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The impact of calorie and physical activity labelling on consumer's emo-sensory perceptions and food choices

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ABSTRACT

Providing labelling information is one of the strategies used to help consumers make healthier choices. However, although the type of information has the potential to assist consumers, it is important to evaluate their sensory and emotional perceptions. Therefore, the objective of this study was to evaluate the effect of different labelling information on consumers' sensory and emotional perceptions and their choices, for three different products (potato chips, juice and yogurt). A total of 480 participants were randomly assigned to one of four information conditions (no information (blind), kilocalorie (kcal) information, physical activity (PA) information [duration of walking required to burn the kcal in the product], kcal + PA information). For each information condition, participants were provided with higher kcal and lower kcal equivalent food pairs and were required to choose one. The participants evaluated their overall liking using a 9-point hedonic scale and answered rate-all-that-apply (RATA) questions related to the sensory and emotional characteristics of the products. The results showed no significant impact of calorie and physical activity labelling on consumers' overall liking for juice and yogurt samples and no impact of PA information for chips. Significant differences in overall liking were found when comparing the blind condition with kcal and kcal + PA information, with lower acceptance of the chips samples when this information was presented. Although providing calorie and physical activity labelling had little impact on consumers' sensory and emotional perceptions, consumers perceived unhealthy attributes and negative emotions, such as fatty and guilty, when information was presented. The present work suggests that, although nutrition labelling may be presented as an important strategy to assist consumers, it is important to evaluate consumers' lifestyles, considering that non-dieters and those low and moderate in dietary restraint may not be impacted by this information.

1. Introduction

The prevalence of overweight and obese individuals has gained attention, especially in the last few decades, and has become a serious concern owing to well-known negative effects, such as heart disease, stroke, hypertension, and type 2 diabetes (World Health Organization, 2016; Reilly & Kelly, 2011; NHS Choices, 2014). Increased energy consumption and reduced energy expenditure from declining levels of physical activity are primary factors in the rise in obesity (Hill, Wyatt, & Peters, 2012; NHS Choices, 2014).

Policies and programs have been implemented by companies, school districts, and governments aiming to prevent and reduce obesity (Cawley, 2015; Vecchio & Cavallo, 2019), such as calorie labelling on food and non-alcoholic drinks (Health, 2013) and calorie labelling and value sizing on menus/menu boards at chain restaurants (Food and Drug Administration, 2018). Since labels play a key role in attracting consumers' attention and in determining product choice (Clement, 2013; Moskowitz, Reisner, Lawlor, & Deliza, 2009), the adoption and implementation of labelling policies that improve well-informed food choice has been prioritized as an obesity-prevention measure (OECD, 2012; Bonsmann & Wills, 2012; Roberto & Khandpur, 2014; Hawkes et al., 2015; Vo, Albrecht, & Kershaw, 2019). Furthermore, these so-called front-of-pack (FoP) labels are a key factor for consumer attention on nutrition information and, thus, one of the most accessible marketing strategies for food companies (Ares et al., 2011; Bialkova, Grunert, & van Trijp, 2013; Bialkova et al., 2014).

The activity equivalent calorie labels may provide an easier reference for people who are less able to interpret current FoP labels; however, more research is needed on the efficacy of this approach (Bleich, Herring, Flagg, & Gary-Webb, 2011; Royal Society for Public Health: Vision, 2016). Lower socio-economic groups often have lower nutritional and health knowledge, so they may not understand what

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calories mean (Schindler, Kiszko, Abrams, Islam, & Elbel, 2013; Miller & Cassady, 2015). Other people may not even notice, or may not care about, the calorie information due to time pressure (Herpen & Trijp, 2011) or competing priorities (Sanlier & Karakus, 2010); while, people who do care about this information, may often select foods and beverages with lower calories if this information were available (Piron, Smith, Simon, & Cummings, 2009; Lando & Labiner-Wolfe, 2007). Piqueras-Fiszman and Spence (2015) have shown differences in how consumers perceive products with and without information.

The way in which calorie information is presented also has a significant influence on consumers' reactions (Gustafson & Zeballos, 2019). Masic, Christiansen, and Boyland (2017), for example, reported that the provision of physical activity information appeared most effective in influencing the selection of lower kilocalorie (kcal) items, when compared with kcal information or without information. The calorie information presented, together with the amount of physical activity required to burn these calories, can be more efficient in motivating changes in consumer behavior (Dowray, Swartz, Braxton, & Viera, 2013; Blumenthal et al., 2010; Bleich & Pollack, 2010; Roberto, Larsen, Agnew, Baik, & Brownell, 2010). Platkin et al. (2014) reported that menu labelling alone may be insufficient to reduce calories compared to menu labelling with calorie information and exercise equivalents. Viera et al. (2017) mentioned that food labelling with only kcal information is unlikely to be sufficient to motivate healthy eating behavior change. Masic et al. (2017) related that the PA label condition resulted in significant lower kcal snack and beverage choices than the kcal label condition. Therefore, more research is needed to examine different types of information presented on the packaging, as well as their combination. The majority of research has been conducted with product packaging or labels using online questionnaires (Hawley et al., 2013, Kleef & Dagevos, 2015), but the effectiveness of these labels still needs to be tested with consumers tasting the products. In this sense, it is important to include the effect of calorie and physical activity labelling on consumers' sensory and emotional perceptions.

When it comes to research on food labelling effects on consumer acceptance, the sensory and emotional profile of consumers may be expected to play an important role. First of all, the effect of FoP labels on consumers' food choices is expected to be strongly related to the sensory characteristics of the products (Lima, Alcantara, Ares, & Deliza, 2019). This is highly relevant in the case of healthy food products. As there is an inverse relationship between healthiness and tastiness, consumers usually believe that "unhealthy = tasty" and "healthy = not tasty". This can lead consumers to avoid the healthy option and choose the unhealthy tasty option instead (Raghunathan, Naylor, & Hoyer, 2006), rejecting products that do not meet their sensory and hedonic expectations (Civille & Oftedal, 2012). Secondly, self-assessment of emotional associations may help to better predict food choice and provide additional possibilities for further understanding consumer perceptions and beliefs towards their preferences than hedonic measurements alone (Dalenberg et al., 2014; Gutjar et al., 2015; Schouteten et al., 2015; Schouteten, Gellynck, & De Steur, 2018). Emotional profiles can be mapped into an emotional space represented by two orthogonal dimensions: valence (positive or negative, unpleasant or pleasant) and activation (low or high arousal) (Spinelli, Masi, Dinnella, Zoboli, & Monteleone, 2013). Emotions with a positive valence and high arousal contribute to the best predictive value for choice (Dalenberg et al., 2014).

This study aimed to evaluate the effect of different types of information (no information (blind), kilocalorie (kcal) information, physical activity (PA) information, and kcal + PA information) on consumer hedonic, sensory and emotional perceptions and their choices (high kcal vs. low kcal), for three different products (potato chips, juice and yogurt).

2. Materials and methods

The test was carried out to evaluate the effect of different labelling information on consumer perceptions and their choices of higher vs. lower kcal potato chips, juice and yogurt. Following a between-subjects experimental design, participants were randomized assigned to one of four information conditions (a) no information (blind), i.e. tasting the samples without any information, (b) kcal information, (c) PA information [duration of walking required to burn the kcal in the product] and (d) kcal + PA information. For each product, participants were provided with high kcal and low kcal content food pairs and were required to choose one.

2.1. Participants

The study involved a total of 480 participants (51.5% male; 18–62 years old) and was conducted in the sensory laboratory of Ghent University. The study was approved by the ethical board of Ghent University Hospital.

Participants were recruited from a database of interested volunteers and at the local university campus. Consumers were divided into 4 groups of 120 for each information condition. They gave written informed consent before starting the study and no compensation was given for their participation.

All participant demographics, as well as body mass index (BMI), diet status and emotional eating, are given in Table 1, with data demonstrating that the groups were well matched on all variables. Physical activity level, numeracy and literacy score by group can be seen in Supplementary Tables 1 and 2.

2.2. Stimuli

Potato chips, yogurt and juice were selected for the case study, given their high popularity in Belgium, and some of these products have been considered by restrained eaters as inconsistent with a diet due to their perceived calorie content (Urbszat, Herman, & Polivy, 2002). Two variables were considered in the experimental design: calorie content (high, low) and information (blind, kcal information, PA information and, kcal + PA information).

All energy information was provided as the number of kcal in the item, as taken from the FoP. The PA information was provided as minutes required to walk off the kcal in a snack portion of the product.

Table 1
Participant demographic information, appetite VAS* and emotional eating behavior** by group (kilocalorie (kcal); physical activity = PA); all mean scores are ± SD).

	Label type				p
	Blind	kcal	PA	kcal + PA	
Gender	51 (F) 69 (M)	57 (F) 63 (M)	63 (F) 57 (M)	62 (F) 58 (M)	0.410
Age	21.8 (± 5.67)	23.4 (± 7.77)	23.4 (± 7.73)	24.0 (± 9.01)	0.116
BMI	21.8 (± 2.57)	21.9 (± 2.78)	21.7 (± 2.35)	22.0 (± 2.68)	0.840
Diet Status	117 (N) 3 (Y)	115 (N) 5 (Y)	116 (N) 4 (Y)	118 (N) 2 (Y)	0.689
Emotional eating					
Low	54 (± 0.27)	48 (± 0.28)	44 (± 0.27)	42 (± 0.28)	0.437
Moderate	51 (± 0.26)	51 (± 0.25)	50 (± 0.25)	51 (± 0.32)	
High	15 (± 0.28)	21 (± 0.32)	26 (± 0.28)	27 (± 0.28)	

*M = Male, F = Female; BMI = Body Mass Index; Diet Status: N = Not dieting, Y = Yes dieting.
**Raw scale score was compared to norm scales according to BMI and gender. These were categorized as follows: very low to low = low, under average, average and above average = moderate, high and very high = high.

This information was based on Dowray et al. (2013) and calculated using the energy expenditure of a 160 lb or 72 kg adult walking at a rate of 30 min per mile (3.2 kcal/min), as assessed by dividing total kcal in the item by the energy expenditure rate).

Samples were bought in a local supermarket from the same batch. The snack portions were based on regular retailer sizes, thus 45 g for potato chips, 125 g for yogurt and 200 ml for orange juice. This research opted only to use verbal words and numbers to limit potential influence by other package cues. Therefore, the samples were potato chips (243 kcal and 76 min/198 kcal and 62 min), yogurt (109 kcal and 34 min/54 kcal and 17 min) and orange juice (102 kcal and 32 min/82 kcal and 26 min).

2.3. Experimental procedure

The participants received the samples coded with 3-digit numbers, two-by-two, for each product; participants were provided with higher kcal and lower kcal content food pairs. Assessment of the samples was balanced for order and carry-over effects, with randomization of the pairs (potato chips, yogurt and orange juice) and the information (blind, kcal, PA or both kcal + PA) within a pair, using Williams' Latin Square design (MACFIE et al., 1989). The questionnaire was administered using EyeQuestion software (Logic8BV, the Netherlands) ensuring that the participants evaluated the samples in the balanced design.

Under each information condition, the participant's dietary status was assessed prior to assessment of the samples by asking “Are you currently following a diet in order to lose body weight?” (yes/no) (Masic et al., 2017) followed by their consumption frequency for the products.

The evaluation followed a three-step procedure with participants first assessing their overall liking for a sample followed by the sensory profiling and finally by the emotional profiling (Schouteten et al., 2017). The quantity of the samples was sufficient to allow 3 bites or sips. This means that participants were required to taste each sample three times. That is, once before the completion of the overall liking questions, once before they continued to the sensory profiling and once before the emotional profiling of the sample. Participants were instructed to clear their palate with water and unsalted crackers.

We used a 9-point hedonic scale (1 = dislike extremely − 9 = like extremely) to rate the overall liking for the sample and applied the rate-all-that-apply (RATA) response format (Ares et al., 2014) for both the sensory and emotional profiling of the samples. The RATA questions were cited to provide more stable sample and term configurations. Sensory and emotional terms that were used in the RATA questions were generated using Schouteten et al. (2015) method (Table 2).

For the RATA questions, participants were first asked to rate the intensity of all applicable sensory terms (Ares, Bruzzone, et al., 2014) and then of the emotional terms, using a 5-point scale ranging from 1 (slightly) to 5 (extremely) (Schouteten et al., 2015). The order in which the terms were presented was different for each product and each participant, following a balanced presentation order design (William's Latin Square) (Ares et al., 2014; Ares, Bruzzone, et al., 2014). After the evaluations of both items of a pair, consumers were asked to choose their preferred sample of the pair, i.e. “Which one of these two samples would you choose to consume a portion (one bag − 45 g) right now? (i.e. Sample 596: 243 kcal/portion and Sample 318: 198 kcal/portion)”.

After evaluation of all the samples, data was collected for variables that could explain variations in the energy selections made by participants (Dowray et al., 2013). These included 10 questions related to restrained eating (Cronbach's α = 0.90) derived from the Dutch Eating Behavior Questionnaire - Restraint subscale [DEBQ-R] (van Strien, Frijters, Bergers, & Defares, 1986) on a 5-point scale (1 = never, 5 = very often) (supplementary file), calorie literacy (a three-item measure which assesses consumer understanding of daily energy requirements (Bleich & Pollack, 2010), basic numeracy (three items (Schwartz, Woloshin, Black, & Welch, 1997) and habitual level of physical activity (Craig et al., 2003). Finally, socio-demographic measures were asked (gender, age, height and body weight). BMI was calculated based on the height and body weight measurements for each individual.

Table 2
Overview of the sensory and emotional terms used for RATA questions for the different food products.

	Chips	Juice	Yogurt
Sensory terms	Aftertaste	Aftertaste	Aftertaste
	Crisps aroma	Bitter	Creamy
	Crunchy	Intense flavour	Dark colour
	Fatty	Light colour	Firm
	Firm	Natural taste	Fruit aroma
	Light	Off-flavour	Fruit flavour
	Off-flavour	Orange aroma	Homogeneous
	Salt	Orange flavour	Liquid
	Smooth	Orange colour	Milk flavour
	Soft	Pulp	Off-flavour
	Sweet	Sour	Smooth
	Tasty	Sweet	Sour
	Yellow colour	Thick	Sweet
		Watery	Thick
Emotional terms	Calm	Enthusiastic	Pleasant surprise
	Contented	Glad	Calm
	Desire	Good	Frustrated
	Disappointed	Happy	Interested
	Discontented	Irritated	Happy
	Disgust	Calm	Stressed
	Dissatisfied	Unpleasant surprise	Good
	Enthusiastic	Discontented	Unpleasant surprise
	Glad	Sad	Discontented
	Good	Dissatisfied	Pleasant
	Guilty	Pleasant	Dissatisfied
	Happy	Guilty	Disappointed
	Pleasant	Disappointed	Contented
	Sad	Warm	Bored
	Satisfied	Worried	Satisfied
	Stressed	Satisfied	Friendly
	Unpleasant surprise	Disgust	Disgust
	Calm	Desire	Steady
		Energetic	

2.4. Statistical analysis

The influence of nutritional information on consumers' perceptions of the three different products was analyzed using Analysis of variance (ANOVA) on overall liking scores.

For each product (chips, juice and yogurt) ANOVAs were performed considering kcal (high/ lower), information (blind, kcal, PA, kcal + PA) and their interactions. When differences were significant at $p < 0.05$, Tukey's test was used for post-hoc comparison of means.

Data collected using RATA questions were analyzed following the procedures recommended by Meyners, Jaeger, and Ares (2016). For each information condition (blind, kcal, PA, kcal + PA), significant differences in frequency of selection (RATA) and weighted frequency of selection (RATA scoring) of items between the samples of a food product were calculated (using 0 for terms that were not selected). Significant differences between samples were established using analysis of variance (ANOVA), followed by post hoc comparison of means, where $p < 0.05$. PCA was applied to the table of average scores for each sample and term of the RATA question.

All analyses were performed using the R statistical language (R Core Team, 2017), with a 5% significance level.

3. Results

All participants consumed the products at least occasionally (53%

sometimes consumed chips, 40% seldom consumed juice and 35% frequently consumed yogurt). Most of the respondents were non-dieters (97%) and reported practicing moderate physical activity and walking.

To explore the impact of the participants' emotional eating behavior on their emotion responses the participants were segmented into three groups according to their average DEBQ-e score, using the norm scales for healthy populations, taking gender and BMI into account. The split was performed by characterizing participants as being either 'low emotional eaters' (L; $M < 2$), 'medium emotional eaters' (M; $2 \leqslant M < 3$), and 'high emotional eaters' (H; $\geqslant 3$) (Piqueras-Fiszman & Jaeger, 2014). The numbers of participants in these groups were respectively: 54, 51, and 15 for the blind condition, 48, 51, and 21 for the kcal information, 44, 50 and 26 for the PA information and 42, 51 and 27 for the kcal + PA information. Approximately half of the participants had moderate emotional eating behavior (42.3%), while low and high emotional eaters accounted for 36.7% and 21.0%, respectively.

Regarding numeracy, 43% of the sample answered all three questions correctly, especially the group of participants who participated in the study with the PA information ($p = 0.00$). While for the calorie literacy questions, only 14% of the sample answered all three correctly (supplementary file).

3.1. Overall liking and choice

A significant effect for the kcal variable was found for all three product categories ($p < 0.001$), with a significant higher liking when a product was high in kcal for the chips ($F_{1,952} = 6.649$, $p = 0.010$), and low in kcal for the juice ($F_{1,952} = 28.900$, $p = 0.000$) and yogurt ($F_{1,952} = 23.707$, $p = 0.000$). Overall liking scores for the potato chips were significantly affected by information ($F_{3,952} = 3.666$, $p = 0.012$), as shown in Table 3, the information about kcal and kcal + PA significantly reduced overall liking scores compared to the blind condition. However, the overall liking scores for the juice ($F_{3,952} = 1.532$, $p = 0.205$) and yogurt ($F_{3,952} = 1.031$, $p = 0.378$) were not influenced by information. Also, no significant interaction effects for energy with information was found for yogurt ($F_{3,952} = 0.321$, $p = 0.810$), chips ($F_{3,952} = 0.385$, $p = 0.764$) or juice ($F_{3,952} = 0.364$, $p = 0.779$).

When the consumers were asked about "Which one of these two samples would you choose to consume right now?" no significant differences were found between the different information conditions ($p > 0.05$). Most participants made at least two healthy choices (low energy), as shown in Fig. 1.

3.2. Sensory profiling

Differences in sensory profiling were found for all products (Table 4–6), suggesting that the choices (high kcal vs. low kcal) as well as the type of information (blind, kcal information, PA information, or kcal + PA information) influenced consumers' perceptions of sensory attributes. Regarding potato chips (Table 4), a kcal effect was observed for 9 out of 13 attributes and an information effect for 5 out of 13 attributes. For the juice (Table 5) a kcal effect was observed for 11 out of 14 attributes and an information effect for 4 out of 14 attributes; and for the yogurt (Table 6) a kcal effect was observed for 7 out of 14 attributes and an information effect for 4 out of 13 attributes.

Table 3
Average overall liking§ scores for the different products considering the two variables in the experimental design: kcal and information.

	Chips	Juice	Yogurt
kcal			
High	6.8^{a} (± 1.20)	5.7^{b} (± 1.61)	6.1^{b} (± 1.56)
Low	6.6^{b} (± 1.47)	6.2^{a} (± 1.52)	6.6^{a} (± 1.42)
Information			
Blind	6.9^{a} (± 1.38)	6.1^{a} (± 1.43)	6.4^{a} (± 1.57)
kcal	6.6^{b} (± 1.22)	5.9^{a} (± 1.68)	6.4^{a} (± 1.43)
PA	6.8^{ab} (± 1.36)	6.1^{a} (± 1.55)	6.2^{a} (± 1.55)
kcal + PA	6.5^{b} (± 1.40)	5.8^{a} (± 1.68)	6.3^{a} (± 1.47)

§ Evaluated in 9-point hedonic scales. Average overall liking scores with different superscript letters within a column and a factor (kcal and information) are significantly different ($p < 0.05$).

No significant interaction effects were found; the only exception was the terms *fatty* ($p = 0.047$), *pulp* ($p < 0.001$) and *thick* ($p = 0.004$) for the chips, juice and yogurt, respectively. Consumers used the term *fatty* significantly with less intensity for the high kcal chips for the blind condition compared to the PA or kcal + PA information, whereas in the case of the low kcal chips both information conditions maintained the intensity of use of the term *fatty*. For the *pulp* term, consumers used the term significantly with more intensity for the low kcal juice when presented with no information and with kcal information, compared to the PA or kcal + PA information. For yogurt, presentation of the information increased the intensity of the term *thick* for the samples with high kcal, while the opposite happened for the samples with low kcal. For the kcal + PA information, the consumers reported the same intensity for this attribute for both products.

Fig. 2 presents PCA plots on sensory intensity scores for chips, juice and yogurt that were assessed with low and high kcal and different information. The first two components explained 82.6%, 75.2% and 65.34% of the total variances for the chips (Fig. 2a), juice (Fig. 2b) and yogurt (Fig. 2c), respectively. On average, the samples with high kcal remained grouped together, as well as those with low kcal. Significant differences were observed in some attributes among these samples ($p \leq 0.05$).

For the potato chips, the samples with high kcal increased the intensity scores for the attributes *salt*, *smooth*, *crisps aroma* and *fatty*, while the low kcal samples increased the intensity scores for the attributes *crunchy*, *off flavor*, *firm* and *light*. Adding information reduced the intensity scores for the attribute *tasty* and increased those for the attribute *firm*. The juice with low kcal was characterized by the attributes *thick*, *orange flavor*, *pulp*, *orange colour* and *natural taste*, and those with high kcal were related to the attributes *off-flavor*, *sour*, *bitter*, *light colour*, *aftertaste* and *watery*. For the yogurt with low kcal, the samples were characterized by the attributes *fruit aroma*, *fruit flavor* and *sweet*, while the yogurt with high kcal was related to the attributes *smooth*, *homogeneous*, *sour* and *liquid*. The PA information increased the intensity scores for the attributes *sweet* compared to the blind condition and kcal information, and *firm* compared to the blind condition and kcal + PA information.

The kcal + PA and PA information increased the intensity scores for the attribute *fatty* for the chips samples and reduced the intensity scores for the attribute *natural taste* for the juice samples and *fruit aroma* for the yogurt samples, compared to the blind condition. However, the kcal information did not differ between samples for these terms. This may be related to the fact that consumers are more familiar with this type of FoP.

3.3. Emotional profiling

The intensity scores for potato chips, juice and yogurt with higher and lower kcal are summarized in Tables 7–9, respectively. Regarding the potato chips, a kcal effect was observed for 7 out of 18 emotional terms and an information effect was observed for 5 out of 18 attributes. For the juice, a kcal effect was observed for 10 out of 19 emotional terms and an information effect for 4 out of 19 emotional terms; and for the yogurt, a kcal effect was observed for 7 out of 18 emotional terms and an information effect for 5 out of 18 emotional terms.

Fig. 3 presents PCA plots on emotional intensity scores for chips, juice and yogurt that were assessed with low and high kcal. The first three components explained 69.8%, 68.1% and 64.1% of the total variances for the chips (Fig. 3a), juice (Fig. 3b) and yogurt (Fig. 3c), respectively.

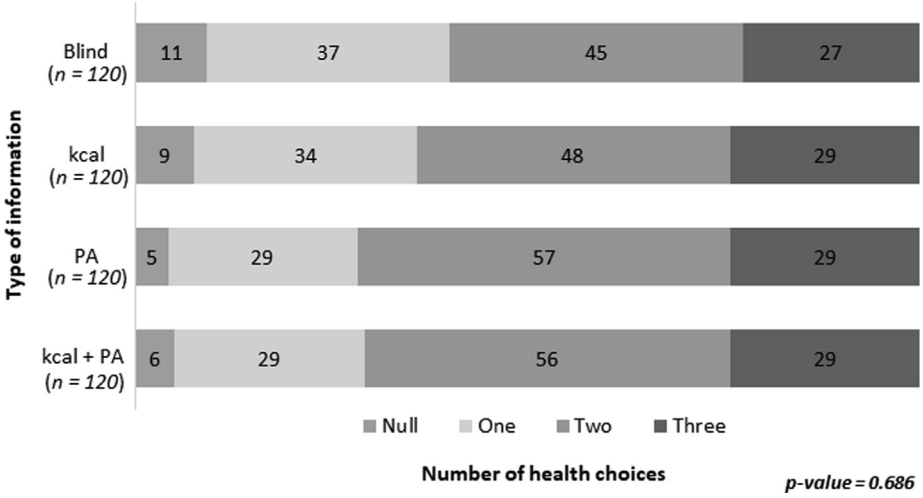

Fig. 1. Combined number of healthy choices (0, 1, 2 or 3) selected by consumers for the different treatments (Blind, kcal, PA and kcal + PA). Consumers answered the question "Which one of these two samples would you choose to consume a portion right now?" for each pair of products (chips, yogurt and juice) separately which led to the combined number of healthy choices.

For the potato chips, the samples with high kcal increased the intensity scores for the attribute *guilty*, while the low kcal samples increased the intensity scores for *unpleasant surprise*, *disappointed* and *dissatisfied*. Adding information reduced the intensity scores for *pleasant*, *satisfied* and *happy* and increased the intensity scores for *contented*. Consumers felt more *guilty* about kcal + PA and PA information than with the kcal information. Regarding juice, the samples with high kcal increased the intensity scores for *disappointed, unpleasant surprise, dissatisfied*, *disgust* and *discontented*, while the low kcal samples increased the intensity scores for *pleasant, happy, good, satisfied* and *glad*. Adding kcal + PA information reduced the intensity scores for the emotional term *happy* compared to the blind condition and kcal information. Consumers presented greater intensity for *dissatisfied* and lower intensity for *pleasant* in relation to the samples when they received information. The emotional term *warm* was perceived as more intense when the sample was accompanied by the PA information in relation to the other information. For the yogurt samples, adding information reduced the intensity scores for *pleasant, happy* and *steady*. However, the opposite occurred with *contented*. Consumers reported a higher intensity for the emotional term *friendly* when the samples were presented with the kcal information.

4. Discussion

In general, participants in this study had a good knowledge about daily energy requirements and basic numeracy. The majority of consumers correctly identified the recommended daily calorie intake for moderately active women (85%), while 42% correctly identified the intake for inactive adults and 48% for moderately active men. In addition, only 2% incorrectly answered the three questions used to assess numeracy. These high knowledge scores, which exceed values reported in similar studies (e.g. McCrory, Vanderlee, White, Reid, & Hammond, 2016), may occur due to the larger proportion of highly educated people in the sample, as education is a recognized determinant for nutrition knowledge (Vasconcelos et al., 2019; Pillai, Liang, Thwaitesc, Sharmad, & Goldsmith, 2019; Mulders, Corneille, & Klein, 2018).

Providing information enables consumers to make more informed choices and encourages the selection of healthier alternatives (Brissette, Lowenfels, Noble, & Spicer, 2013; Bialkova et al., 2014; Hieke et al., 2015; Dodds, 2014; Acton & Hammond, 2018; Arrúa, Curutchet et al., 2017; Khandpur et al., 2018; Machín, Aschemann-Witzel, Curutchet, Giménez, & Ares, 2018; Talati et al., 2017). However, it is necessary to present FoP nutrition labelling that is easy to understand.

Table 4
Significance values and mean intensity scores for sensory terms obtained for potato chips samples with low and high kcal and different information using RATA questions.

Terms	kcal		Information		kcal		Information			
	F		F		Low	High	Blind	kcal	kcal + PA	PA
Aftertaste	0.7	NS	3.1	*	0.8	0.7	0.9^{a}	0.9^{a}	0.7^{ab}	0.6^{b}
Crisps aroma	46.5	***	2.8	*	1.0^{B}	1.7^{A}	1.5^{a}	1.2^{b}	1.2^{b}	1.5^{a}
Crunchy	53.6	***	1.4	NS	3.7^{A}	2.9^{B}	3.4	3.2	3.2	3.4
Fatty	215.6	***	5.2	**	0.6^{B}	2.1^{A}	1.0^{b}	1.3^{ab}	1.6^{a}	1.5^{a}
Firm	41.2	***	6.4	***	1.4^{A}	0.7^{B}	0.6^{b}	1.1^{a}	1.1^{a}	1.2^{a}
Light	8.8	**	0.2	NS	1.0^{A}	0.7^{B}	0.8	0.8	0.9	0.9
Off-flavour	14.9	***	0.9	NS	0.4^{A}	0.2^{B}	0.3	0.3	0.4	0.3
Salt	74.3	***	1.6	NS	2.2^{B}	3.1^{A}	2.8	2.7	2.6	2.5
Smooth	11.5	***	2.0	NS	0.1^{B}	0.3^{A}	0.2	0.3	0.1	0.2
Soft	1.6	NS	0.1	NS	0.3	0.3	0.3	0.3	0.3	0.3
Sweet	2.7	NS	0.7	NS	0.2	0.2	0.2	0.2	0.2	0.2
Tasty	2.4	NS	4.9	**	1.8	2.0	2.3^{a}	1.9^{b}	1.7^{b}	1.7^{b}
Yellow colour	51.4	***	1.4	NS	2.0^{A}	1.2^{B}	1.8	1.4	1.6	1.6

F-values and p-values are derived from linear mixed models with kcal, information and kcal:information interaction as fixed effects, and subjects as random effects. Significant interaction effects were found for the *Fatty* term ($F = 2.7$, $p < 0.05$).
Probabilities are presented as *($p < 0.05$), **($p < 0.01$), ***($p < 0.001$) and NS($p > 0.05$). Different capital letters indicate significant differences between potato chips kcal ($p < 0.05$), i.e. low and high. Different lower case letters indicate significant differences between potato chips with different information ($p < 0.05$), i.e. potato chips blind condition and with kcal, kcal + PA and PA.

Table 5
Significance values and mean intensity scores for sensory terms obtained for juice samples with low and high kcal and different information using RATA questions.

Terms	kcal		Information		kcal		Information			
	F		F		Low	High	Blind	kcal	kcal + PA	PA
Aftertaste	13.0	***	1.8	NS	0.7^{B}	1.0^{A}	1.1	0.8	0.8	0.8
Bitter	7.4	**	0.2	NS	0.3^{B}	0.5^{A}	0.4	0.4	0.4	0.4
Intense flavour	0.5	NS	2.3	NS	0.9	1.0	0.7	1.1	1.0	0.9
Light colour	70.4	***	1.0	NS	0.3^{B}	1.0^{A}	0.6	0.6	0.8	0.7
Natural taste	30.9	***	2.8	*	1.3^{A}	0.7^{B}	1.2^{a}	1.0^{ab}	0.9^{b}	0.8^{b}
Off flavour	10.6	**	1.0	NS	0.3^{B}	0.5^{A}	0.3	0.4	0.3	0.5
Orange aroma	0.0	NS	0.3	NS	1.4	1.4	1.4	1.4	1.4	1.5
Orange colour	28.6	***	3.6	*	1.9^{A}	1.2^{B}	1.8^{a}	1.6^{ab}	1.3^{b}	1.5^{ab}
Orange flavour	7.4	**	0.3	NS	2.0^{A}	1.7^{B}	1.8	2.0	1.9	1.9
Pulp	607.1	***	7.6	***	2.4^{A}	0.2^{B}	1.5^{a}	1.6^{a}	1.2^{b}	1.0^{b}
Sour	41.3	***	2.0	NS	1.0^{B}	1.7^{A}	1.2	1.4	1.2	1.5
Sweet	0.3	NS	0.4	NS	1.6	1.5	1.5	1.5	1.6	1.5
Thick	10.9	***	1.0	NS	0.4^{A}	0.2^{B}	0.2	0.4	0.3	0.4
Watery	9.1	**	3.6	*	1.0^{B}	1.3^{A}	1.4^{a}	1.1^{ab}	1.2^{ab}	0.9^{b}

F-values and p-values are derived from linear mixed models with kcal, information and kcal:information interaction as fixed effects, and subjects as random effects. Significant interaction effects were found for the *Pulp* term ($F = 6.4$, $p < 0.001$).
Probabilities are presented as *($p < 0.05$), **($p < 0.01$), ***($p < 0.001$) and NS($p > 0.05$). Different capital letters indicate significant differences between juice kcal ($p < 0.05$), i.e. low and high. Different lower case letters indicate significant differences between juice with different information ($p < 0.05$), i.e. juice blind condition and with kcal, kcal + PA and PA.

4.1. Overall liking and choice

The present work involved two FoP nutrition labelling schemes (calorie content and physical activity), but it found no significant differences between them, except for potato chips. According to sensory tests performed with consumers, significant differences in overall liking were found compared to the blind condition with kcal and kcal + PA information, with lower acceptance of the potato chips samples when this information was presented. A positive effect for information has been reported in several studies due to a decrease in consumers' uncertainty about the characteristics of tasted products (Torres-Moreno, Tarrega, Torrescasana, & Blanch, 2012; Ježovičová, Turčínková, & Drexler, 2016).

Research involving the effect of nutrition labelling on food choice has mostly been conducted using online questionnaires, or did not involve actual tasting of the products that this study investigated. Since the present study found no significant effect of information on consumers' overall liking for juice and yogurt samples and no effect of PA information for chips, it may be considered that food choices were based mainly on the sensory properties of the products. The limited effect of nutrition and health claims on consumers' food choice upon tasting the product has been observed in previous research (Lima et al., 2019).

Another explanation could involve the kcal and PA information provided by the products; the values may not have been sufficient for consumers to recognize the products as different (i.e. 26 and 32 min of walking to burn off the energy from orange juice). Although more consumers preferred low kcal samples, some scholars refer to the effect of information on nutritional characteristics of products, which depends on the degree of difference between consumers' sensory perceptions of reformulated products and their regular counterparts (Reis, Alcairec, Deliza, & Ares, 2017). Similar results were also found by Lima et al. (2019); consumers demonstrated interest in consuming products with lower sugar content when looking at the packages, but FoP nutrition labelling did not modify their choices when they tasted the product.

Table 6
Significance values and mean intensity scores of sensory terms obtained for yogurt samples with low and high kcal and different information using RATA questions.

Terms	kcal		Information		kcal		Information			
	F		F		Low	High	Blind	kcal	kcal + PA	PA
Aftertaste	1.0	NS	2.0	NS	0.7	0.8	0.9	0.6	0.9	0.7
Creamy	1.7	NS	0.4	NS	1.8	1.9	1.9	2	1.8	1.8
Dark colour	0.0	NS	0.2	NS	0.1	0.1	0.1	0.1	0.1	0.1
Firm	1.5	NS	5.4	**	0.6	0.4	0.3^{c}	0.6^{ab}	0.4^{bc}	0.7^{a}
Fruit aroma	23.9	***	4.2	**	1.7^{A}	1.2^{B}	1.8^{a}	1.5^{ab}	1.3^{b}	1.3^{b}
Fruit flavour	49.8	***	0.4	NS	2.6^{A}	1.8^{B}	2.1	2.3	2.1	2.2
Liquid	6.3	*	1.8	NS	0.6^{B}	0.9^{A}	0.6	0.8	0.9	0.7
Milk flavour	0.5	NS	4.5	**	1.1	1.2	1.4^{a}	0.9^{b}	1.1^{b}	1.1^{b}
Homogeneous	105.7	***	1.0	NS	0.6^{B}	1.8^{A}	1.3	1.2	1.1	1.1
Off-flavour	1.1	NS	0.6	NS	0.3	0.4	0.3	0.4	0.4	0.4
Smooth	30.3	***	2.1	NS	1.1^{B}	1.7^{A}	1.6	1.4	1.2	1.4
Sour	7.8	**	0.6	NS	0.2^{B}	0.4^{A}	0.3	0.3	0.4	0.3
Sweet	7.7	**	3.2	*	2.5^{A}	2.1^{B}	2.1^{b}	2.1^{b}	2.4^{ab}	2.6^{a}
Thick	0.0	NS	2.0	NS	1.0	1.0	0.8	1.2	0.9	1.1

F-values and p-values are derived from linear mixed models with kcal, information and kcal:information interaction as fixed effects, and subjects as random effects. Significant interaction effects were found for the *Thick* term ($F = 4.6$, $p < 0.01$).
Probabilities are presented as *($p < 0.05$), **($p < 0.01$), ***($p < 0.001$) and NS($p > 0.05$). Different capital letters indicate significant differences between yogurt kcal ($p < 0.05$), i.e. low and high. Different lower case letters indicate significant differences between yogurt with different information ($p < 0.05$), i.e. yogurt blind condition and with kcal, kcal + PA and PA.

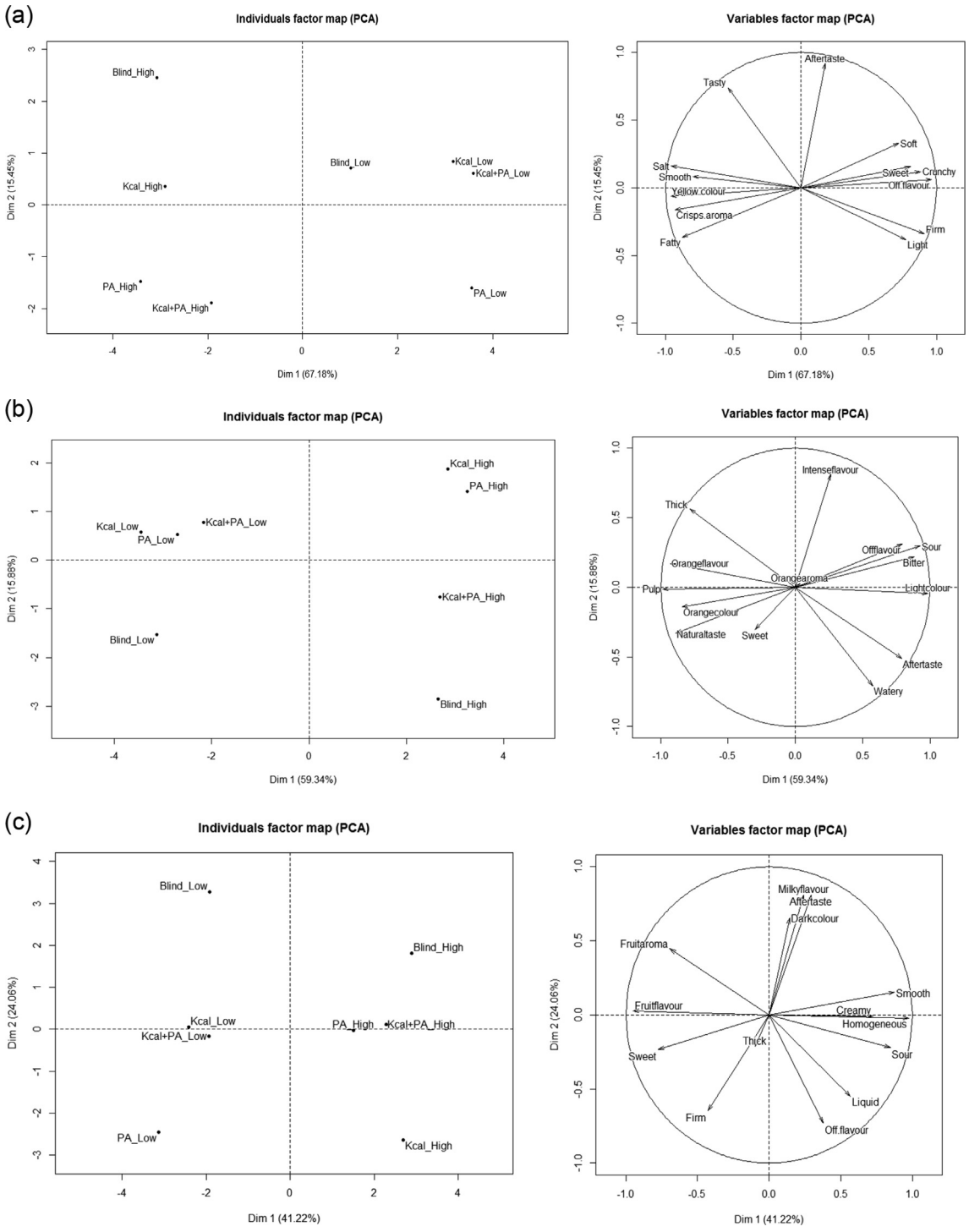

Fig. 2. Representation of samples (left) and sensory terms (right) in the first two dimensions of the Principal Component Analysis (PCA) performed on average scores of the rate-all-that-apply (RATA) question for describing 3 different products with high and low energy and different nutritional information: (a) Chips, (b) Juice and (c) Yogurt.

4.2. Sensory profiling

The information increased consumer sensory discrimination of the samples; consumers perceived the intensities of flavors and aromas as weaker when some information was presented. For example, the sensory attributes *tasty* for chips, *natural taste* for juice and *fruit aroma* for yogurt were mentioned less when PA and kcal + PA information were presented. The effect of the information was also found for unhealthy attributes. For example, the chips were seen as more *fatty* compared to blind information. These results are in line with previous studies reporting that the information influenced consumer perceptions of sensory characteristics (Reis et al., 2017). Oliveira, Ares, and Deliza (2018) reported that sensory characteristics of the products were the main determinants of consumers' hedonic reactions. Schouteten et al. (2015) also reported that health claims altered perceptions of sensory attributes.

Table 7
Significance values and mean intensity scores for emotional terms obtained for potato chips samples with low and high kcal and different information using RATA questions.

Terms	kcal		Information		kcal		Information			
	F		F		Low	High	Blind	kcal	kcal + PA	PA
Calm	0.5	NS	1.0	NS	0.7	0.6	0.8	0.6	0.6	0.7
Contented	0.9	NS	4.7	**	1.1	1.2	0.9^{b}	1.3^{a}	1.2^{a}	1.5^{a}
Desire	3.3	NS	1.7	NS	0.5	0.7	0.7	0.5	0.5	0.7
Disappointed	16.6	***	1.4	NS	0.6^{A}	0.3^{B}	0.4	0.5	0.4	0.4
Discontented	5.5	*	1.3	NS	0.2^{B}	0.3^{A}	0.2	0.3	0.3	0.2
Disgust	1.0	NS	0.6	NS	0.1	0.0	0.0	0.0	0.1	0.1
Dissatisfied	6.5	*	0.5	NS	0.5^{A}	0.3^{B}	0.3	0.4	0.4	0.4
Enthusiastic	2.8	NS	2.0	NS	0.6	0.4	0.7	0.5	0.4	0.6
Glad	1.1	NS	2.2	NS	0.7	0.8	0.6	0.7	0.8	0.9
Good	4.2	*	0.8	NS	1.5^{B}	1.7^{A}	1.8	1.5	1.6	1.6
Guilty	14.6	***	3.6	*	0.1^{B}	0.4^{A}	0.2^{bc}	0.1^{c}	0.4^{a}	0.3^{ab}
Happy	0.0	NS	9.2	***	0.9	0.9	1.3^{a}	0.8^{bc}	0.6^{c}	0.9^{b}
Pleasant	1.2	NS	4.6	**	0.7	0.8	1.1^{a}	0.7^{b}	0.6^{b}	0.7^{b}
Pleasant surprise	4.4	*	0.5	NS	0.7^{A}	0.5^{B}	0.6	0.5	0.6	0.5
Sad	0.6	NS	1.8	NS	0.1	0.1	0.1	0.0	0.1	0.0
Satisfied	0.7	NS	6.4	***	0.9	1.0	1.3^{a}	0.7^{b}	0.8^{b}	0.9^{b}
Stressed	0.1	NS	2.3	NS	0.0	0.1	0.0	0.1	0.1	0.0
Unpleasant surprise	12.3	***	1.2	NS	0.4^{A}	0.2^{B}	0.2	0.3	0.4	0.2

F-values and p-values are derived from linear mixed models with kcal, information and kcal:information interaction as fixed effects, and subjects as random effects. No significant interaction effects were found.
Probabilities are presented as *($p < 0.05$), **($p < 0.01$), ***($p < 0.001$) and NS($p > 0.05$). Different capital letters indicate significant differences between potato chips Kcal ($p < 0.05$), i.e. low and high. Different lower case letters indicate significant differences between potato chips without or with different information ($p < 0.05$), i.e. potato chips blind condition and with kcal, kcal + PA and PA.

4.3. Emotional profiling

The information also influenced consumer perceptions of emotional aspects; negative attributes such as *discontented* for juice and *guilty* for chips were mentioned more when some information was presented. These results are in line with previous findings indicating that health-related information might impact consumers' emotional profiling of food products (Reis et al., 2017; Schouteten et al., 2015).

4.4. General discussion

Even though consumers are aware that unhealthy eating is a major contributor to disease, this is not always reflected in actual food choices (Mai & Hoffmann, 2015; Hartley, Keast, & Liem, 2019). In this study, the information only influenced the overall liking for potato chips, but differences in sensory and emotional profiling were found for all products, both for sensory and emotional terms. Research reports that consumer behavior and food choice are influenced by many interacting factors (Köster & Mojet, 2018) and that sensory and emotional

Table 8
Significance values and mean intensity scores of emotional terms obtained for juice samples with low and high kcal and different information using RATA questions.

Terms	kcal		Information		kcal		Information			
	F		F		Low	High	Blind	kcal	kcal + PA	PA
Calm	0.3	NS	0.3	NS	0.8	0.8	0.8	0.8	0.7	0.8
Desire	2.0	NS	1.2	NS	0.2	0.2	0.2	0.2	0.2	0.3
Disappointed	5.6	*	0.2	NS	0.5^{B}	0.7^{A}	0.6	0.5	0.6	0.6
Discontented	6.5	*	3.3	*	0.4^{B}	0.6^{A}	0.3^{b}	0.6^{a}	0.6^{a}	0.5^{ab}
Disgust	10.7	**	2.1	NS	0.1^{B}	0.2^{A}	0.2	0.2	0.3	0.1
Dissatisfied	6.1	*	0	NS	0.3^{B}	0.5^{A}	0.4	0.4	0.4	0.4
Energetic	2.1	NS	1.8	NS	0.5	0.3	0.3	0.4	0.3	0.5
Enthusiastic	2.7	NS	2.5	NS	0.5	0.4	0.3	0.5	0.5	0.4
Glad	7.8	**	0.9	NS	0.8^{A}	0.5^{B}	0.6	0.6	0.6	0.8
Good	13.3	***	0.6	NS	1.7^{A}	1.3^{B}	1.6	1.5	1.4	1.5
Guilty	0.4	NS	0.5	NS	0.1	0.1	0.1	0.1	0.1	0.1
Happy	4.3	*	3.4	*	0.8^{A}	0.6^{B}	0.9^{a}	0.8^{a}	0.5^{b}	0.7^{ab}
Irritated	0.0	NS	1.8	NS	0.2	0.2	0.1	0.3	0.3	0.2
Pleasant	4.8	*	5	**	0.7^{A}	0.5^{B}	0.9^{a}	0.4^{b}	0.5^{b}	0.6^{b}
Sad	1.7	NS	1.0	NS	0.1	0.1	0.1	0.1	0.1	0.1
Satisfied	19.3	***	0.6	NS	1.0^{A}	0.6^{B}	0.9	0.9	0.7	0.8
Unpleasant surprise	19.7	***	0.6	NS	0.3^{B}	0.6^{A}	0.4	0.4	0.5	0.4
Warm	0.0	NS	3.4	*	0.2	0.2	0.1^{b}	0.1^{b}	0.1^{b}	0.3^{a}
Worried	0.6	NS	0.3	NS	0.1	0.1	0.1	0.1	0.0	0.1

F-values and p-values are derived from linear mixed models with kcal, information and kcal:information interaction as fixed effects, and subjects as random effects. No significant interaction effects were found.
Probabilities are presented as *($p < 0.05$), **($p < 0.01$), ***($p < 0.001$) and NS($p > 0.05$). Different capital letters indicate significant differences between juice kcal ($p < 0.05$), i.e. low and high. Different lower case letters indicate significant differences between juice without or with different information ($p < 0.05$), i.e. juice blind condition and with kcal, kcal + PA and PA.

Table 9
Significance values and mean intensity scores of emotional terms obtained for yogurt samples with low and high kcal and different information using RATA questions.

Terms	kcal		Information		kcal		Information			
	F		F		Low	High	Blind	kcal	kcal + PA	PA
Bored	15.3	***	2.4	NS	0.2^{B}	0.4^{A}	0.2	0.3	0.4	0.4
Calm	0.8	NS	0.3	NS	0.8	0.9	0.8	0.9	0.9	1.0
Contented	7.6	**	10.4	***	1.3^{A}	1.0^{B}	0.6^{b}	1.4^{a}	1.2^{a}	1.3^{a}
Disappointed	9.7	**	1.7	NS	0.3^{B}	0.5^{A}	0.3	0.4	0.6	0.4
Discontented	2.3	NS	1.0	NS	0.3	0.4	0.3	0.3	0.4	0.4
Disgust	2.2	NS	1.2	NS	0.1	0.1	0.1	0.2	0.1	0.1
Dissatisfied	3.8	NS	0.4	NS	0.3	0.4	0.3	0.3	0.4	0.3
Friendly	0.1	NS	3.4	*	0.4	0.4	0.4^{ab}	0.6^{a}	0.3^{b}	0.4^{b}
Frustrated	0.2	NS	0.6	NS	0.1	0.1	0.0	0.1	0.1	0.1
Good	2.6	NS	0.8	NS	1.7	1.5	1.7	1.4	1.6	1.6
Happy	5.8	*	3.4	*	0.9^{A}	0.7^{B}	1.0^{a}	0.7^{b}	0.6^{b}	0.7^{b}
Interested	3.4	NS	0.2	NS	0.5	0.3	0.4	0.4	0.4	0.4
Pleasant	0.0	NS	7.2	***	0.7	0.6	1.0^{a}	0.6^{b}	0.5^{b}	0.4^{b}
Pleasant surprise	7.5	**	0.8	NS	0.8^{A}	0.5^{B}	0.5	0.7	0.7	0.6
Satisfied	7	**	1.1	NS	1.1^{A}	0.8^{B}	1.1	1.0	0.9	0.9
Steady	0.4	NS	5.4	**	0.2	0.2	0.3^{a}	0.1^{b}	0.1^{b}	0.2^{b}
Stressed	0.5	NS	0.2	NS	0.1	0.0	0.1	0.0	0.1	0.1
Unpleasant surprise	8.9	**	1.4	NS	0.3^{B}	0.5^{A}	0.3	0.4	0.5	0.4

F-values and p-values are derived from linear mixed models with kcal, information and kcal:information interaction as fixed effects, and subjects as random effects. No significant interaction effects were found.
Probabilities are presented as *($p < 0.05$), **($p < 0.01$), ***($p < 0.001$) and NS($p > 0.05$). Different capital letters indicate significant differences between yogurt kcal ($p < 0.05$), i.e. low and high. Different lower case letters indicate significant differences between yogurt without or with different information ($p < 0.05$), i.e. yogurt blind condition and with kcal, kcal + PA and PA.

responses to products may differ independently of liking (Oliveira et al., 2018; Spinelli, Monteleone, Ares, & Jaeger, 2019).

Although the majority of consumers perceive some nutrition information in food products (Visschers, Hess, & Siegrist, 2010), this information is overshadowed by other information on food products if consumers have a taste motivation. On the other hand, health motivation may stimulate people's attention for nutrition information, facilitating their detection, and may lead to deeper information processing than taste motivation (Visschers et al., 2010; Miller & Cassady, 2015). While the type of information has the potential to assist consumers, it is important to consider the target audience, given that the effect of information may only occur for dieters, not for non-dieters (Temple et al., 2011; Girz, Polivy, Herman, & Lee, 2012), or may even be absent altogether (Elbel, Kersh, Brescoll, & Dixon, 2009; Elbel, Gyamfi, & Kersh, 2011; Swartz, Braxton, & Viera, 2011; Tandon et al., 2011; Holmes, Serrano, Machin, Duetsch, & Davis, 2013). Oliveira et al. (2018) reported that information increased the acceptance of sugar-reduced nectars for the consumer segment interested in this type of product. Hartley et al. (2019) reported that the physical activity calorie equivalent label may not be an effective labelling strategy to reduce liking or consumption of food products; the label was not effective in reducing liking for less health-focused individuals. In the present work, 97% of participants were non-dieters; thus future studies should balance this variable. In addition, the effect of this information must be assessed for different age groups and levels of education. This was a limitation of this study, since the participants were, on average, 23 years old and highly educated. These limitations in the study may have influenced the results.

Overall, the results suggest that providing calorie and physical activity labelling had little impact on consumers' sensory and emotional perceptions; that is, perceptions of sensory and emotional attributes were altered by providing information. Previous studies also found little impact of labelling on emotional and sensory profiling using RATA questions (Schouteten et al., 2018; Schouteten, Gellynck, & Slabbinck, 2019). Although previous research has obtained discriminating sensory profiles using the RATA approach (Ares, Bruzzone, et al., 2014), the methodology used may have had an impact on the results; future studies may use the CATA questions and compare the results; the CATA question is a less analytical and more natural task for consumers (Vidal, Ares, Hedderley, Meyners, & Jaeger, 2018).

Future studies should evaluate the effect of this information by balancing consumers between dieters and non-dieters, since mainly non-dieters participated in this research. This may be one of the reasons why providing information had no effect, or only a modest effect, on overall liking and healthier food choices, suggesting that consumers may be more responsive to kcal and kcal + PA information than only blind information. According to sensory and emotional perceptions, consumers were able to discriminate between high and low kcal samples, especially when information was provided, suggesting that consumers were aware of their choices.

Although this study involved actual tasting of the products, the controlled laboratory-like environment may not be a true reflection of actual consumer behavior in a supermarket or restaurant. Conducting similar research in food-ordering environments might offer new insigths to understand food labelling schemes and their potential impact on food choices.

Credit authorship contribution statement

Denize Oliveira: Conceptualization, Methodology, Formal analysis, Writing - original draft, Writing - review & editing. **Hans De Steur:** Writing - original draft. **Sofie Lagast:** Writing - original draft. **Xavier Gellynck:** Writing - original draft. **Joachim J. Schouteten:** Investigation, Conceptualization, Methodology, Writing - original draft, Writing - review & editing.

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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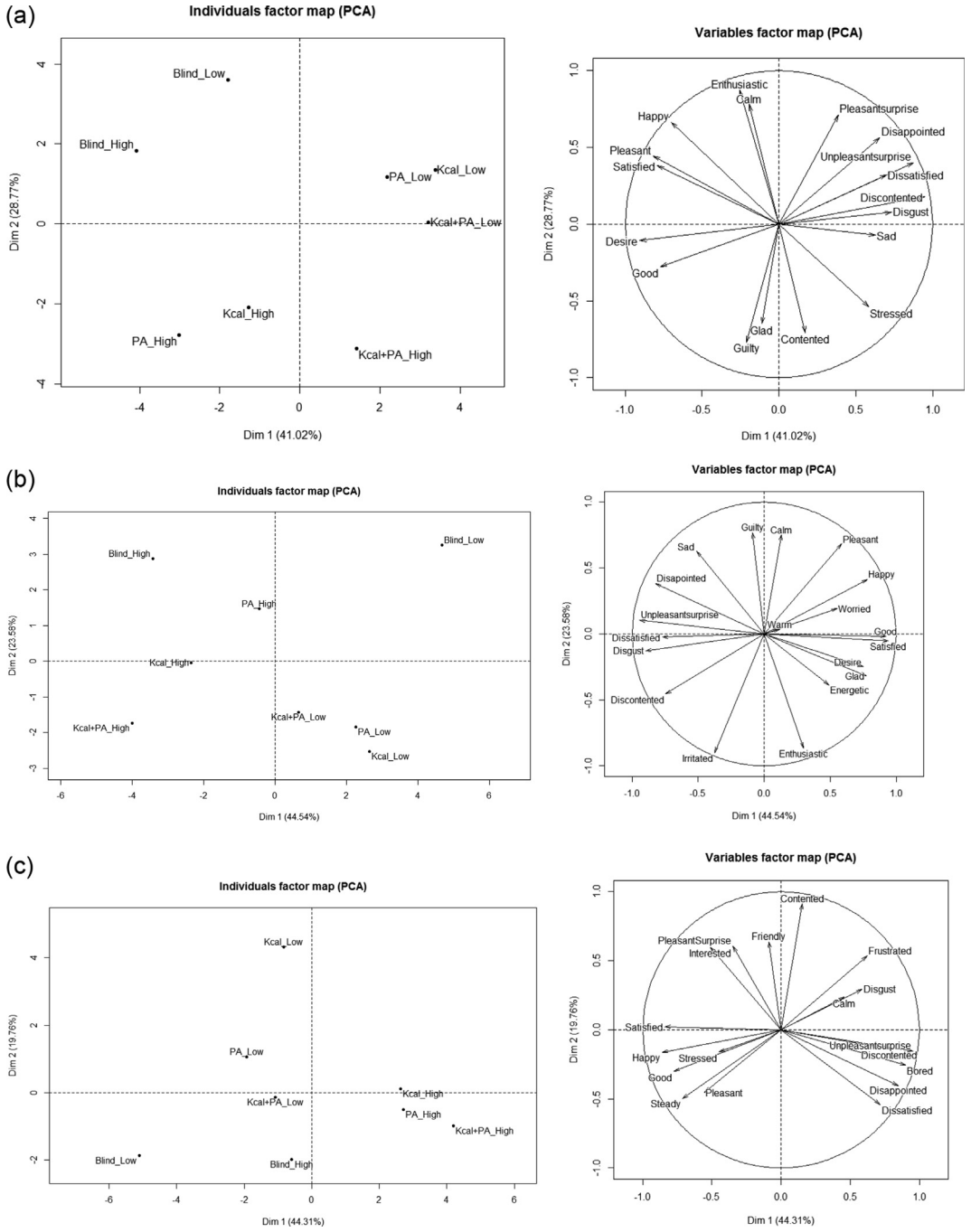

Fig. 3. Representation of samples (left) and emotional terms (right) in the first two dimensions of the Principal Component Analysis performed on average scores of the rate-all-that-apply (RATA) question for describing 3 different products with high and low energy and different nutritional information: (a) Chips, (b) Juice and (c) Yogurt.

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Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.foodres.2020.109166.

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