta de Fatores. In V. Minim (Ed.). *Análise sensorial: estudo com consumidores*. Viçosa: Editora UFV.

Carvalho, F. M., & Spence, C. (2019). Cup colour influences consumers' expectations and experience on tasting specialty coffee. *Food Quality and Preference, 75*, 157–169.

Castro, L. (2018). A Leiteria lança 1° Kefir no Brasil com apoio da Globalfood. Available at: https://www.grupomaisfood.com.br/mais_leite/a-leiteria-lanca-1o-Kefir-no-brasil-com-apoio-da-globalfood/. Accessed 22 December 2018.

Chrysochou, P., & Grunert, K. G. (2014). Health-related ad information and health motivation effects on product evaluations. *Journal of Business Research, 67*(6), 1209–1217.

Claret, A., Guerrero, L., Gartzia, I., Garcia-Quiroga, M., & Ginés, R. (2016). Does information affect consumer liking of farmed and wild fish? *Aquaculture, 454*, 157–162.

Conti-Silva, A. C., & de Souza-Borges, P. K. (2018). Sensory characteristics, brand and probiotic claim on the overall liking of commercial probiotic fermented milks: Which one is more relevant? *Food Research International*.

Dantas, M. I. S., Minim, V. P. R., & Deliza, R. (2003). Tradução e validação para a língua portuguesa do questionário Health Consciousness utilizado em estudos de consumidor. *Boletim sbCTA, 37*(2), 103–105.

Das, G., Wiener, H. J. D., & Kareklas, I. (2019). To Emoji or not to Emoji? Examining the influence of Emoji on consumer reactions to advertising. *Journal of Business Research, 96*, 147–156.

De Beukelaar, M. F. A., Zeinstra, G. G., Mes, J. J., & Fischer, A. R. H. (2019). Duckweed as human food. The influence of meal context and information on duckweed acceptability of Dutch consumers. *Food Quality and Preference, 71*, 76–86.

Demartini, E., De Marchi, E., Cavaliere, A., Mattavelli, S., Gaviglio, A., Banterle, A., ... Perugini, M. (2019). Changing attitudes towards healthy food via self-association or nutritional information: What works best? *Appetite, 132*, 166–174.

Dertli, E., & Çon, A. H. (2017). Microbial diversity of traditional kefir grains and their role on kefir aroma. *LWT - Food Science and Technology, 85*, 151–157.

Ditlevsen, K., Sandøe, P., & Lassen, J. (2019). Healthy food is nutritious, but organic food is healthy because it is pure: The negotiation of healthy food choices by Danish consumers of organic food. *Food Quality and Preference, 71*, 46–53.

Dos Reis, S. A., da Conceição, L. L., Dias, M. M., Siqueira, N. P., Rosa, D. D., de Oliveira, L. L., ... Peluzio, M. do C. G. (2019). Kefir reduces the incidence of pre-neoplastic lesions in an animal model for colorectal cancer. *Journal of Functional Foods, 53*, 1–6.

Edwards, J. S. A., Hartwell, H. J., & Brown, L. (2013). The relationship between emotions, food consumption and meal acceptability when eating out of the home. *Food Quality and Preference, 30*(1), 22–32.

Erdogan, F. S., Ozarslan, S., Guzel Seydim, Z. B., & Tas, T. K. (2019). The effect of kefir produced from natural kefir grains on the intestinal microbial populations and antioxidant capacities of balb/C mice. *Food Research International, 115*, 408–413.

Emojipedia (2018). Emojipedia Smileys and people. https://Emojipedia.org/whatsapp/ Accessed 19 November 2018.

Evans, V. (2015). No, the rise of the Emoji doesn't spell the end of language. Available at: < https://theconversation.com/no-the-rise-of-the-Emoji-doesnt-spell-the-end-oflanguage-42208/ > Accessed 19 November 2018.

Evers, C., Dingemans, A., Junghans, A. F., & Boevé, A. (2018). Feeling bad or feeling good, does emotion affect your consumption of food? A meta-analysis of the experimental evidence. *Neuroscience & Biobehavioral Reviews, 92*, 195–208.

Fibri, D. L. N., & Frøst, M. B. (2020). Indonesian millennial consumers' perception of tempe – and how it is affected by product information and consumer psychographic traits. *Food Quality and Preference, 80*, 103798.

Gallo, K. E., Swaney-Stueve, M., & Chambers, D. H. (2017). A focus group approach to understanding food-related emotions with children using words and Emoji. *Journal of Sensory Studies, 32*, e12264.

Giboreau, A., & Meiselman, H. L. (2018). Emotions before and after a meal in a natural eating situation. *Food Quality and Preference, 65*, 191–193.

Giraldo, M., Buodo, G., & Sarlo, M. (2019). Food processing and emotion regulation in vegetarians and omnivores: An event-related potential investigation. *Appetite*104334.

Glibowski, P., & Kowalska, A. (2012). Rheological, texture and sensory properties of kefir with high performance and native inulin. *Journal of Food Engineering, 111*(2), 299–304.

Guo, J., Wang, X., & Wu, Y. (2020). Positive emotion bias: Role of emotional content from online customer reviews in purchase decisions. *Journal of Retailing and Consumer Services, 52*, 101891.

Gutjar, S., de Graaf, C., Kooijman, V., de Wijk, R. A., Nys, A., ter Horst, G. J., et al. (2015). The role of emotions in food choice and liking. *Food Research International, 76*, 216–223.

Hatmal, M. M., Nuirat, A., Zihlif, M. A., & Taha, M. O. (2018). Exploring the influence of culture conditions on kefir's anticancer properties. *Journal of Dairy Science, 101*(5), 3771–3777.

Hu, X., & Lee, J. (2018). Emotions elicited while beverageing coffee: A cross-cultural comparison between Korean and Chinese consumers. *Food Quality and Preference*.

Hubbard, E. M., Jervis, S. M., & Drake, M. A. (2016). The effect of extrinsic attributes on liking of cottage cheese. *Journal of Dairy Science, 99*(1), 183–193.

Jaeger, S. R., Lee, S. M., Kim, K.-O., Chheang, S. L., Jin, D., & Ares, G. (2017). Measurement of product emotions using Emoji surveys: Case studies with tasted foods and beverages. *Food Quality and Preference, 62*, 46–59.

Jaeger, S. R., Lee, P.-Y., & Ares, G. (2018). Product involvement and consumer food-elicited emotional associations: Insights from Emoji questionnaires. *Food Research International, 106*, 999–1011.

Jaeger, S. R., Roigard, C. M., Jin, D., Vidal, L., & Ares, G. (2018). Valence, arousal and sentiment meanings of 33 facial Emoji: Insights for the use of Emoji in consumer

research. *Food Research International, 119*, 895–907.
Jaeger, S. R., Lee, S. M., Kim, K.-O., Chheang, S. L., Roigard, C. M., & Ares, G. (2018). CATA and RATA questions for product-focused emotion research: Five case studies using emoji questionnaires. *Food Quality and Preference, 68*, 342–348.
Jaeger, S. R., Xia, Y., Lee, P.-Y., Hunter, D. C., Beresford, M. K., & Ares, G. (2018). Emoji questionnaires can be used with a range of population segments: Findings relating to age, gender and frequency of Emoji/emoticon use. *Food Quality and Preference, 68*, 397–410.
Jaeger, S. R., Roigard, D., & Ares, G. (2018). Measuring consumers' product associations with emoji and emotion word questionnaires: Case studies with tasted foods and written stimuli. *Food Research International, 111*, 723–747.
Jaeger, S. R., Lee, P.-Y., Xia, Y., Chheang, S. L., Roigard, C. M., & Ares, G. (2019). Using the emotion circumplex to uncover sensory drivers of emotional associations to products: Six case studies. *Food Quality and Preference, 77*, 89–101.
Janiaski, D. R., Pimentel, T. C., Cruz, A. G., & Prudencio, S. H. (2016). Strawberry-flavored yogurts and whey beverages: What is the sensory profile of the ideal product? *Journal of Dairy Science, 99*(7), 5273–5283.
Jiang, Y., King, J. M., & Prinyawiwatkul, W. (2014). A review of measurement and relationships between food, eating behavior and emotion. *Trends in Food Science and Technology, 36*, 15–28.
Jones, A. C., & Herr, N. R. (2018). Emotion differentiation mediates the association between emotion regulation difficulties and caloric intake. *Eating Behaviors, 29*, 35–40.
Juodeikiene, G., Zadeike, D., Klupsaite, D., Cernauskas, D., Bartkiene, E., Lele, V., et al. (2018). Effects of emotional responses to certain foods on the prediction of consumer acceptability. *Food Research International, 112*, 361–368.
Kesenkaş, H., Gürsoy, O., & Özbaş, H. (2017). Kefir A2 - Frias, Juana. In C. Martinez-Villaluenga, & E. Peñas (Eds.). *Fermented foods in health and disease prevention* (pp. 339–361). Boston: Academic Press.
Kim, S.-K., & Frisby, C. L. (2019). Gaining from discretization of continuous data: The correspondence analysis biplot approach. *Behavior Research Methods, 51*, 589–601.
Kim, J.-H., Song, H., & Youn, H. (2019). The chain of effects from authenticity cues to purchase intention: The role of emotions and restaurant image. *International Journal of Hospitality Management*102354.
Kytö, E., Järveläinen, A., & Mustonen, S. (2018). Hedonic and emotional responses after blind tasting are poor predictors of purchase behavior. *Food Quality and Preference, 70*, 49–56.
Lemos, T. C., Almo, A., Campagnoli, R. R., Pereira, M. G., Oliveira, L., Volchan, E., et al. (2020). A red code triggers an unintended approach motivation toward sweet ultra-processed foods: Possible implications for front-of-pack labels. *Food Quality and Preference, 79*, 103784.
Lesme, H., Courcoux, P., Alleaume, C., Famelart, M.-H., Bouhallab, S., Prost, C., & Rannou, C. (2019). Contribution of Temporal Dominance of Sensations performed by modality (M-TDS) to the sensory perception of texture and flavor in semi-solid products: a case study on fat-free strawberry yogurts. *Food Quality and Preference*103789.
Lima, M., De Alcantara, M., Martins, I. B. A., Ares, G., & Deliza, R. (2019). Can front-of-pack nutrition labeling influence children's emotional associations with unhealthy food products? An experiment using Emoji. *Food Research International, 120*, 217–225.
Lima, M. dos S. F. de, Souza, K. M. S., Albuquerque, W. W. C., Teixeira, J. A. C., Cavalcanti, M. T. H., & Porto, A. L. F. (2017). Saccharomyces cerevisiae from Brazilian kefir-fermented milk: An in vitro evaluation of probiotic properties. *Microbial Pathogenesis, 110*, 670–677.
Luangrath, A. W., Peck, J., & Barger, V. A. (2017). Textual paralanguage and its implications for marketing communications. *Journal of Consumer Psychology, 27*, 98–107.
McLeod, S. A. (2018). Cognitive dissonance. Available at: < https://www.simplypsychology.org/cognitive-dissonance.html > Accessed on 20 May 2019.
Meiselman, H. L. (2015). A review of the current state of emotion research in product development. *Food Research International, 76*, 192–199.
Meyners, M., Jaeger, S. R., & Ares, G. (2016). On the analysis of rate-all-that-apply (RATA) data. *Food Quality and Preference, 49*, 1–10.
Miccoli, L., Martínez-Fiestas, M., Delgado-Rodríguez, R., Díaz-Ferrer, S., Rodríguez-Ruiz, S., & Fernández-Santaella, M. C. (2018). Adolescent emotions toward sweet food cues as a function of obesity and risky dieting practices. *Food Quality and Preference, 68*, 205–214.
Miguel, M. G. da C. P., Cardoso, P. G., Lago, L. de A., & Schwan, R. F. (2010). Diversity of bacteria present in milk kefir grains using culture-dependent and culture-independent methods. *Food Research International, 43*(5), 1523–1528.
Milkpoint. (2018). Bio-tiful Dairy lança o primeiro Kefir-Quark do mundo no Reino Unido. Available at: < https://www.milkpoint.com.br/colunas/novidades-lancamentos-lacteos/biotiful-dairy-lanca-o-primeiro-Kefirquark-do-mundo-no-reino-unido-207066/ > . Accessed 30 December 2018.
Munoz-de-Escalon, E., & Canas, J. (2017). *Online measuring of available resources. H-Workload 2017: The first international symposium on human mental workload.* Dublin Institute of Technology28–30.
Nacef, M., Lelièvre-Desmas, M., Symoneaux, R., Jombart, L., Flahaut, C., & Chollet, S. (2019). Consumers' expectation and liking for cheese: Can familiarity effects resulting from regional differences be highlighted within a country? *Food Quality and Preference, 72*, 188–197.
Nale, Z., Tontul, I., Aşçi Arslan, A., Sahin Nadeem, H., & Kucukcetin, A. (2017). Microbial viability, physicochemical and sensory properties of Kefir microcapsules prepared using maltodextrin/Arabic gum mixes. *International Journal of Dairy Technology, 71*, 61–72.
Oliveira, D., Ares, G., & Deliza, R. (2018). The effect of health/hedonic claims on consumer hedonic and sensory perception of sugar reduction: Case study with orange/passion fruit nectars. *Food Research International, 108*, 111–118.
Palczak, J., Blumenthal, D., Rogeaux, M., & Delarue, J. (2019). Sensory complexity and its influence on hedonic responses: A systematic review of applications in food and beverages. *Food Quality and Preference,* 66–75.
Peltier, C., Visalli, M., & Thomas, A. (2019). Using temporal dominance of emotions at home. Impact of coffee advertisements on consumers' behavior and methodological perspectives. *Food Quality and Preference, 71*, 311–319.
Pinto, V. R. A., Freitas, T. B. O., Dantas, M. I. S., Della Lucia, S. M., Melo, L. F., Minim, V. P. R., et al. (2017). Influence of packaging and health-related claims on perception and sensory acceptability of snack bars. *Food Research International, 101*, 103–113.
Piqueras-Fiszman, B., & Jaeger, S. R. (2014). The impact of the means of context evocation on consumers' emotion associations towards eating occasions. *Food Quality and Preference, 37*, 61–70.
Piqueras-Fiszman, B., & Spence, C. (2015). Sensory expectations based on product-extrinsic food cues: An interdisciplinary review of the empirical evidence and theoretical accounts. *Food Quality and Preference, 40*, 165–179.
Pohjanheimo, T., & Sandell, M. (2009). Explaining the liking for drinking yoghurt: The role of sensory quality, food choice motives, health concern and product information. *International Dairy Journal, 19*(8), 459–466.
R Core Team (2014). *R: A language and environment for statistical computing.* Vienna, Austria: R Foundation for Statistical Computing.
Riordan, M. A. (2017). Emoji as tools for emotion work: Communicating affect in text messages. *Journal of Language and Social Psychology, 36*, 549–567.
Rodrigues, K. L., Caputo, L. R. G., Carvalho, J. C. T., Evangelista, J., & Schneedorf, J. M. (2005). Antimicrobial and healing activity of kefir and kefiran extract. *International Journal of Antimicrobial Agents, 25*(5), 404–408.
Russell, C. G., Burke, P. F., Waller, D. S., & Wei, E. (2017). The impact of front-of-pack marketing attributes versus nutrition and health information on parents' food choices. *Appetite, 116*, 323–338.
Schouteten, J. J., De Steur, H., Sas, B., De Bourdeaudhuij, I., & Gellynck, X. (2017). The effect of the research setting on the emotional and sensory profiling under blind, expected, and informed conditions: A study on premium and private label yogurt products. *Journal of Dairy Science, 100*(1), 169–186.
Schouteten, J. J., Verwaeren, J., Lagast, S., Gellynck, X., & De Steur, H. (2018). Emoji as a tool for measuring children's emotions when tasting food. *Food Quality and Preference, 68*, 322–331.
Singh, P. K., & Shah, N. P. (2017). Other Fermented Dairy Products. *Yogurt in Health and Disease Prevention,* 87–106.
Spence, C. (2017). Comfort food: A review. *International Journal of Gastronomy and Food Science, 9*, 105–109.
Spinelli, S., Masi, C., Zoboli, G. P., Prescott, J., & Monteleone, E. (2015). Emotional responses to branded and unbranded foods. *Food Quality and Preference, 42*, 1–11.
Spinelli, S. (2017). Implications of the science of emotion for applied research: Comments on Prescott (2017). *Food Quality and Preference, 62*, 369–371.
Spinelli, S., & Jaeger, S. R. (2019). What do we know about the sensory drivers of emotions in foods and beverages? *Current Opinion in Food Science, 27*, 82–89.
Sukkwai, S., Kijroongrojana, K., Chonpracha, P., Pujols, K. D., Alonso-Marenco, J. R., Ardoin, R., et al. (2018). Effects of colorant concentration and "natural colour" or "sodium content" claim on saltiness perception, consumer liking and emotion, and purchase intent of dipping sauces. *International Journal of Food Science & Technology, 53*(5), 1246–1254.
Swaney-Stueve, M., Jepsen, T., & Deubler, G. (2018). The Emoji scale: A facial scale for the 21st century. *Food Quality and Preference, 68*, 183–190.
Thompson, J. L., Lopetcharat, K., & Drake, M. A. (2007). Preferences for commercial strawberry drinkable yogurts among African American, Caucasian, and Hispanic consumers in the United States. *Journal of Dairy Science, 90*(11), 4974–4987.
Thomson, D., Crocker, C., & Marketo, C. G. (2010). Linking sensory characteristics to emotions: An example using dark chocolate. *Food Quality and Preference, 21*, 1117–1125.
Vidal, L., Ares, G., & Jaeger, S. R. (2016). Use of emoticon and Emoji in tweets for food-related emotional expression. *Food Quality and Preference, 49*, 119–128.
Vidal, L., Ares, G., Hedderley, D. I., Meyners, M., & Jaeger, S. R. (2018). Comparison of rate-all-that-apply (RATA) and check-all-that-apply (CATA) questions across seven consumer studies. *Food Quality and Preference, 67*, 49–58.
Waldman, K. B., & Kerr, J. M. (2018). Does safety information influence consumers' preferences for controversial food products? *Food Quality and Preference, 64*, 56–65.
Zhou, X., van Tilburg, W. A. P., Mei, D., Wildschut, T., & Sedikides, C. (2019). Hungering for the past: Nostalgic food labels increase purchase intentions and actual consumption. *Appetite, 140*, 151–158.

Supplementary Table 1. Stimuli chosen

Stimuli	Ingredients
Strawberry yogurt	Milk, sugar, milk powder, strawberry pulp (strawberry and sugar) and starter culture*
Mixed beverage with 15% added Kefir **Mixed beverage with 30% added Kefir** **Mixed beverage with 50% added Kefir**	**Strawberry yogurt with kefir (UHT milk and Kefir grains)**

* Delvo YOG FVV-122DSF, DSM Food Specialties, Delft, Netherlands. Samples were served at cooling temperature (7 °C ± 1 °C).

Supplementary Table 2. Recruitment for Brazilian consumers (n =100).

Characteristics	Percentage (%)
Gender	
Female	55
Male	45
Age (years)	
18-25	64
26-35	27
36 years or more	9
Married?	
No	88
Yes	12
Education level	
Primary or secondary school	65
Completed Higher Education	15
Postgraduate (master's degree)	19
Postgraduate (PhD)	1
Read food labels	
Always or often	53
Sometimes	45
Very infrequently	2
Consume dairy beverages (yogurt, milk beverage or fermented milk)	
Often (3-7 times a week)	42
Sometimes (1-2 times a week)	31
Rarely (every 15 days to 1 time per month)	27

Frequency of WhatsApp use (Counted by activity time)	
Always (> 90% of the time)	34
Often (65-90% of the time)	41
Sometimes (35-65% of the time)	18
Rarely (10-35% of the time)	5
Very infrequently (<10% of the time)	2
Frequency of Emoji use	
Always (> 90% of the time)	22
Often (65-90% of the time)	33
Sometimes (35-65% of the time)	25
Rarely (10-35% of the time)	11
Never or very infrequently (<10% of the time)	9
Health Concern*	
Low (Up to 38.45)	17.2
Average (38.46 to 69.67)	63.6
High (69.68 to 88.2)	19.2

*Categories based on the study of Filho et al. (2015).

Table 3. List of Emoji used in the study (WhatsApp version 2.17).

Emoji	Description	Emoji	Description
	Beaming face with smiling eyes		Squinting face with tongue
	Smiling face with open mouth		Drooling face
	Winking face		Unamused face
	Smiling face		Pensive face, sad face or sorrowful
	Face savoring delicious food		Confused face
	Smiling face with heart eyes		Money-mouth face
	Face blowing a kiss		Astonished face
	White smiling face		Frowning face
	Slightly smiling face		Confounded face
	Thinking face		Face with steam from nose
	Face with raised eyebrow raised		Loudly crying face
	Neutral face		Anguished face
	Face without mouth		Grimacing face
	Face with rolling eyes		Face screaming in fear
	Persevering face		Dizzy face
	Sad but relieved face		Angry face
	Face with open mouth		Face with thermometer

	Tired face Sleeping face Relieved face Face with tongue		Nauseated face Face vomiting Face with monocle

5. CHAPTER IV
Proposal for determining valence and arousal thresholds: Compromised pleasure threshold, unpleasure threshold, and arousal threshold

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ORIGINAL ARTICLE

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Proposal for determining valence and arousal thresholds: Compromised pleasure threshold, unpleasure threshold, and arousal threshold

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Abstract

Individuals' emotions have been studied for nearly half a century, but the literature has not advanced to the point of estimating the intensity of a stimulus capable of influencing valence and arousal. The aim of this study was to elucidate three new thresholds: the valence thresholds, represented by the compromised pleasure threshold (CPT) and unpleasure threshold (UT), and the arousal threshold (AT). Valence and arousal ratings were obtained through the affective slider (AS), and CPT, UT, and AT were determined for images of moldy Brazilian carrot cake. Results showed CPT occurs after 1.9 days of deterioration and the AT is reached after 10.5 days of deterioration. The moldy carrot cake was valenced negatively, in the low-arousal region. The methodology was shown to be appropriate for measuring emotion thresholds, which highlights its potential to generate deeper understanding of consumers' perceptions of valence and arousal.

Practical Applications

When it comes to emotion-driven food choices, emotion thresholds methodology can help in the monitoring of unhealthy food choices, because it will be able to provide thresholds corresponding to variables capable of significantly influencing the consumer's mood. Likewise, they may also be useful to industry, public policymakers, and health professionals, in order to facilitate the identification of the intrinsic and extrinsic factors that improve the mood of the consumer. Mitigation efforts can focus on the relationship between eating disorders and negative emotional states, which affect CPT, UT, and AT and, in turn, decision-making. We propose that identifying the psychophysiological reactions to comforting stimuli allows us to examine differences in food processing cues among individuals with eating disorders (e.g., compulsive eating, anorexia, and bulimia), and how they shape emotion thresholds. This creates opportunities for psychoeducational interventions and improvements in decision-making.

1 | INTRODUCTION

1.1 | Valence and arousal evoked by food experiences

Emotions go hand in hand with hedonic perceptions, since they are capable of providing information beyond the sensorial properties of the food products, such as acceptance and preference, as well as behaviors, feelings and motivations with regard to foods (Prescott, 2017; Schouteten, 2020). Emotions allow researchers to capture reactions that are expressed spontaneously on a plane with harmonious choices and consumption experiences, which provide insights for developing new products and services (Jaeger, Roigard, Jin, Vidal, & Ares, 2019).

Decisions based on relatively affective stimuli, such as foods, are strongly influenced by modulators of food choices, such as hunger, caloric density of the food and subjective valence associated with the stimulus (Garlasco, Osimo, Rumiati, & Parma, 2019). Valence (pleasure–unpleasure) is a property of emotional stimuli that plays an important role in the diversity of human emotional experiences (Imbir, Jurkiewicz, Duda-Goławska, & Żygierewicz, 2019) and, along with the degree of arousal (activation–deactivation), has a prominent effect on the emotional response of consumers (Jaeger et al., 2019; Pinto et al., 2020; Schouteten, Verwaeren, Lagast, Gellynck, & De Steur, 2018).

The affect encompasses the dimensions of not only pleasure and arousal, but also anguish, depression, satisfaction and relaxation, among others. However, it is believed that the perpendicular relationship that exists between valence and arousal on a two-dimensional plane is most significant to explain most of the evoked emotions (Mehrabian, 1996; Mehrabian & Russell, 1974; Russell, 1980).

Valence and arousal are associated with neural activation in specific areas of the brain (Wade-Bohleber, Thoma, & Gerber, 2020). They act in a segregated way in different regions (e.g., hippocampus, anterior cingulate, prefrontal cortex, somatosensory) from different stimuli (Bestelmeyer, Kotz, & Belin, 2017; Wade-Bohleber et al., 2020). Together, these dimensions are interrelated in a highly systematic way (Russell, 1980), dwelling in our brain circuits and shaping what we choose, consume and reject (Berridge, Ho, Richard, & DiFeliceantonio, 2010).

In terms of applicability, the use of emojis was considered adequate to convey degrees of emotional valence in relation to food stimuli. Advantages include enhanced ecological validity, familiarity, and culturally shared significance for assessing emotions (Jaeger, Jin, Hunter, Roigard, & Hedderley, 2020), showing a positive correlation with taste and intention to buy (Jaeger, Jin, et al., 2020; Pinto et al., 2020; Schouteten, De Steur, Sas, De Bourdeaudhuij, & Gellynck, 2017; Sukkwai et al., 2018). Regarding arousal, Jaeger, Jin, et al. (2020) pointed out that the use of currently available emojis to evaluate degrees of arousal remains limited, requiring caution in their interpretation, and it is often preferable to evaluate arousal through verbalization. Moreover, consumers have a range of interpretations when it comes to emojis, which makes it difficult to obtain a response pattern in terms of arousal (Jaeger, Vidal, & Ares, 2020; Schouteten, 2020). The tendency of greater or lesser arousal is strongly dependent on the condition of the individual (e.g., whether or not they have an eating disorder), of the type of stimulation evoked by the food (e.g., alcohol and opiates reduce arousal), the degree of hunger or satiation and individual personality traits (e.g., temperament), which makes the arousal assessment even more complex than the valence (e.g., compulsive and easily stressed consumers positively stimulate the traits of arousal) (Mehrabian, 1996). Digital self-reporting scales, such as affective slider (AS) and EmojiGrid, appear promising approaches to improve these subjective affective ratings since they have been demonstrated to be valid and efficient culturally independent emotion assessment tools (Betella & Verschure, 2016; Kaneko et al., 2019).

1.2 | Proposal for determining valence and arousal thresholds

To date, attempts to consolidate sensory thresholds have focused on acceptance and preference. Prescott, Norris, Kunst, and Kim (2005) proposed the consumer rejection threshold (CRT) from assessing preferences. Lima Filho, Minim, da Silva, Della Lucia, and Minim (2015), Lima Filho et al. (2017) and Lima Filho, Della Lucia, Minim, Silva, and Minim (2018) proposed new hedonic thresholds using the hedonic thresholds methodology (HTM) to evaluate how the intensity of one or more stimuli significantly changes the acceptance (compromised acceptance threshold) or leads to sensorial rejection (rejection threshold). A study by Ardoin, Romero, Marx, and Prinyawiwatkul (2020) expanded the rejection thresholds (RTs) to provide more realistic interpretations of rejection-type thresholds based on user-defined allowable rejection levels. With new sensory thresholds, the rejection tolerance threshold, and an associated rejection range, based on a binomial acceptability question and a probit regression model, these authors suggest conducting a single testing session gives a more expansive view of RTs.

Efforts to estimate the intensity of stimuli that influences hedonic perceptions are finally coming to fruition. Lima Filho et al. (2018) conducted seven experiments to show the HTM has proven performance criteria, generating reliable results for many applications including technological and sensory improvements in food products (e.g., reducing sucrose, sodium, and fat to expected healthy levels). HTM presents pairs in ascending or descending order of stimuli concentration, which makes it possible to identify the corresponding thresholds (for further details, see Lima Filho et al., 2015; Lima Filho et al., 2017; Lima Filho et al., 2018). Advances, such as determining thresholds by targeting sensory attributes (e.g., aroma, texture, flavor, and overall impression) (Lima Filho et al., 2019), the performance of different scales in the HTM (Gamba et al., 2020) and the use of HTM over more than one stimulus, are among the main propulsors of sensory thresholds (Lima Filho, de Souza, Della Lucia, Minim, & Minim, 2020).

Recent intensification of sensory thresholds in studies is driven by a strengthened "food healthiness" trend. In a study by Souza et al. (2021), over 14% of the sucrose in yogurt could be reduced without compromising sensory acceptance, from a control sample containing 10.64% sucrose. Sant'anna et al. (2020) determined the compromised acceptance threshold (CAT) and the RT for salt concentrations in salty cookies, showing that when the sodium chloride concentration was reduced from 1.81 to 0.84%, product acceptance is impaired. They conclude that only cookies without added sodium chloride were sensory rejected. Lobo and de Castro Ferreira (2021) found sodium could be reduced by 42% in bread through their findings using the CAT parameter. Studies using only one sensory attribute modality, however, such as the examining food photos (visual) to determinate sensory thresholds, remain scarce.

At present, there is a need to better understand how the intensity of stimuli associated with food and drink influences the dimensions of the emotion, in a way that separates the relationship between unique sensorial properties and specific emotions (Spinelli & Jaeger, 2019). Emotions are more complex than taste, since they are more dynamic and less stable, and can be rapidly modified by mood swings, sensory stimuli, and principally by psychological factors associated with the consumer (Juodeikiene et al., 2018; Mulligan & Scherer, 2012). Schouteten (2020) points out that some emotional measurements may provide information on the product that may not be related to the taste and are often capable of improving the predictability of food preference and acceptance. Woodward, Treat, Cameron, and Yegorova (2017) consider that the understanding of these affective evaluations, whether automatic or controlled, can shape eating behavior and assist in decision-making regarding the choice of the intervention. Identifying the stimuli that may potentially facilitate compulsive behavior (Woodward et al., 2017), for example, stimuli capable of generating rapid changes in the consumer's emotional state, is a way to evaluate how to intervene in consumer behavior using emotional thresholds (ET). Thus, ET consolidates advances beyond the feelings engendered by the stimuli.

Based on these premises, the existing literature on consumer emotions has not yet advanced to the point of estimating how sensory stimulus intensity may impact the intensity of emotions evoked. The question remains, how can stimuli compromise pleasure, changing pleasure to unpleasure or significantly interfering in the arousal, leading to an activation or deactivation of the felt emotion? Although over time the HTM has advanced in obtaining better precision from the hedonic evaluation of food products, there is still no evidence of a methodology that can evaluate the variation of sensorial stimulus to trace thresholds that are indicative of change in a consumer's emotional state.

In this study, we proposed a new methodology for determining three emotion thresholds: compromised pleasure threshold (CPT), indicating the intensity of the stimulus capable of compromising the positive emotion valence, unpleasure threshold (UT), corresponding to the transition from pleasure to unpleasure (negative valence) and arousal threshold (AT), corresponding to the intensity of the stimulus capable of taking the consumer from an activated state to deactivated state, or vice versa. The degree of carrot cake deterioration was chosen as the stimulus intensity for proposing the methodology. From these created emotional parameters, we intended to facilitate quality control and improve marketing management in the food market, create opportunities for psychoeducational interventions, and stimulate healthier choices without compromising the experience of high valence and arousal.

1.3 | Brazilian carrot cake

Carrot cake is a classic Brazilian confectionary food, traditionally consumed with creamy chocolate syrup, and is associated with positive emotional experiences (Dawson, 2018; SEBRAE, 2017). Subtle signs of mold may be seen to the naked eye when a carrot cake is in the process of deterioration; however, in decisions of consumption of less-than-ideal foods, we defend that the carrot cake may become an antagonist in the diet, since its attractive appearance may bias the sensorial perception of the ideal, on the point of view of food safety for consumption. Spence, Okajima, Cheok, Petit, and Michel (2016) warn about the danger that our growing exposure to beautifully presented images of food have detrimental consequences on food choice.

Previous studies have shown that "low attention" impairs the ideal incorporation of previous knowledge in perceptual decisions, leading to decision making that is guided more by the emotions at the expense of comfort (Morales et al., 2015; Rahnev & Denison, 2018). According to Pinto et al. (2021) consumers who are less concerned with health issues, as well as low-income people and consumers with a low level of education, are more likely to choose comforting foods (e.g., carrot cake).

Decisions on less-than-ideal food consumption from a health and safety perspective is especially worrisome, because they stem from misperceptions capable of bringing health risks to the consumer, compromising health for comfort. Recent studies have shown that children tend to tolerate foods in suboptimal conditions much more than adults (Makhal, Thyne, Robertson, & Mirosa, 2020), which would be worrisome from a safety perspective, since carrot cake is a food popularly consumed by these consumers. Based on that, this study also aimed to discuss the implications that the thresholds obtained from the evoked emotions may bring harmful consequences for consumer choice and decision.

2 | MATERIALS AND METHODS

2.1 | Samples

2.1.1 | Formulation

The Brazilian carrot cake was formulated start by blending the carrots (25% wt/vol), eggs (three units), oil (18% wt/vol), and sugar (30% wt/vol). The liquid batter was homogenized in a blender for 5 min and then transferred to a bowl, where flour (22% m/v) and baking powder

(one tablespoon) were gently added. The cake batter was heated at 180°C for 45 min in a gas stove. Finally, it was decorated with chocolate icing and granulated Belgian chocolate. A piece of the cake was used as object to obtain the visual stimuli.

2.1.2 | Preparation of visual stimuli

The visual stimuli were prepared with the use of the Nikon D3300 camera (AF-S DX NIKKOR 18-55 mm f/3.5-5.6G VR II, 24.2-megapixel), following the luminosity and photo framing standards (studio with white light and camera fixed on a tripod). Photos of Brazilian carrot cake were captured each day for 21 days and divided into six stages of degradation (spoilage at room temperature, approximately 25°C), one for determining the control sample and five for the samples being compared with the control sample (stimulus samples). Brazilian carrot cake was chosen for being a familiar cake, generally appreciated by all (inclusion criteria) and often consumed in southeastern Brazil. Brazilian carrot cake is also considered a comfort food (SEBRAE, 2017); thus, it was considered an appropriate stimulus to be associated with positive emotions.

Eleven different photos were previously evaluated in preliminary online testing (acceptance test; $N = 220$ consumers) to choose the six visual stimuli (Figure 1). From the hedonic scores obtained in the acceptance test, we noticed that stimulus variation occurred more in the geometric than the linear plane (see curve in Figure 1), which is why we chose geometric progression (GP) of ratio 2 to differentiate the stimuli. In this step, we conducted an informal survey that also showed that many of these 220 consumers use the estimation in days to observe quality traits in carrot cake, such as dry texture and mold.

To complement the choice of the objective criteria of differentiation of the stimuli, we included a marketing phase, involving cross-checked the expiry date of carrot cake bought from the bakeries and supermarkets. Based on the consensus among a three-member expert panel operating in food science and technology, they perceived that the carrot cake expiration date is a maximum of 7 days. Therefore, consumers also use the carrot cake expiration as the objective estimate to judge their quality traits. From this, similar to Saleem et al. (2020) that expressed the results of their research in terms of days to evaluate consumers' perceptions of bakery products, spoilage in days was chosen as an adequate measure for this study.

The control sample was assigned time zero (t0), since the variation of the stimuli in relation to the control was a function of the days of deterioration, which corresponded to 2 days from the storage date. This was because of framing problems related to the images obtained on processing Days 0 and 1, thus those images were discarded and the image from Day 2 was chosen as being the closest to the control sample. In addition to the chosen stimuli in GP (1, 2, 4, 8, and 16 days of storage in relation to the control sample), we arbitrarily included a stimulus outside of the GP, corresponding to the last day of storage to increase the range of stimulus intensity in the study, since it is impractical to include a sample stored for 32 days due to high deterioration of the product. The prespecified hypothesis of this study is that there is a moldy stimulus generalization for the control sample, that is, pairing the sample that generates pleasure may elicit displeasure in some consumers as the amount of mold increases in the paired sample.

2.2 | Participants

A total of 262 adults who were residents of Espírito Santo State participated in an online research survey. The participants were considered eligible for the research when they verified they lived in Espírito Santo, consumed Brazilian carrot cake at least occasionally and agreed to participate using a notebook or desktop computer with the browser in full screen mode. The convenience sampling method was helpful in this research, because it was applied in the pandemic

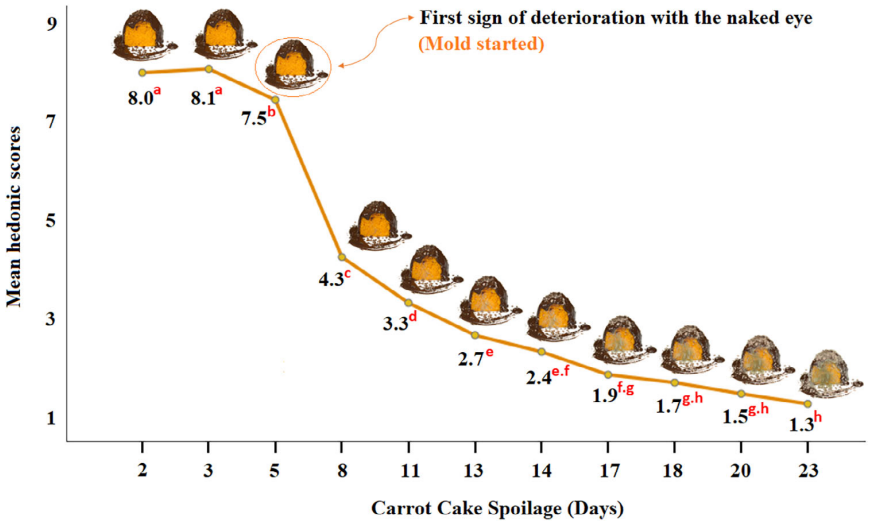

FIGURE 1 Averages of acceptance of the 11 images of carrot cake evaluated in the acceptance test. Overall impression was evaluated on a 9-point hedonic scale (1 = dislike extremely, 5 = neither like nor dislike, 9 = like extremely). Pairs of means same letter do not differ by the Tukey test ($p > .05$) ($N = 220$)

scenario, characterized by the social distancing and enforcement of COVID-19 stay-at-home orders. In addition, our study allowed us to capture responses from consumers in their own contexts beyond the controlled environment of the laboratory. Similar to Lima Filho et al. (2018), to evaluate the reproducibility of the emotion thresholds methodology (ETM) in a future validation step, we established the criteria of people living in Espírito Santo State to compare with results of people living in Minas Gerais State. For reliability, the use of emojis in text and online communications was evaluated in order to demonstrate participants' familiarity with emojis. The use of emojis "never or very infrequently" did not constitute a criterion for exclusion, but at least "sometimes" was preferable.

Our research protocol followed the guidelines of the Helsinki Declaration and all procedures involving human subjects were approved by the Committee on Ethics in Research with Human Beings at the Federal University of Viçosa (No. 3.805.746). Vision problems that prevented viewing the images were considered exclusion criteria. See Table 1 for further information on the participants of this study.

TABLE 1 Summary of participant characteristics in Espírito Santo, Brazil ($n = 202$)

Participant characteristic	(%)
Gender	
Female	65
Male	35
Age	
18–30 years old (y.o.)	35
31–45 y.o.	45
46–60 y.o.	16
>60 y.o.	4
Education level	
Primary or secondary school	13
Completed higher education	19
Postgraduate (master's degree/specialization)	39
Postgraduate (PhD)	30
Household income (R$)	
Less than 1 salary (<1.045,00)	5
1–3 salaries (1.045,00–3.135,00)	22
3–5 salaries (3.135,00–5.225,00)	18
5–10 salaries (5.225,00–10.045,00)	23
10–15 salaries (10.045,00–15.675,00)	21
More than 15 salaries (>15.675,00)	12
Consume cake	
Often (one to seven times a week)	22
Sometimes (one to three times a month)	60
Rarely (less than once a month)	18
Consume carrot cake	
Often (one to seven times a week)	1
Sometimes (one to three times a month)	43
Rarely (less than once a month)	56
Frequency of emoji use	
Always	62
Sometimes	29
Never or very infrequently	9
Level of understanding for the evaluation scales	
Very easy	31
Easy	58
Reasonable/difficult	11
Degree of difficulty in using the scale's cursor	
None	73
Low	14
Moderated	13

2.3 | Experimental protocol

In the HTM, the consumers evaluated, in the same session, a pair of samples (one control and one stimulus) regarding acceptance (Lima Filho et al., 2015). In an analogous manner, in the ETM, consumers were instructed to evaluate a pair of carrot cake images from left to right using the digital scale for self-assessment with the AS emotion (Figure 2), anchored by emoticons, composed of two separate sliders that measure pleasure (i.e., unhappy/happy) and arousal (i.e., sleepy/wide-awake) (Betella & Verschure, 2016; Mehrabian & Russell, 1974).

The AS scale was chosen as an instrument for assessing emotions because of the fact that it is a more current scale for evaluating valence and arousal, it is easy to understand, functional, can be applied globally in digital platforms and its measurements represent precision at high resolution (Betella & Verschure, 2016). Moreover, the use of emojis has been shown to make it easy to understand food contexts with pictograms for both children and adults (Jaeger, Lee, 2017; Jaeger, Vidal, Kam, & Gastón, 2017; Sick, Spinelli, Dinnella, & Monteleone, 2020), minimizing biases resulting from intercultural barriers (e.g., language barriers) (Schouteten, 2020).

AS is a digital self-reporting tool that consists of two sliders for assessing pleasure and arousal (Figure 2). AS uses two independent controls that are located one on top of the other and a neutral chromatic palette to avoid bias in ratings due to the emotional connotations of colors. Underneath each slider are two isosceles triangles (symmetrically mirrored from the topmost vertex) that serve as a visual cue for intensity (Betella & Verschure, 2016). Emoticons visually representing bipolar affective states from Mehrabian and Russell's emotionality scales are at opposite ends of each slider (Betella & Verschure, 2016). Participants were instructed to move the sliders to express how they feel while viewing the picture. AS was systematically compared to the popular Self-Assessment Manikin (SAM) and validated as a self-assessment method that uses modern design, inside the interfaces and metacommunicative pictorial representations. The research on human emotions using AS is rising,

notably in psychological investigations to assess people's affective states (Flynn et al., 2020; López-Carral, Grechuta, Verschure, & Doering, 2020; Quoidbach, Sugitani, Gross, Taquet, & Akutsu, 2019; Rietveld, van Dolen, Mazloom, & Worring, 2020; Schaefer, Reinhardt, Garbow, & Dressler, 2020), which demonstrates the potential of this new measurement tool with modern design principles to access human emotion (Lemos et al., 2020; Mogilever et al., 2018; Toet et al., 2018; Toet & van Erp, 2020). In the current pandemic situation of COVID-19, AS is an ally in this research, due to be easily reproduced in digital devices (e.g., desktops, notebooks, smartphones, and tablets).

Following the detailed guidelines and design recommendations (S1 guidelines) (Betella & Verschure, 2016), along with the procedures adopted from Lima Filho et al. (2015), we developed an online questionnaire composed of four main sections: (a) informed consent and collection of sociodemographic data (frequency of consumption of Brazilian carrot cake, gender, age, income and level of education); (b) instructions, (c) photoclassification; and (d) debriefing. Prior to photoclassification, participants were asked to complete the assessment in a calm, well-lit environment, with no interference from noises and not too satiated or hungry, in order to avoid bias in the pleasure and arousal assessments (Woodward et al., 2017).

After completing Section A, we provided the participants instructions on the concepts of pleasure and arousal described by Mehrabian and Russell (1974). A didactic video was created by the principal author (V. R. A. P.) to make the explanation more interactive and dynamic. Following the same procedures adopted by Betella and Verschure (2016), on the same page as the sample assessments and before the images, the participants were instructed to put their web browser into full-screen mode to maximize resolution and avoid external distractions, such as software running in the background. Additionally, we showed a warning message in red, explaining that the order of the pleasure and arousal scales would be randomized, requiring careful attention so that the evaluation would not be compromised by confusion between the scales.

After the instructions on how to use the scales, the participants received a pair of samples and were invited to "move the sliders to express how you actually feel while evaluating the picture." We adopted a neutral monochromatic color scheme to avoid bias in the classifications (Betella & Verschure, 2016). In addition to the randomization of the pleasure and arousal scales, the order of presentation of the control sample within each session was also randomized to avoid automatisms. After evaluating one pair of samples, the consumer proceeded to evaluate the next pair, pressing the button "to send and continue," until all six pairs of samples (six sessions) were evaluated (see Figure 3 and Supplementary Material A for high resolution images). A black screen was presented for 2 s between each session.

After completing all tests, the consumers were asked to rate their level of understanding for the evaluation scales, the degree of difficulty in using the scale's cursor and the frequency of using emojis in their virtual messages (see further details in Table 1). Finally, a debriefing page was presented to each participant, which included

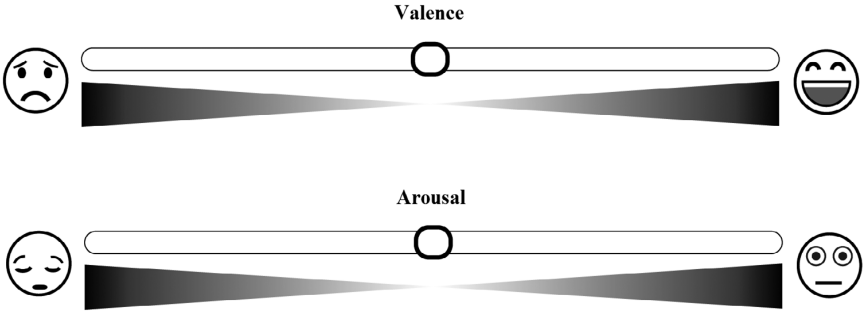

FIGURE 2 Overview of the affective slider (AS) (Betella & Verschure, 2016), which measures pleasure (top) and arousal (bottom) on a continuous scale. The visual order of the scales was randomized

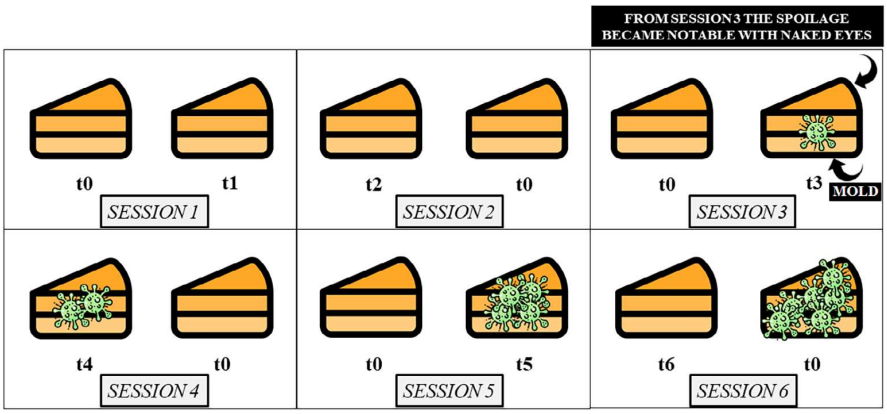

FIGURE 3 Samples of carrot cake presented in the six sessions

acknowledgments and the physical and e-mail addresses of the researchers for further questions or clarification.

After performing a preliminary analysis of the dataset for the entire sample, we observed that approximately 23% of the volunteers did not meet the inclusion/exclusion criteria, did not successfully fill out the sociodemographic data, did not complete all evaluations, or participated twice in the experiment (probably by manually refreshing the web page, network connection problems or incorrect use of the "back" button of the browser). After resolving divergences and inconsistencies in the data of some participants, our final sample resulted in a total of 202 participants (18–65 years old; 65% female) (Table 1).

2.4 | CPT and UT

The scores obtained on the pleasure scale for each session were subjected to the paired *t* test, considering the comparison between the score obtained for the control sample and the hedonic score of the stimulus sample. The obtained *t* values were used to graph the *t* value for each session (Y1 axis) as a function of the degree of deterioration of the carrot cake (X). The region where significant differences among the samples began to occur in terms of pleasure indicated the cutoff point corresponding to the CPT, which was represented by the dotted line referring to the tabulated *t* at significance level of 5% ($N = 202$; $t_{tab} = 1.972$). To determine the degree of deterioration where there is a significant difference among the samples in terms of pleasure, the regression model was adjusted to the points on the graph. The choice of the best fit model to the data depended on the evaluation of the regression and determination coefficients r^2 (SSregression/SStotal), as well as the root mean square error (RMSE), following the procedures adopted by Ostertagová (2012) to find the best arrangement (highest r^2 and lowest possible RMSE and *p*-value). The *t* tests and model adjustment were performed using SPSS software (Statistical Package Statistical System - SAS), version 24.0 and Microsoft Excel 2016.

CPT was calculated from the model equation, where the degree of deterioration corresponded to the point where the calculated *t*-value became equal to the standard *t*-value ($p = .05$), that is, the point where a significant change in pleasure occurs due to its lower degree of deterioration.

To determine the point of inversion from positive to negative emotion, the second Y2 axis was inserted in the same graph, keeping the X axis as the one corresponding to the average pleasure score. The intersection point on the Y2 axis was represented by the score of 0.5, that is, the point where the transition occurs from the minimum positive emotion to negative emotion (the midpoint on the pleasure and arousal scales, anchored by the dimensionless values 0 and 1.0). To determine the degree of deterioration where there is change in the emotional state from positive to negative, a regression model was adjusted for the points corresponding to the Y2 axis. The same procedures adopted to determine the best fit model for CPT were adopted to find UT. The corresponding UT value was obtained by substituting the 0.5 value in the equation of the obtained regression model.

2.5 | Arousal threshold

In an analogous way to the procedures adopted for obtaining UT, the mean scores obtained from the arousal scale were extracted for each stimulus corresponding to each session and then the degree of deterioration where the activated state changed to deactivated was determined, adjusting a regression model for the corresponding points (mean arousal scores) to the Y3 axis in a new graph (arousal graph). We did not consider the "compromising of arousal," because it is not sufficient to consider a compromised arousal if the context is based on high or low arousal (i.e., high or low arousal can be compromising depending on the context).

The cutoff point of the Y3 axis was represented by the score of 0.5, that is, the point where the transition occurs from the minimum non-aroused/aroused states. The same procedures used to determine the best fit model for CPT and UT were used to find the AT. The UT value was obtained by substituting the 0.5 value in the equation of the obtained regression model.

2.6 | Verbalization in the evaluation of carrot cake images

In order to examine the relationship between stimuli type and text, data from comments on the test sessions (AS scale followed by comment field), correspondence analysis (CA) was carried out. The CA showed relative similarities and differences between responses to stimuli and was performed on a frequency table that showed the samples in rows and total frequency of descriptive terms in columns. Data was processed using Microsoft Excel 2021, and the IBM SPSS Statistics 26.0.

3 | RESULTS

The cubic polynomial regression model was the one that presented lower error and *p*-value statistics ($p < .05$) and higher regression coefficients (r^2), higher than .98 to determine CPT and UT, which justified its choice as a best fit model (Table 2). The quadratic regression model was the one that best fitted the data obtained for arousal. In this study, the dependent variable was represented by average pleasure or arousal scores whereas the independent variable was carrot cake spoilage (days). The uncertainty on the shape of the curve (linear or nonlinear) reminds us that fitting a second-degree polynomial ("quadratic regression model") ($Y = a + bX + cX2$) is commonly the preferred curve to solve the deadlock (Armstrong & Hilton, 2014). Its goodness of fit is compared with a straight line in order to investigate if the data fits significantly better than a straight line. With more complex curves, higher order polynomials (3, 4..., *n*), such as the cubic polynomial regression model (a polynomial of order 3; $Y = a + bX + cX2 + dX3$) can be used to approximate a complex nonlinear relationship, best fitting the data. Based on these

considerations, we perceived that cubic and quadratic polynomials provided the best fit to this data.

Figure 4 shows the calculated *t*-values (Y1 axis) and the average pleasure score (Y2 axis) (emotional valence) as a function of carrot cake deterioration time (X axis). By substituting Y1 with 1.972 (INVT function; $N = 202$; 5% significance), a value of 1.91 was obtained, which corresponded to 1.9 days of deterioration in relation to the control sample, that is, from this point on the positive valence begins to be reduced because there is a compromise of pleasure. It is clear there is a negative trend in the data; that is, pleasure decreases as the cake becomes more deteriorated.

As the deterioration of the carrot cake progressed and the mold became increasingly visible, there was a successive reduction in the positive valence observed until the inversion from positive to negative emotions, which occurred at 5.94 days of deterioration. Feelings of happiness, pleasure and satisfaction gave way to emotions of unpleasure, repulsion, disgust. It is important to highlight that the mold growth was visible to the naked eye only after 3 days of deterioration and this sample was placed between the hedonic terms "liked slightly" and "liked moderately" when the pretest was done to define the stimuli. Therefore, there was only a reversal from positive to negative emotion after 5 and 6 days of deterioration, which led us to believe that, although the stimulus related to 3 days of deterioration was not included in the P.G., many high-educated consumers would accept less-than-ideal carrot cake with little visible mold growth (including t3 = 4 days of deterioration), because they would be primarily motivated by indulgence and a feeling of comfort (e.g., visual attractiveness, overall appearance) and less by aspects like food safety.

In Figure 5, it is possible to observe that, although the unpleasure occurs around 5.9 days, the change of activated state to deactivated only occurred after 10.5 days. Negative valence increased as deterioration progressed (Figure 6), as shown in the study by Hartigan and Richards (2017), where the deactivation of the emotion occurs only after consumers had a negative exposure or high activation (e.g., disgust).

4 | DISCUSSION

4.1 | Overall background

Our study showed that after 1.9 days of deterioration of carrot cake, a positive emotional impairment starts to occur, which was also observed in the control stimulus. At 5.9 days, there was a reversal from positive to negative emotion, caused by negative feelings

TABLE 2 Adjusted regression model with effects of carrot cake spoilage on pleasure

Valence thresholds		
Model	r^2	***p*-Value**
Equation (1) $Y1 = -0.0011X^3 - 0.0242X^2 + 2.6925X - 3.0722$ (CPT)	.9883	.017*
Equation (2) $Y2 = 1E\text{-}05X^3 + 0.0022X^2 - 0.0959X + 0.9897$ (UT)	.9842	.024*
Arousal threshold		
Model	r^2	***p*-Value**
Equation (3) $Y3 = 0.001X^2 - 0.0357X + 0.7649$ (AT)	.8926	.032*

Note: *Significant at 5% ($p < .05$).

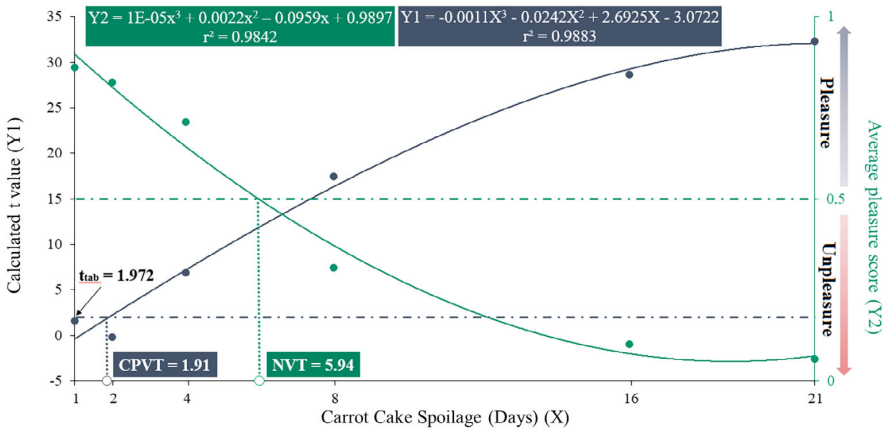

FIGURE 4 Calculated *t* values and average valence scores as a function of carrot cake spoilage. The blue dashed line indicates the tabulated *t* value (ttab = 1.972; $N = 202$) for significant difference at 5% ($p < .05$). The green dashed line refers to a mean valence score of 0.5 (neither pleasure nor displeasure)

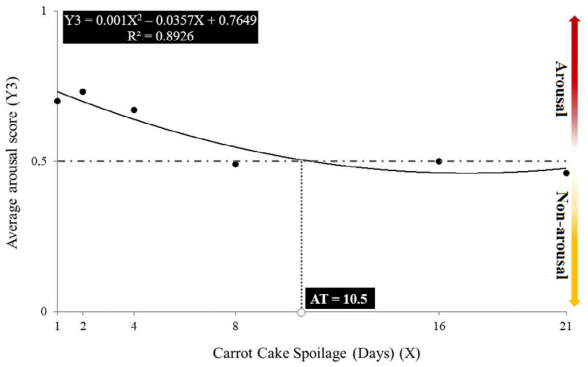

FIGURE 5 Average arousal scores as a function of carrot cake spoilage. The black dashed line indicates the mean arousal score of 0.5 (neither non-arousal nor arousal)

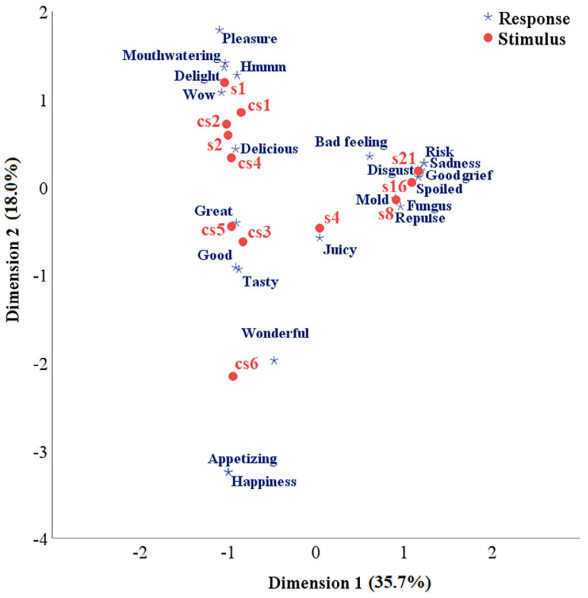

FIGURE 6 Correspondence analysis of the most significant words for the stimuli assessed in the six-session of the EMT. cs—control stimulus of the Sessions 1–6 (cs1–cs6); s1: 1-day of storage stimulus; s2: 2 2-days of storage stimulus; s4: 4 days of storage stimulus; s8: 8 days of storage stimulus; s16: 16 days of storage stimulus; s21: 21 days of storage stimulus

(e.g., repulsion, disgust, unpleasure) associated with the high mold growth, which was visible to the naked eye. The deactivation in relation to the control sample was significant only after 10.5 days of deterioration, which indicates that new negative feelings were evoked from this point and were responsible for the change from high to low arousal (e.g., non-stimulating or indifferent), or a deactivation of positive emotion.

Table 2 shows that 98.8% of the variation in the pleasure is explained by the variation in the deterioration of the carrot cake, taking into consideration a cubic function of the average pleasure scores. For the arousal, 89.3% of the variation was explained by the variation in the deterioration of the carrot cake. These models corroborate the findings presented by Kaneko et al. (2019) who, when testing emotions associated with moldy foods, demonstrated the best adjustment of polynomial models to explain valence and arousal, with adjustment values considered excellent (r^2 > .83).

As the carrot cake deterioration advanced, average pleasure dropped for the control sample, reflecting that moldy cake evokes negative emotions and diminishes the pleasure relative to the cake without mold over the sessions. This contrast of stimuli for the same cake shows that the negative emotion in relation to the stimulus with mold exceeded the positive feelings evoked from the perception of the cake without mold (control sample). According to the conditioned reflexes (Pavlov, 1927), these results highlight one important turning point in these participants' perceptions associated with negative emotions: the effect of evaluative conditioning (the pairing of stimuli).

Considering that repulsion and disgust are the predominant emotional response to contamination (Armstrong & Olatunji, 2017; Benedict & Gast, 2020), mold stimulus is an unconditioned stimulus and the control stimulus was a neutral stimulus for negative emotions. When pairing unconditioned and control stimuli, the control stimulus becomes a conditioned stimulus for negative emotion. Therefore, increased disgust to the pleasant stimulus was an expected outcome as a result of the increasing degree of spoilage and increased disgust sensitivity. This evaluative conditioning occurs by the apparent transfer of negative valence from the unconditioned stimulus (mold stimulus) to the conditioned stimulus (control stimulus) (Armstrong & Olatunji, 2017).

According to Miskovic and Keil (2012), negative emotions for the control stimulus are conditioned to the presence of mold stimulus and increase when participants are reexposed to the same stimulus (mold) (e.g., by association, "Do all the samples have mold?" or "The pleasure of the mold-free sample decreased when seeing it moldy"). Thus, we cannot reject the hypothesis that there was a moldy stimulus generalization for the control sample, that is, pairing the sample that generated pleasure may have elicited displeasure in some consumers as the amount of mold increased in the paired sample, which explains the slight drop in pleasure scores for this sample throughout the sessions.

Becker, Flaisch, Renner, and Schupp (2016) affirm that the brain responds selectively to the appetite value and significance of food stimuli, and is sensitive to visual signs of food that are spoiled or rotten, as modulatory effects on these alimentary stimuli on attention, specifically activating regions of the occipital inferior and of the parieto-occipital sensor involved in the motivational processes. From this, we speculated that the emotion felt in relation to the mold stimulus reduces the indulgence bias in relation to the control sample, increasing selective attention during the tasting sessions. For developing new products and reputation management, the effect of pairing cannot be disregarded and the use of systematic desensitization and counter-conditioning strategies (Pavlov, 1927) may be necessary for decision-making on behalf of emotion thresholds and food product reputation. In determining AT, this interference should be

meticulously considered, since the control sample received high arousal and was used as a comparative pair with the moldy cake.

Our results also identified predominantly unpleasure and reduced arousal (≤0.5) for more deteriorated stimuli. Contrary to our predictions past studies have shown that feelings like repulsion, nauseousness, disgust are concentrated more in the region of moderate to high arousal (Bakker, van der Voordt, Vink, & de Boon, 2014; Kaneko et al., 2019). The variability in arousal, even among stimuli of similar nature (i.e., mold), implies substantial challenges in determining ATs because according to Hartigan and Richards (2017), the exposure to disgust may influence subsequent emotional processing, but it does so in a discriminant way among individuals with different characteristics and traits (e.g., self-control or courage). This premise is important for considering that images of aversive scenes, such as the moldy cake, diverge electrophysiologically, even within the classifications of valence and overall arousal. Therefore, we do not disregard the possibility of obtaining quadratic regressions in the same direction (control and moldier stimulus sample: high arousal).

There are several other possible explanations for this difference, among which Jaeger et al. (2019) demonstrated that emojis convey valence and emotional arousing over a gamut corresponding to different emotions. For example, emojis representing "grimace" and "disappointed face" would be easily associated with the moldy cake in this study, and the authors realized that these emojis presented average arousal scores of around 6 and 3 (on an arousal scale of from 1 to 9), corroborating our findings for moderate to low arousal.

It is also important to take into consideration the fact that consumers make comparisons between the foods to judge their degree of arousal. For example, meat and meat, products are generally considered highly arousal when compared to other food categories (e.g., cereal, fruits, and vegetables) (Padulo et al., 2017). In a similar manner, it is not surprising that arousal can come from comparing different stimuli within the same category, and low arousal has been attributed to the carrot cake with mold.

4.2 | Applications of emotion thresholds in food science and industry

Emotions play in people's beliefs and decisions. Growing evidence has shown that emotional responses are strongly correlated with hedonic responses (Pinto et al., 2020; Schouteten, Verwaeren, Lagast, et al., 2018). As it becomes possible to trace thresholds of emotional valence, there is room for the emotion thresholds to go hand in hand with the hedonic thresholds in more in-depth research on consumer perceptions. The evaluation of valence and arousal to determine the CPT, UT, and AT thresholds will match the existing CAT, RT, and CRT thresholds, by expanding the limits among preferring, rejecting and feeling. As with the HTM, the methodology for verifying the variation in pleasure and arousal as a function of the variation of stimulus intensity used regression models adjusted to identify the new thresholds, which were less sensitive to errors and more robust. Therefore, CAT, RT, CPT, UT, and AT are all relevant for understanding the real choice of foods and drinks and cannot be considered interchangeable.

It is widely accepted that, by measuring consumer emotions, information can be obtained beyond general acceptance and improved food choice prediction (Schouteten, 2020). Although it is difficult to measure emotions and there are still many controversies around the reliability of the types of questionnaires and scales to capture emotions in relation to foods (Schouteten, 2020), it is clear that the advances, especially those related to measuring valence and arousal, provide increasingly robust insights and contribute to improving efficiency in predicting food product choices. Thus, thresholds based on the valence (CPT and UT) may generate safer estimates for a decision-making in terms of cost reduction and quality control strategies.

In practical terms, CPT is more interesting than UT for intervening in unhealthy practices, since the quality of the cake when it reaches UT will be even more compromised from the point of view of consumption than when it reaches CPT. The smaller the difference between the control sample and the stimulus with mold, the higher the CPT; therefore, the greater the tolerance to the presence of mold on the carrot cake. In other words, consumers will be more tolerant of accepting comfort foods in less-than-ideal conditions, compromising their health. In this sense, there are many benefits of CPT for promoting effective interventions in relation to consumer health, providing greater control over the growth of the sale of sub-ideal foods under the slogan "fun foods" (Aschemann-Witzel, Giménez, & Ares, 2018; Makhal et al., 2020), or even to propose improvements in the development of new products. From determining the CPT, measures could be adopted to intervene in subconscious choices, reducing the bias toward indulgence and feelings of comfort, since the elicitation of disgust at the sight of spoiled and rotten food is an adaptation to avoid things that represents danger, such as the ingestion of harmful microorganisms and pathogens (Becker et al., 2016).

Moreover, for the industry, determining CPT implies making decisions more rapidly and that may prevent large financial losses, since this point gives indications of changes necessary to impact pleasure in a less drastic manner. Lima Filho et al. (2015) affirm that the advantage of determining CAT over HRT is because, by using CAT, the industry may reduce the content of excess ingredients (e.g., sugars) with losing market space, since the reductions in the CAT value did not reduce product acceptance. In an equivalent manner, the sample with stimulus intensity referred to in the CPT will be significantly less accepted than the control sample, although it can still present pleasure; thus, a suprathreshold stimulus intensity that guarantees a change in stimulus intensity at the satisfactory level of pleasure can be used. Therefore, CPT would be safer than UT for the industry if decision-making is based on modifying products that already exist in the market without compromising pleasure, since expectations have already been formed in relation to them.

UT is advantageous in that it allows the industry to more clearly identify which stimuli are capable of generating sudden changes in emotions, that is, as an ingredient, a packaging element an image is capable of provoking a change of state (pleasure/unpleasure). It can

benefit from this result in favor of industry and consumer health; therefore, the industry will benefit more from UT in the development of new products. When it comes to AT, the industry may be able to identify the stimuli capable of positively activating emotions and perceiving what kind of intrinsic and extrinsic food sources are capable of taking the consumer to the deactivated state, thus impairing their food choices.

4.3 | Does managing CAT, UT, and AT cause consumers to make healthier choices?

Pinto et al. (2020) tested different stimuli of mixed yogurt drink with kefir (0, 15, 30, and 50% kefir addition), and found that expressions of positive emotions increased when the participants were exposed to functional properties of kefir, while negative expressions of emotion, such as they are associated with excess acidity, decreased. The supply of information made the valence more positive in relation to mixed drink with 30% kefir and there was a deactivation of the associated negative emotions. Providing information on the functional properties of kefir would be an alternative to increasing the quantity of kefir in the yogurt without affecting the pleasure (higher CPT), without resulting in unpleasure (higher UT) and without resulting in a deactivated state (higher AT) of the emotion of the consumer, favoring the industry to work with the binomial positive valence and high arousal.

In two studies conducted by David et al. (2017), when using photos of ultra-processed products that provoke emotions ranging from extremely negative to extremely positive valence and from low to high levels of arousal, the authors used a strategy of providing health warnings as a public policy tool to reduce the appetite motivation. This also could be an efficient strategy for reducing CPT, UT, and AT, as indicators of reducing unhealthy food choices. Woodward et al. (2017) also provided images of foods and found that hunger and compulsive eating increased arousal, while BMI and restriction increased pleasure. An intervention with the use of EMT would enable strategies for food restriction more associated with valence, and for the alimentary compulsion, more connected to arousal in accordance with the obtained valence and ATs. In this sense, when thinking about balancing inhibition and the execution of the response through food stimuli, making use of tools such as EMT will help reduce overeating while simultaneously maintaining positive attitudes toward food and improving the predictability of food choice (Weinbach, Keha, Leib, & Kalanthroff, 2020).

Our study does not intend to segregate individual emotions, but to determine a point where the decision for foods may be immediately influenced by the emotion in terms of valence and arousal, which may make it viable for the industry to make decisions based on emotional responses. An advantage of the emotion thresholds (CPT, UT, and AT) over existing thresholds is that they allow finding a limit that discriminates one emotional state from another, even though the emotion is considered complex and changes dynamically over time (Kamaruddin & Rahman, 2013). Compare to HTM, the advantage of the ETM is that it is a starting point for understanding how different food stimuli can modulate different response patterns in the brain. Therefore, in the long run, EMT may be useful in understanding the brain effects caused by the stimuli of fear, repulsion, and disgust, as well as pleasure, satisfaction, and reward. EMT also set precedents for future interventions in perception and food choices, from the stimulation of brain areas in favor of positive valence and high arousal for healthy foods.

5 | LIMITATIONS AND FUTURE PERSPECTIVES

The results of our study show it was possible to find polynomial models that fit the data, in order to allow the proposition of the new emotion thresholds of valence and arousal. Tests with competing valence and arousal scales, such as EmojiGrid 2D, are necessary to elucidate the discriminating power of obtaining emotion thresholds. Gamba et al. (2020) realized that the ULSWC (9 cm unstructured hedonic with the addition of the term "neutral" in the intermediate position) presented high discriminating potential with the greatest accuracy for hedonic thresholds. However, ULSOC scales were not suitable for use in the HTM, because they did not meet the prerequisite of having no significant difference between acceptance of the control samples and the first stimulus sample. Although AS may be difficult to understand for elderly and low-educated individuals, it has been shown to be promising and an alternative to the SAM scale for assessing pleasure and arousal. Although exists the disadvantageous by increasing the possibility that the consumer will move the cursor by estimation (reference), we speculated that continuous scales seem to be more viable for evaluating valence and arousal, since emotions are expressed according to a broad spectrum of felt intensity (Juodeikiene et al., 2018; Mulligan & Scherer, 2012). Future studies investigating the use of categorical pleasure and arousal scales and/or alternatives to the unstructured continuous scale will continue to be necessary to elucidate the performance of different scales within the methodology of determining emotion thresholds. For the possibility of improving the valence and arousal scales, it is expected that future researchers will strive to test the discriminant power and the precision of these unstructured scales with a neutral emoji in the middle position.

Our study allowed us to capture responses from consumers in their own environmental contexts beyond the controlled reality of the laboratory. On the one hand, there is the advantage of obtaining more reliable responses according to the particular context; on the other hand, it does not eliminate the influence of external variables that interfere in the evocation of the emotions, for example, the time of evaluation, to be satiated or with hunger. In online surveys, controlling the variability resulting from these factors is even more difficult and, according to Garlasco et al. (2019), valence and arousal are permeated by satiety and hunger in food choices. Despite these shortcomings, the results evaluated in a laboratory setting and online are equivalent and proven, even with the difference in the control in the

experimental conditions (Betella & Verschure, 2016), which leads us to believe that is possible to expand the use of the AS in sensory tasting conditions, providing similar results. Future studies should consider the laboratory environment, as well as the influence of time on the perception of the visual stimulus and the influence of the degree of deterioration on the perception of the consumer in addition to the visual stimulus (images).

2D food images can be used to find quality indices (e.g., CPT, UT, and AT), which allow shelf-life assessment to be simplified practically and easily, but two-dimensional representations of real food are probably not comprehensive of all the visual information needed by the panelists to produce an acceptability/unacceptability judgment (Manzocco, Rumignani, & Lagazio, 2012). Spinelli and Jaeger (2019) reinforce that there are sensory drivers of emotions and the perceived intensity of the sensory sensations (e.g., odor, taste) also contributes to the emotions elicited by the product and need to be valued. Moreover, Dalenberg, Weitkamp, Renken, and ter Horst (2018) emphasize that the modality of the visual stimulus (e.g., color, clarity, brightness) also interferes in the processing of the valence. Thus, we emphasize that the determination of the emotion thresholds must be carefully conducted with regard to these aspects.

In relation to AT, it is a challenge to overcome the still-present barriers to understanding arousal. Jaeger, Jin, et al. (2020) and Jaeger, Vidal, and Ares (2020) point out that emojis seem to transmit less arousal when compared to their capacity for transmitting valence, and that understanding the diverse meanings of emojis remains a challenge to be overcome. This can facilitate a better understanding of the arousal scale anchors, since, as Jaeger, Vidal, and Ares (2020) point out, the ecological validity of the emoji scales to evaluate arousal remains controversial, mainly because of difficulties in consumer understanding. Yet it is crucial to confirm whether or not consumer interpretations of the concept are converging with their assessment to effectively consider the ascendance of AT.

Another fundamental question is the presupposition that a wide range of stimulus variation will not always encompass a wide range of arousal (from low to high). This leads us to resume the previous discussion about the comparisons between competing scales. Although a wide range of deterioration variation has been considered for discriminating the stimuli of carrot cake (highly accepted stimulus to highly rejected stimulus), a wide range of arousal was not observed (lowest arousal stimulus = 0.46). According to Pavlov (1927), an increase in the intensity of the stimulus will not always be accompanied by an increase in the magnitude of the response. For example, in the habituation phenomenon, as successive elicits (increase in mold intensity) occur, the magnitude of the response decreases. In addition, research on emotions suggests valence may explain a larger portion of emotional responses when compared to arousal, because evaluating stimuli by means of arousal can be confusing or stressful for the participant (Deubler & Swaney-Stueve, 2020; Schouteten, Verwaeren, Gellynck, & Almli, 2018).

Finally, among the last hypotheses that support our statements for challenges in AT are the category of food evaluated, the type of varied stimulus, the consumers' excitatory state, and the consumers' satiety state. For example, Privitera, Diaz, and Haas (2014) affirm that increased arousal in a typical eating environment increases intake of less palatable foods, and healthy foods (i.e., fruits and vegetables). Woodward et al. (2017) perceived that in a less hungry condition, women rated high added-sugar foods as both pleasant and arousing, but hungry women rated high added-fat foods as pleasant, but not arousing. High fat and sugar foods were associated with high arousal (high palatable foods), while healthier foods were generally associated with lower arousal (considered lower in palatability) (Pinto et al., 2020; Privitera et al., 2014).

We believe that a necessary extension of this work may be to study different segments of carrot cake consumers, who present different degrees of arousal because of the various negative feelings evoked. In this sense, future intercultural studies are fundamental for considering the level of arousal and verbalization associated with understanding the feelings of the consumer when seeing the greatest quantity of mold on the cake, and why it was classified as low arousal. The future consideration of personality traits and psychopathologies (e.g., catatonia, psychopathy traits) on consumer behavior may also corroborate a subsequent drop in arousal, even if the mold becomes increasingly large. Thus, an increase, not a decrease, of the arousal may be also considered throughout the deterioration stages with the visible increase in mold. For example, one segment could evaluate the control sample as having high arousal because of the positive feelings evoked and the moldy stimuli as having high arousal because of negative feelings, while another segment evaluates moldy stimuli as having low arousal because of the relative comparison with the control sample (in other words, "if the sample without mold arouses me, the sample with mold does not arouse me").

Finally, it is important to note that the carrot cake is a product of both the bakery and the confectionary. Therefore, considering the variation of one or more stimuli present in the carrot cake (e.g., color and chocolate syrup) it would be interesting to understand how the different visual stimuli separately and jointly impact the emotion thresholds. Juodeikiene et al. (2018), for example, realized that chocolate was associated with greater intensities of happiness, reducing the level of neutrality, while bakery products generated greater expressions of neutrality and sadness, and low expression of happiness. Therefore, further studies with carrot cake are necessary to evaluate the interaction stimulus × emotion thresholds, corroborating emotions associated with this type of food.

6 | CONCLUSION

The ETM demonstrated the potential to identify the CPT and UT valence thresholds, and the AT facilitating the future understanding of the process of choosing products and services. When the focus is on the search for greater reliability in determining the point where the emotional state begins to change, emotion thresholds show usefulness and promise.

When it comes to emotion-driven food choices, this methodology can help in the monitoring of unhealthy food choices, because it will

be able to provide thresholds corresponding to variables capable of significantly influencing the consumer's mood. Likewise, they may also be useful to industry, public policymakers, and health professionals, in order to facilitate identification of the factors that improve the mood of the consumer, while also encouraging the consumption of healthier foods.

This study supports advances that somehow manage to measure consumer emotions, making it possible to detect the point where their emotions can be significantly modified. Specifically, eating disorders associated with negative emotional states may also affect emotion thresholds. Ideally, psychoeducational interventions to reduce negative psychological outcomes associated with risky decision-making scenarios are expected as a crucially important practical application from this new methodology, creating substantial mitigation opportunities of unconscious affective responses to food.

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CONFLICT OF INTEREST

The authors declare no potential conflicts of interest.

AUTHOR CONTRIBUTIONS

Vinícius Rodrigues Arruda Pinto: Conceptualization, investigation, methodology; data analysis, writing– original draft, review and editing. **Tarcísio Lima Filho**: Conceptualization; supervision; data analysis, writing – review and editing. **Valéria Paula Rodrigues Minim**: Supervision; review. **Suzana Maria Della Lucia**: Supervision; conceptualization, investigation, methodology. **Louise Bergamin Athayde de Souza**: Investigation, methodology. **Fernanda Lopes Silva**: Investigation, methodology. **Márcia Teixeira Cristina Ribeiro Vidigal**: Supervision; conceptualization, investigation, methodology. **Antônio Fernandes de Carvalho**: Review and editing. **Ítalo Tuler Perrone**: Supervision; methodology; review and editing.

DATA AVAILABILITY STATEMENT

Research data are not shared.

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REFERENCES

Ardoin, R., Romero, R., Marx, B., & Prinyawiwatkul, W. (2020). Exploring new and modified rejection-type thresholds using cricket snack crackers. *Food*, *9*, 1352.

Armstrong, R. A., & Hilton, A. C. (2014). *Statisitical analysis in microbiology*: *StatNotes*. Hoboken, NJ: Wiley-Blackwell. https://doi.org/10.1002/9780470905173

Armstrong, T., & Olatunji, B. O. (2017). Pavlovian disgust conditioning as a model for contamination-based OCD: Evidence from an analogue study. *Behaviour Research and Therapy*, *93*, 78–87.

Aschemann-Witzel, J., Giménez, A., & Ares, G. (2018). Consumer in-store choice of suboptimal food to avoid food waste: The role of food category, communication and perception of quality dimensions. *Food Quality and Preference*, *68*, 29–39.

Bakker, I., van der Voordt, T., Vink, P., & de Boon, J. (2014). Pleasure, arousal, dominance: Mehrabian and Russell revisited. *Current Psychology*, *33*(3), 405–421.

Becker, C. A., Flaisch, T., Renner, B., & Schupp, H. T. (2016). Neural correlates of the perception of spoiled food stimuli. *Frontiers in Human Neuroscience*, *10*, 302.

Benedict, T., & Gast, A. (2020). Evaluative conditioning with fear- and disgust-evoking stimuli: No evidence that they increase learning without explicit memory. *Cognition and Emotion*, *34*(1), 1–15.

Berridge, K. C., Ho, C.-Y., Richard, J. M., & DiFeliceantonio, A. G. (2010). The tempted brain eats: Pleasure and desire circuits in obesity and eating disorders. *Brain Research*, *1350*, 43–64.

Bestelmeyer, P. E. G., Kotz, S. A., & Belin, P. (2017). Effects of emotional valence and arousal on the voice perception network. *Social Cognitive and Affective Neuroscience*, *12*(8), 1351–1358.

Betella, A., & Verschure, P. F. M. J. (2016). The affective slider: A digital self-assessment scale for the measurement of human emotions. *PLoS One*, *11*(2), e0148037.

Dalenberg, J. R., Weitkamp, L., Renken, R. J., & ter Horst, G. J. (2018). Valence processing differs across stimulus modalities. *NeuroImage*, *183*, 734–744.

David, I. A., Krutman, L., Fernández-Santaella, M. C., Andrade, J. R., Andrade, E. B., Oliveira, L., … Braga, F. (2017). Appetitive drives for ultra-processed food products and the ability of text warnings to counteract consumption predispositions. *Public Health Nutrition*, *21*(3), 1–15.

Dawson, A. (2018). Classic cakes ready to make a comeback. Retrieved from https://bakeryinfo.co.uk/finished-goods-reports/classic-cakes-ready-to-make-a-comeback/625419.article

Deubler, G., & Swaney-Stueve, M. (2020). The K-State emoji scale, a cross-cultural validation with adults. *Journal of Sensory Studies*, *35*(4), e12573.

Flynn, M., Effraimidis, D., Angelopoulou, A., Kapetanios, E., Williams, D., Hemanth, J., & Towell, T. (2020). Assessing the effectiveness of automated emotion recognition in adults and children for clinical investigation. *Frontiers in Human Neuroscience*, *14*, 70.

Gamba, M. M., Lima Filho, T., Della Lucia, S. M., Vidigal, M. C. T. R., Simiqueli, A. A., & Minim, V. P. R. (2020). Performance of different scales in the hedonic threshold methodology. *Journal of Sensory Studies*, *35*(5), e12592.

Garlasco, P., Osimo, S. A., Rumiati, R. I., & Parma, V. (2019). A hierarchical-drift diffusion model of the roles of hunger, caloric density and valence in food selection. *Appetite*, *138*, 52–59.

Hartigan, A., & Richards, A. (2017). Individual differences in processing emotional images after reading disgusting and neutral sentences. *Neuropsychologia*, *145*, 106580.

Imbir, K. K., Jurkiewicz, G., Duda-Goławska, J., & Żygierewicz, J. (2019). The role of valence and origin of emotions in emotional categorization task for words. *Journal of Neurolinguistics*, *52*, 100854.

Jaeger, S. R., Jin, D., Hunter, D. C., Roigard, C. M., & Hedderley, D. I. (2020). Multi-response approaches in product-focused investigations: Methodological variations across three case studies. *Food Research International*, *132*, 109113.

Jaeger, S. R., Lee, S. M., Kim, K.-O., Chheang, S. L., Jin, D., & Ares, G. (2017). Measurement of product emotions using emoji surveys: Case studies with tasted foods and beverages. *Food Quality and Preference*, *62*, 46–59.

Jaeger, S. R., Roigard, C. M., Jin, D., Vidal, L., & Ares, G. (2019). Valence, arousal and sentiment meanings of 33 facial emoji: Insights for the use

of emoji in consumer research. *Food Research International*, *119*, 895–907.

Jaeger, S. R., Vidal, L., & Ares, G. (2020). Should emoji replace emotion words in questionnaire-based food-related consumer research? *Food Quality and Preference*, *92*, 104121.

Jaeger, S. R., Vidal, L., Kam, K., & Gastón, A. (2017). Can emoji be used as a direct method to measure emotional associations to food names? Preliminary inestigations with consumers in USA and China. *Food Quality and Preference*, *56*, 38–48.

Juodeikiene, G., Zadeike, D., Klupsaite, D., Cernauskas, D., Bartkiene, E., Lele, V., … Adomaitiene, V. (2018). Effects of emotional responses to certain foods on the prediction of consumer acceptance. *Food Research International*, *112*, 361–368.

Kamaruddin, N., & Rahman, A. W. A. (2013). IEEE 2013 International Conference on Electronics, Computer and Computation (ICECCO)—Valence-arousal approach for speech emotion recognition system.

Kaneko, D., Toet, A., Ushiama, S., Brouwer, A.-M., Kallen, V., & van Erp, J. B. F. (2019). A 2D pictorial scale for cross-cultural emotion assessment of negatively and positively valenced food. *Food Research International*, *115*, 541–551.

Lemos, T. C., Almo, A., Campagnoli, R. R., Pereira, M. G., Oliveira, L., Volchan, E., … David, I. A. (2020). A red code triggers an unintended approach motivation toward sweet ultra-processed foods: Possible implications for front-of-pack labels. *Food Quality and Preference*, *79*, 103784.

Lima Filho, T., de Souza, L. B. A., Della Lucia, S. M., Minim, L. A., & Minim, V. P. R. (2020). The hedonic thresholds methodology varying two stimuli: Extending the range of sensory threshold applications. *Food Quality and Preference*, *86*, 104003.

Lima Filho, T., Della Lucia, S. M., Minim, L. A., Gamba, M. M. L., Moulin, R., & Minim, V. P. R. (2019). Directional hedonic thresholds for sodium concentration in hamburger. *Food Quality and Preference*, *78*, 103722.

Lima Filho, T., Della Lucia, S. M., Minim, L. A., Silva, R., da Silva, A. N., & Minim, V. P. R. (2017). Validation of the hedonic threshold methodology in determining the compromised acceptance threshold. *Journal of Sensory Studies*, *32*(2), e12255.

Lima Filho, T., Della Lucia, S. M., Minim, L. A., Silva, R., & Minim, V. P. R. (2018). Validation of the hedonic threshold methodology in determining the hedonic rejection threshold. *Journal of Sensory Studies*, *33*(1), e12313.

Lima Filho, T., Minim, V. P. R., da Silva, R., Della Lucia, S. M., & Minim, L. A. (2015). Methodology for determination of two new sensory thresholds: Compromised acceptance threshold and rejection threshold. *Food Research International*, *76*, 561–566.

Lobo, C. P., & de Castro Ferreira, T. A. P. (2021). Hedonic thresholds and ideal sodium content reduction of bread loaves. *Food Research International*, *140*, 110090.

López-Carral, H., Grechuta, K., Verschure, P. F. M. J., & Doering, S. (2020). Subjective ratings of emotive stimuli predict the impact of the COVID-19 quarantine on affective states. *PLoS One*, *15*(8), e0237631.

Makhal, A., Thyne, M., Robertson, K., & Mirosa, M. (2020). "I don't like wonky carrots"—An exploration of children's perceptions of suboptimal fruits and vegetables. *Journal of Retailing and Consumer Services*, *54*, 101945.

Manzocco, L., Rumignani, A., & Lagazio, C. (2012). Use of images in shelf life assessment of fruit salad. *Journal of Food Science*, *77*(7), s258–s262.

Mehrabian, A. (1996). Pleasure-arousal-dominance: A general framework for describing and measuring individual differences in temperament. *Current Psychology: Developmental, Learning, Personality, Social*, *14*(4), 261–292.

Mehrabian, A., & Russell, J. A. (1974). *An approach to environmental psychology*. Cambridge, MA: MIT Press.

Miskovic, V., & Keil, A. (2012). Acquired fears reflected in cortical sensory processing: A review of electrophysiological studies of human classical conditioning. *Psychophysiology*, *49*(9), 1230–1241.

Mogilever, N. B., Zuccarelli, L., Burles, F., Iaria, G., Strapazzon, G., Bessone, L., & Coffey, E. B. J. (2018). Expedition cognition: A review and prospective of subterranean neuroscience with spaceflight applications. *Frontiers in Human Neuroscience*, *12*, 407.

Morales, J., Solovey, G., Maniscalco, B., Rahnev, D., de Lange, F. P., & Lau, H. (2015). Low attention impairs optimal incorporation of prior knowledge in perceptual decisions. *Attention, Perception, & Psychophysics*, *77*(6), 2021–2036.

Mulligan, K., & Scherer, K. (2012). Toward a working definition of emotion. *Emotion Review*, *4*, 345–357.

Ostertagová, E. (2012). Modelling using polynomial regression. *Procedia Engineering*, *48*, 500–506.

Padulo, C., Carlucci, L., Manippa, V., Marzoli, D., Saggino, A., Tommasi, L., … Brancucci, A. (2017). Valence, familiarity and arousal of different foods in relation to age, sex and weight. *Food Quality and Preference*, *57*, 104–113.

Pavlov, I. P. (1927). *Conditioned reflexes: An investigation of the physiological activity of the cerebral cortex*. Oxford, UK: Oxford University Press.

Pinto, V. R. A., de Abreu Campos, R. F., Rocha, F., Emmendoerfer, M. L., Vidigal, M. C. T. R., da Rocha, S. J. S. S., … Perrone, Í. T. (2021). Perceived healthiness of foods: A systematic review of qualitative studies. *Future Foods*, 100056.

Pinto, V. R. A., Teixeira, C. G., Lima, T. S., De Almeida Prata, E. R. B., Vidigal, M. C. T. R., Martins, E., … Carvalho, A. F. (2020). Health beliefs towards kefir correlate with emotion and attitude: A study using an emoji scale in Brazil. *Food Research International*, *129*, 108833.

Prescott, J. (2017). Some considerations in the measurement of emotions in sensory and consumer research. *Food Quality and Preference*, *62*, 360–368.

Prescott, J., Norris, L., Kunst, M., & Kim, S. (2005). Estimating a consumer rejection threshold for cork taint in white wine. *Food Quality and Preference*, *16*(1), 345–349.

Privitera, G. J., Diaz, M., & Haas, M. C. (2014). Enhanced auditory arousal increases intake of less palatable and healthier foods. *Global Journal of Health Science*, *6*(3), 1–8.

Quoidbach, J., Sugitani, Y., Gross, J. J., Taquet, M., & Akutsu, S. (2019). From affect to action: How pleasure shapes everyday decisions in Japan and the U.S. *Motivation and Emotion*, *43*, 948–955.

Rahnev, D., & Denison, R. N. (2018). Suboptimality in perceptual decision making. *Behavioral and Brain Sciences*, *41*, 1–107.

Rietveld, R., van Dolen, W., Mazloom, M., & Worring, M. (2020). What you feel, is what you like influence of message appeals on customer engagement on Instagram. *Journal of Interactive Marketing*, *49*, 20–53.

Russell, J. A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology*, *39*(6), 1161–1171.

Saleem, Z., Khan, M. H., Ahmad, M., Sohaib, A., Ayaz, H., & Mazzara, M. (2020). Prediction of microbial spoilage and shelf-life of bakery products through hyperspectral imaging. *IEEE Access*, *8*, 176986–176996.

Sant'anna, L. J., Araújo, C. I. A., Cornejo, L. L., da Silva Moreira, E., de Paula, M. C., de Carvalho, R. V., … Lima Filho, T. (2020). Hedonic thresholds for sodium chloride reduction in cracker. *Research, Society and Development*, *9*(12), e36491211376.

Schaefer, M., Reinhardt, A., Garbow, E., & Dressler, D. (2020). Sweet taste experience improves prosocial intentions and attractiveness ratings. *Psychological Research Psychologische Forschung*, *85*(4), 1724–1731. https://doi.org/10.1007/s00426-020-01336-x

Schouteten, J., Verwaeren, J., Gellynck, X., & Almli, V. (2018). Comparing a standardized to a product specific emoji list for evaluating food products by children. *Food Quality and Preference*, *72*, 86–97.

Schouteten, J. J. (2020). Are questionnaires the best way to measure emotions for food products and beverages? *Food Quality and Preference*, *92*, 104122.

Schouteten, J. J., De Steur, H., Sas, B., De Bourdeaudhuij, I., & Gellynck, X. (2017). The effect of the research setting on the emotional and sensory profiling under blind, expected, and informed conditions: A study on premium and private label yogurt products. *Journal of Dairy Science*, *100*(1), 169–186.

Schouteten, J. J., Verwaeren, J., Lagast, S., Gellynck, X., & De Steur, H. (2018). Emoji as a tool for measuring children's emotions when tasting food. *Food Quality and Preference*, *68*, 322–331.

SEBRAE. (2017). Os aspectos da indulgência no consumo de panificados e confeitaria. Retrieved from https://bibliotecas.sebrae.com.br/chronus/ARQUIVOS_CHRONUS/bds/bds.nsf/cf9df998d82cf85090bd4918ae1fdb8f/$File/19205.pdf.

Sick, J., Spinelli, S., Dinnella, C., & Monteleone, E. (2020). Children's selection of emojis to express food-elicited emotions in varied eating contexts. *Food Quality and Preference*, *85*, 103953.

Souza, L. B. A., de, Pinto, V. R. A., Nascimento, L. G. L., Stephani, R., Carvalho, A. F., & Perrone, I. T. (2021). Low-sugar strawberry yogurt: Hedonic thresholds and expectations. *Journal of Sensory Studies*, *36*(3), e12643.

Spence, C., Okajima, K., Cheok, A. D., Petit, O., & Michel, C. (2016). Eating with our eyes: From visual hunger to digital satiation. *Brain and Cognition*, *110*, 53–63.

Spinelli, S., & Jaeger, S. R. (2019). What do we know about the sensory drivers of emotions in foods and beverages?. *Current opinion in food science*, *27*, 82–89.

Sukkwai, S., Kijroongrojana, K., Chonpracha, P., Pujols, K. D., Alonso-Marenco, J. R., Ardoin, R., & Prinyawiwatkul, W. (2018). Effects of colorant concentration and "natural colour" or "sodium content" claim on saltiness perception, consumer liking and emotion, and purchase intent of dipping sauces. *International Journal of Food Science & Technology*, *53*(5), 1246–1254.

Toet, A., Kaneko, D., Ushiama, S., Hoving, S., de Kruijf, I., Brouwer, A.-M., … van Erp, J. B. F. (2018). EmojiGrid: A 2D pictorial scale for the assessment of food elicited emotions. *Frontiers in Psychology*, *9*, 2396.

Toet, A., & van Erp, J. B. F. (2020). Affective rating of audio and video clips using the EmojiGrid. *F1000Res*, *9*, 970.

Wade-Bohleber, L. M., Thoma, R., & Gerber, A. J. (2020). Neural correlates of subjective arousal and valence in health and panic disorder. *Psychiatry Research: Neuroimaging*, *305*, 111186.

Weinbach, N., Keha, E., Leib, H., & Kalanthroff, E. (2020). The influence of response inhibition training on food consumption and implicit attitudes toward food among female restrained eaters. *Nutrients*, *12*, 3609.

Woodward, H. E., Treat, T. A., Cameron, C. D., & Yegorova, V. (2017). Valence and arousal-based affective evaluations of foods. *Eating Behaviors*, *24*, 26–33.

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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6. OTHER PRODUCTS AND AWARDS EMERGED DURING THE DOCTORATE

6.1.Computer Program: TRUE FEELINGS

Full registration scope in portuguese

As respostas emocionais geradas a partir da avaliação de amostras que são servidas no varejo e no laboratório de análise sensorial são mais eficazes em gerar percepções globais para a indústria. Isso porque as emoções são respostas mais dinâmicas que determinam a escolha e a recompra. Nesse sentido, a ideia de se ter um software para rastrear sentimentos a partir de emojis associado às escalas hedônica, de atitude, prazer e excitação, representa a possibilidade de se trabalhar com um instrumento eficaz na obtenção de perfis emocionais para qualquer alimento, conectando indústria e consumidor a partir de uma degustação interativa no local de compra e nos locais de abrangência da análise sensorial. Isto significa que as respostas poderão nos dar uma capacidade de mensurar emoções e intensidade de sentimentos, o que possibilitará aos interessados identificar as principais características sensoriais e não sensoriais envolvidas em uma decisão-chave. Em seguida será apresentado o software TRUE FEELINGS, proposta de software para analisar dados de pesquisas em análise sensorial e pesquisa com consumidores, seguido do seu registro de patente.

Versão: 1.0

Plataforma: web utilizando servidor Apache, php 7.0 e banco de dados MySQL

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Departamento da UFV: Tecnologia de Alimentos

Área de aplicação: IN02 -Tecnologia e PS01-Psicologia

Sub-área: Pesquisa com consumidores

Tipo de programa: AP01-Aplicativo

Descrição: True Feelings é um software que permite realizar análise sensoriais com consumidores de alimentos a partir de escalas interativas afetivas, gerando retorno rápidode respostas e propiciando a interpretação de resultados estatísticos robustos, de fácil compreensão e entendimento para a tomada de decisão. O software é endereço a indústriae instituições que almejam otimizar o seu processo de pesquisa e desenvolvimento de novos produtos, focando em pesquisa com consumidores para a tomada de decisão de forma independente, rápida e segura do ponto de vista econômico. A possibilidade de personalizar as escalas de avaliação dá aos interessados autonomia para conduzir os testescom consumidores, de modo que os resultados obtidos já lhes fornecem a possibilidade de tomada de decisão, sema a necessidade de depender de profissionais para tal. Maioresdetalhes são descritos a seguir.

Função: Um tablet contendo um software específico (True Feelings) com escalas afetivasé colocado ao lado do stand da empresa que está realizando a degustação e os consumidores fornecem com poucos cliques o seu sentimento e sua disposição para consumir o alimento degustado. A avaliação também é adaptada para desktop, notebooke smartphone, pensando no interesse da empresa ou da instituição para obtenção de respostas mais rápidas, sem delimitação geográfica, mas com possibilidade de obter avaliações georeferenciadas e fora da modalidade presencial. Sua função principal é gerarrespostas rápidas de avaliações afetivas com resultados estatísticos robustos para atomada de decisão em relação a produtos e serviços. A escala para respostas emocionais é composta por emojis comumente conhecidos (sendo personalizável de acordo com cadaatividade), semelhantes àqueles frequentemente utilizados em aplicativos e mídias sociais, e com os quais os consumidores já estão familiarizados. O consumidor complementa a sua resposta emocional (visual) com uma resposta verbal que pode ser selecionada dentre até nove opções de escalas hedônica e de atitude de disposição para o consumo do alimento-alvo.

Problema original

Atualmente existe uma desconexão entre empresa e consumidor quando se propõe a realizar uma degustação de novos produtos e o propósito se reduz a apenas divulgação doproduto. A empresa expõe os produtos, o consumidor degusta e vai embora sem dar seu feedback para a empresa. Além disso, as empresas estão “viciadas” em avaliar novos produtos e tomar sérias decisões a partir de teste de aceitação, que são, muitas vezes, limitados à avaliação hedônica.

Em uma exposição de produto realizada no varejo por meio da degustação tradicional, o consumidor não tem informação suficiente sobre o produto degustado e, ao avaliar o alimento em uma escala com emoji para expressar seu sentimento, as empresas conseguem captar nuances do efeito da categoria do alimento (Como os consumidores conceitualizam a categoria do produto degustado), do efeito sensorial causado (Quais respostas às características sensoriais específicas de cada produto podem ser captadas) e do efeito do gosto (gostar ou desgostar de determinado particular do produto), para além do hedonismo. Nem sempre é possível diferenciar produtos da mesma categoria em testes simples de aceitação ou preferência, porque as respostas emocionais são mais holísticas, ou seja, capazes de discriminar melhor produtos semelhantes. Além disso, atitudes, desejos, intenção de compra e outras nuances podem ser captadas por escalas de emoção, o que as torna mais completas, mais fidedignas da decisão de compra, já que é sabido que o consumidor adota as emoções como ponto de partida para a maioria de suas decisões alimentares.

Solução

Um tablet é um instrumento interativo, que motiva os consumidores a participarem mais ativamente do processo de opinião em torno do produto, porque ele é dinâmico, envolveuma escala simples e objetiva na avaliação dos produtos. Além disso, este instrumento, ao conter um software que permite ser usado em múltiplos estabelecimentos varejistas, da feira ao supermercado, para avaliar diversos produtos alimentícios, gera informações globais e locais dos consumidores participantes, aproximando-os mais ativamente da indústria, não necessitando de tempo dispendido para avaliação, tal como ocorre em um ambiente controlado de laboratório.

Embora suas vantagens econômicas e práticas sejam muitas, o True Feelings pode ser acessado em desktop, notebook e smartphones, para que a indústria ou a instituição não se limite apenas à etapa presencial com consumidores e seja obrigatoriamente fadada a gastar com dispositivos eletrônicos para uso do software. Deste modo, em uma possibilidade de atingir um maior número de consumidores em contextos interculturais, poder-se-á utilizar o software como surveys de avaliação sensorial em plataformas onlineque requer apenas que os consumidores tenham acesso à internet.

Diferencial

Interface simples, objetiva e atualizada de comunicação com os reais consumidores, quecapta respostas emocionais em testes com novos produtos e se utiliza de uma quantidade diferenciada de análises estatísticas robustas para obtenção de respostas mais fidedignas, pautadas em níveis de rigorosidade probabilísta eficazes, que facilitarão a tomada de decisão com menor risco financeiro para as empresas. Boa taxa de retorno rápido, pela possibilidade de coletar um grande número de reais consumidores em um curto espaço detempo, já que o teste é feito no varejo onde há grande movimentação de consumidores, em laboratório específico para análise sensorial ou de forma online. Retorno rápido e mais fidedigno das reações positivas e negativas associadas a novos produtos que são geradassem ocasionar desgaste do consumidor para respondê-las, e, posteriormente à coleta de dados, o software gera análises estatísticas bastante robustas, de cunho descritivo e multivariado, de fácil entendimento e compreensão, visualização e interpretação para a tomada de decisão. O software pode ser constantemente atualizado, propiciando, por exemplo, a evolução da escala para emojis animados e emojis com graus de intensidade de sentimento. A adaptação vai depender do objetivo do que se quer testar e como o público-alvo poderá ser avaliado.

Benefícios

É de baixo custo operacional porque ele só requer os custos iniciais de desenvolvimento, instalação e atualização do software. A quantidade de tablets a colocar nos pontos específicos é um critério da empresa e elimina-se os altos custos decorrentes de gastos com papéis e embalagens para avaliação sensorial, contribuindo para a sustentabilidade ambiental. Contudo, ela pode escolher fazer uso do True Feelings apenas na modalidadeonline, sem aquisição de dispositivos eletrônicos. As respostas para as empresas são maisreais, porque

envolvem emojis, os quais são de conhecimento e de uso comum em aplicativos de smarthphones e mídias sociais, eliminando o esforço de leitura para obtenção de respostas. Outro diferencial é que futuramente o próprio varejo poderá adquirir o software e deixar à disposição dos compradores para avaliações dentro do próprio varejo, permitindo ainda mais a participação ativa do consumidor. Caso o varejose interesse por instalar smartphones nos corredores de gôndolas, como já acontece por exemplo com pesquisas de satisfação, os gastos para as empresas conduzirem estes testespodem ser ainda menores pois, uma vez adquirida a licença do software, os novos custosserão advindos apenas de manutenção e renovação da licença.

LOGO OFICIAL DO SOFTWARE

INSTITUTO NACIONAL DA PROPRIEDADE INDUSTRIAL

30/08/2021 870210079907 16:05

29409191927334250

Pedido de Registro de Programa de Computador - RPC

Número do Processo: 512021002109-6

Dados do Titular

Titular 1 de 2

Nome ou Razão Social: UNIVERSIDADE FEDERAL DE VIÇOSA
Tipo de Pessoa: Pessoa Jurídica
CPF/CNPJ: 25944455000196
Nacionalidade: Brasileira
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PETICIONAMENTO ELETRÔNICO

Esta solicitação foi enviada pelo sistema Peticionamento Eletrônico em 30/08/2021 às 16:05, Petição 870210079907

REPÚBLICA FEDERATIVA DO BRASIL
MINISTÉRIO DA ECONOMIA
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DIRETORIA DE PATENTES, PROGRAMAS DE COMPUTADOR E TOPOGRAFIAS DE CIRCUITOS INTEGRADOS

Certificado de Registro de Programa de Computador

Processo Nº: **BR512021002109-6**

O Instituto Nacional da Propriedade Industrial expede o presente certificado de registro de programa de computador, válido por 50 anos a partir de 1° de janeiro subsequente à data de 03/08/2020, em conformidade com o §2°, art. 2° da Lei 9.609, de 19 de Fevereiro de 1998.

Título: TRUE FEELINGS

Data de criação: 03/08/2020

Titular(es): UNIVERSIDADE FEDERAL DE VIÇOSA; UNIVERSIDADE FEDERAL DE JUIZ DE FORA

Autor(es): ÍTALO TULER PERRONE; RODRIGO STEPHANI; NAYARA CRISTINA PIMENTA PENA; VINÍCIUS RODRIGUES ARRUDA PINTO *; ANTONIO FERNANDES DE CARVALHO; SAMUEL JOSÉ SILVA SOARES DA ROCHA

Linguagem: OUTROS

Campo de aplicação: IN-02; PS-01

Tipo de programa: AP-01

Algoritmo hash: SHA-512

Resumo digital hash:
c0b9d5736e07735b44946661c4079162288297c0a590b3f881a16a723c79a6545b58101dd395d2be077cec246b8c4cba8358c394e6e77c80d48947d3fdf3e561

Expedido em: 08/09/2021

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6.2.Published Papers

1. Souza, P. B. A., Santos, M. D. F., Carneiro, J. D. D. S., **Pinto, V. R. A**., & Carvalho, E. E. N. (2022). The effect of different sugar substitute sweeteners on sensory aspects of sweet fruit preserves: A systematic review. *Journal of Food Processing and Preservation*, *46*(3), e16291.

2. **Pinto, V. R. A**., Gomes, J. R., da Fonseca, F. V. S., & de Melo Fernandes, M. (2022). Proposta de intervenção psicopedagógica em caso de dislexia a partir das perspectivas do filme "Como Estrelas na Terra". *Research, Society and Development*, *11*(1), e48611125127-e48611125127.

3**.** de Souza, L. B. A., **Pinto, V. R. A**., Nascimento, L. G. L., Stephani, R., de Carvalho, A. F., & Perrone, Í. T. (2021). Low-sugar strawberry yogurt: Hedonic thresholds and expectations. *Journal of Sensory Studies*, *36*(3), e12643.

4. Campos, R. C., **Pinto, V. R. A**., Melo, L. F., da Rocha, S. J. S. S., & Coimbra, J. S. (2021). New sustainable perspectives for "Coffee Wastewater" and other by-products: A critical review. *Future Foods*, *4*, 100058.

5. **Pinto, V. R. A**., Mattar, J. B., Cabral, L. F. M., & Bressan, J. (2019). Preocupação com a saúde medeia a relação entre alegação de saúde e aceitação de barras alimentícias. *Brazilian Journal of Development*, *5*(11), 24076-24081.

6. **Pinto, V. R. A**., Melo, L. F., & Bressan, J. (2019). Prediction of body image dissatisfaction in university students by multivariate statistical methods. *Acta Scientiarum. Health Sciences*, *41*, 44186.

7. **Pinto, V. R. A**., de Souza Araújo, L. G., de Freitas, L. S., Domingos, A. L. G., de Oliveira Freitas, T. B., Melo, L. F., & Bressan, J. (2019). A Preliminary Study for Assessing the Relationship Between Body Image Concern and Health Concern of Consumers of Snack Bars. *American Journal of Food Science and Health*, *5*(2), 61-66.

8. **Pinto, V. R. A**., Oliveira Freitas, T. B. D., Melo, L. F., Freitas, L. S. D., Souza Araújo, L. G. D., Minim, V. P. R., ... & Bressan, J. (2018). What Grabs Our Attention Most to Consume A Snack Bar In Brazil? Following Trends In Choice of Snack Bars To Boost Market For Healthier Options. *The Open Food Science Journal*, *10*(1).

7. GENERAL CONCLUSIONS

Overall, the desire for more palatable "healthy" foods may explain a growing attention for future foods providing good feelings (e.g., green comfort foods). Making health policies and educational interventions may help increase the importance of healthiness in a stimulus-independent manner to maximize potential healthier choices, influencing sensory pathways **(Chapters I, II and III)**. This creates opportunities for targeted mitigation, making more

conscious consumers and healthy foods more friendly and tasty for consumers (e.g., yogurt enriched with kefir).

This study demonstrates the impact that health expectations exert on consumers' acceptance, purchase intent and emotional responses toward food and beverages. This is the first study to analyse the viability of the use of emojis in Brazil as well their strong correlations with the purchase intent **(Chapter III).** This will contribute to recent literature to advance in the emotion measurement area.

When it comes to emotion-driven food choices, this methodology can help in the monitoring of unhealthy food choices, because it will be able to provide thresholds corresponding to variables capable of significantly influencing the consumer's mood. Likewise, they may also be useful to industry, public policymakers and health professionals, in order to facilitate identification of the factors that improve the mood of the consumer. Specifically, eating disorders associated with negative emotional states may also affect emotion thresholds. Ideally, psychoeducational interventions to reduce negative psychological outcomes associated with risky decision-making scenarios are expected as a crucially important practical application from this new methodology, creating substantial mitigation opportunities of unconscious affective responses to food (**Chapter IV**). In this regard, it is important that the industry, consumers, and government priorities be aligned with in the future.