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Consumer emotional response to nutritional labels in the context of cake selection

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ABSTRACT

Food's appearance, flavour, aroma, and presentation all contribute to a sensory experience that can stick in your memory. Food is now an art form that communicates values, narratives, and cultural identity and is a source of nourishment. However, these days, elements like nutritional makeup and the availability of healthier substitutes are now significantly impacting visitors' decisions. This change results from people's shifting eating patterns and increased interest in leading more nutritious lives. Modern gastronomy must balance aesthetic, taste, and health considerations to meet sustainability and quality standards. This change presents a chance to reinterpret the culinary experience and reaffirm its applicability in the contemporary world. This study uses face reading to examine how knowledge about the nutritional makeup of cakes affects people's emotional reactions. Even though this knowledge can only slightly reverse consumer decisions, the data indicate that it considerably alters emotional responses. Even minor emotional changes can substantially impact consumers' preferences regarding a product. Purchasing decisions made during shopping are strongly influenced by emotions. This impulsive behavior often does not align with selecting healthy food options. In this study, visual attractiveness was evaluated using biometric measurement, specifically eye tracking, in addition to declarative methods. The study verifies a congruence in consumer preferences by utilizing heat maps to compare conscious evaluations with biometric data on visual attention. A detailed analysis of customer behavior, combining eye gaze tracking and emotion analysis, provides a more comprehensive understanding of decision-making processes. The findings indicate that front-of-pack labelling is crucial in shaping product preferences, as demonstrated through facial expression analysis and eye movement tracking. These insights can contribute to more effective marketing strategies and improved health-oriented product presentation.

Keywords: nutritional labeling, face-reading, emotions, gastronomy, eye tracking

INTRODUCTION

1. Importance of Nutritional Labels in Modern Gastro Industry

In the past, dietary targets have focused primarily on preventing nutritional deficiencies by ensuring adequate nutrient intake. Since then, this goal has been broadened to emphasise the use of diet to maintain or improve overall health. Similarly, the evolution of gastronomy towards haute cuisine has seen the incorporation of new ingredients and cutting-edge techniques that can interact with nutrients and alter the dietary impact of meals. The primary goal of haute cuisine chefs is to create innovative and delicious dishes that present unique textures and flavours, providing diners with new and rewarding sensory experiences **[1]**.

Research increasingly suggests that eating food prepared away from home can significantly affect calorie and nutrient intake, which can impact overall health **[2]**, **[3]**, and **[4]**. The Michelin Guide is seeing a growing trend among award-winning chefs to use healthy and nutritious ingredients, including seaweed, tempeh and millet, which are expected to appear more and more on their tasting menus **[5]**. A review of the literature on luxury gastronomy **[6]** revealed a significant shift by Michelin chefs towards healthier and more environmentally sustainable culinary practices. This trend is driven by the evolving demands of an increasingly demanding and

ecologically conscious clientele. However, despite their high ratings, there is still a lack of data on the nutritional adequacy of the food offered in these restaurants **[7]**.

The traditionally separate disciplines of nutrition and gastronomy are showing increasing convergence. While nutrition has traditionally focused on the biochemical aspects of food and its impact on health, modern trends are moving it towards the multisensory experience of food, which is the domain of gastronomy. At the same time, gastronomy incorporates the principles of nutrition, thereby enhancing the nutritional value of its creations without compromising their taste and aesthetics. This mutual influence is evident in the growing phenomenon of 'gourmet health,' which emphasizes the fusion of culinary art and nutritional principles **[8]**.

Current political discussions on nutrition increasingly focus on the importance of front-of-pack food labelling as an effective tool to support healthy consumer choices at purchase **[9]**, and **[10]**. The World Health Organization considers front-of-pack labelling one of the most effective strategies for preventing diet-related diseases **[11]**. Initially developed by an independent academic group, Nutri-Score offers a comprehensive assessment of the nutritional quality of food and beverages through an intuitive color-coded system, where green (A) indicates healthier options and dark orange (E) less healthy ones **[9]**, and **[10]**. France was the first country to officially adopt Nutri-Score as front-of-pack labelling in 2017 **[12]**, **[13]**, **[14]**, **[15]**, **[16]**, and **[17]**.

The widespread awareness of the Nutri-Score has prompted health authorities to consider extending its use to unpackaged foods and food services, which could improve transparency in overall dietary choices **[18]**. Based on research results, the authors suggest that implementing Nutri-Score not only on packaged products leads to positive changes in the population's dietary habits **[19]**. The immediate effect was an improvement in the overall nutritional value of the diet. At the same time, the long-term impact was a reduction in total food intake, suggesting an adaptation in consumption behaviour.

2. Theoretical frameworks of consumer behaviour and factors influencing food choice decisions

Numerous definitions exist for how consumer behaviour is distributed, depending on the influencing factors. We have chosen the most relevant and current definitions for our study. Following the collaborative effort to overcome the COVID-19 pandemic and the subsequent six-week lockdown **[20]**, which significantly impacted consumer behaviour, **[21]** noted a surge in demand for products like flour and snacks (e.g., nuts) compared to the previous year. Human behaviour is generally understood to be the result of two distinct decision-making processes: rapid (automatic and unconscious) and deliberate (reflective and conscious) **[22]**.

According to recent studies, consumers can be divided into three main groups based on their eating habits: Emotional eaters sometimes overeat and become obese because they eat to cope with negative emotions like fear, anxiety, or anger **[23]**. Regardless of internal indicators of hunger and fullness, external eaters react to outside stimuli, such as the taste or look of food. An elevated risk of obesity is linked to this eating pattern **[24]**. To manage their body weight, restrictive eaters deliberately attempt to restrict their food intake. However, strict dietary restrictions can result in overeating and impulsive behavior **[25]**.

The World Health Organization reports a concerning rise in obesity, which has intensified the emphasis in the media on proper diet and food choices for both children and adults **[26]**. To address this, researchers are actively developing diverse tools and methodologies through continuous nutrition education to enhance food awareness among today's consumers and improve the global situation **[27]**.

Several strategies aim to influence consumer behaviour **[28]** by educating customers through various channels **[29]**. Today, consumers are expected to make informed and sustainable food choices. This necessitates the development of effective interventions and incentives to guide their decision-making process **[30]**, **[31]**, and **[32]**.

3. The Role of Emotional and Psychological Factors in Purchasing Decisions (in relation to nutritional brands)

When examining emotional and psychological factors in purchasing, especially in nutritional brands, it is essential to focus on various theories demonstrating how emotions and psychology influence consumer decision-making.

Kotler and Keller highlight that psychological factors such as motivations, perception, and attitude significantly affect consumer decisions. Regarding nutritional brands, their analysis reveals that consumers choose products that align with their perceptions of health and nutrition, often guided by subjective and emotional influences **[33]**.

Focus on brand communities and the role of emotional connections with brands. In the case of nutritional products, the consumer’s perception of a brand regarding values like health or lifestyle is crucial **[34]**.

Thompson, Rindfleisch, and Arsel emphasize emotional marketing strategies and their impact on brand perception. For nutritional products, how a brand evokes emotional responses is important in shaping consumer

preferences within a healthy lifestyle framework. Negative brand perception impacts its value, while positive emotional responses are vital for positioning the brand as authentic and contributing to healthy living **[35]**.

Schmitt **[36]** explores the psychological aspects of consumer behavior in the context of brands, including emotional factors critical to decision-making regarding nutritional brands. He found that emotional connections between consumers and brands play a key role in shaping their decisions and preferences. Schmitt focuses on how brands create strong emotional bonds that influence consumer behavior through functional product features and emotional and symbolic values.

Schmitt argues that consumers often choose brands that reflect their own values and identities. These emotional connections are powerful for brands that appeal to personal, cultural, and social aspects, as well as those addressing psychological and emotional needs (e.g., self-expression, social status, or a sense of security).

In the context of nutritional brands, these emotional connections can involve consumers making decisions based on health, lifestyle, and perceptions of brand authenticity. Schmitt also highlights the importance of brand authenticity and how perceiving a brand as "authentic" or "reliable" can be a decisive factor in product selection.

4. Importance and Benefits of Measuring Visual Attention and Emotional Reactions (Eye-Tracking and EEG) on Food Products in Relation to Front-of-Pack Labeling

Measuring visual attention and emotional reactions to food products, mainly through technologies like eye-tracking and electroencephalography (EEG), is crucial for understanding how front-of-pack (FOP) design influences purchasing behavior. These methods enable analysis of where consumers look, how long they focus on specific visual elements, and the emotional responses triggered by these elements. Such insights are invaluable for optimizing packaging design to enhance product appeal and support consumer decision-making.

Various experts and institutions conduct research in this area. For example, researchers at the Faculty of Business and Economics of Mendel University in Brno analyze consumer visual attention using eye-tracking technologies. Ing. Denis Drexler and Ing. Martin Souček, Ph.D., examine how different visual elements influence consumer behavior in retail environments **[37]**.

The study uses eye-tracking and EEG to investigate visual attention and emotional reactions to food products **[38]**. It found that consumers tend to focus on information placed on the front of the package, particularly prominent graphic elements and logos. The most attention was given to colors (e.g., green, red) and immediately readable and understandable information.

In this study, the emotional reactions to packaging were analysed. EEG results showed that products emphasizing health and ecological benefits (e.g., "organic" or "natural") elicited positive emotional responses such as satisfaction and trust. Conversely, overly complex or unclear information caused confusion and stress, reducing engagement and purchase interest. Furthermore, the study revealed that products with clear, concise front-of-pack information received higher ratings in consumer decision-making tests. Consumers preferred packaging highlighting key product benefits (e.g., nutritional values, ecological components) without unnecessary visual distractions.

In Slovakia, the Faculty of Management, Economics, and Business at the University of Prešov operates a Neuromarketing Laboratory with technologies for measuring galvanic skin response (GSR/EDA), eye-tracking, and respiratory monitoring. These tools comprehensively analyze consumer emotional responses to marketing stimuli **[39]**.

These studies and institutions provide valuable insights into how visual cues on food packaging influence consumer attention and emotional reactions, which are critical for effective packaging design and marketing strategies.

Scientific Hypothesis

Nutri-Score labelling on cake samples significantly influences consumers' emotional responses (valence and arousal) and visual attention, leading to measurable changes in their product perception and selection preferences.

Objectives

Primary objectives: The article's objective is to investigate the impact of Nutri-Score labelling on consumer emotional responses, visual attention, and product selection preferences when choosing chocolate cakes. The study aims to differentiate between conscious (explicit) and subconscious (implicit) consumer reactions by utilizing FaceReader and eye-tracking technologies to measure changes in valence (emotional positivity/negativity) and arousal.

MATERIAL AND METHODS

Samples

Samples description: The test focused on three chocolate cake samples with varying nutritional compositions, made by students at Piešťany's Ľudovít Winter Secondary Hotel School. The cake samples looked almost the same, but their nutritional makeup varied because some of them were made with better substitutes for components, including carrots or cane sugar. Details can be seen in Table 1.

Table 1 Characteristics of the cake samples compared.

Parameter	EGLO	ENGA	EGGC
Weight (g)	32	25	47
Dimensions (cm)	(6x6x1,4)	(5,8x5,8x1,3)	(5,8x5,8x1,5)
Main Ingredients	Cocoa powder, milk, sugar, egg, butter, baking powder, self-rising flour, all-purpose flour, salt, water	Cocoa powder, milk, brown sugar, butter, egg, baking powder, spelt flour, salt, water	Cocoa powder, almond unsweetened milk, apple cider vinegar, vegan butter, brown sugar, egg, baking powder, vanilla extract, all-purpose flour, salt, water
Others	Nutri-Score (E)	Nutri-Score (D)	Nutri-Score (C) & different styling

Note: Source: Authors' documentation based on research, 2024.

Samples collection: Samples were presented at room temperature, e.g., 20°C.

Samples preparation: Samples were presented on a black plate made of natural slate stone. For the examination, we have used the whole cake pieces.

Number of samples analysed: Tree (3)

Description of the Experiment

Study flow: Thirty healthy respondents aged 18 to 61 years (67% female) with no intolerances participated in the testing. Before the test, participants received training on the procedure and filled out a consent form authorizing the processing and storage of their biometric and personal data. As per the International Code ICC/ESOMAR (Code of Ethics of the Laboratory of Consumer Studies FEM SUA in Nitra from 2020), everything is done in compliance with the Code of Ethics.

Respondents were first shown three samples of cakes with the labels EGLO, ENGA, and EGGC but without nutritional labelling as part of the study. The samples were falsely labelled without any additional context. Each sample was then supplemented with Nutri-Score indications to provide information on its nutritional balance. Figure 1 illustrates the testing process.

Quality Assurance

Number of repeated analyses: -

Number of experiment replications: -

Reference materials: -

Calibration: The eye-tracking device was calibrated based on the manufacturer's recommended standards for calibration and use of the device.

Laboratory accreditation: Experiments were not performed in the accredited laboratory.

Data Access

Due to the respondents ' General Data Protection Regulation and experiment data privacy, data are available at the request of the corresponding author.

Statistical Analysis

The biometric information and recorded responses were processed using descriptive and inductive statistics in R Studio 2022, Matlab 2020, and MS Excel 2013 software programs. To evaluate the impact of Nutri-Score labelling on consumer emotional responses and attention, a paired t-test was applied as the primary statistical method for comparing two related data sets, aiming to determine a statistically significant difference between the means of two paired (dependent) samples **[40]**. Before the comparison, the Shapiro-Wilk test was used to assess the normality of the data distribution. Additionally, ChatGPT-4.0 was utilized for boxplot visualization, and Tobii Studio PRO LAB 1.232 software was employed for visualizing heatmaps of visual attention, providing deeper insights into gaze behavior and fixation patterns.

This article investigates how the Nutri-Score affects emotional response when choosing a chocolate cake. A traditional qualitative preference test is not all that this is. Our study differentiates between conscious (explicit) feedback gathered using conventional research instruments like questionnaires and subconscious/unconscious (implicit) feedback gathered using consumer neuroscience products like Face Reader software. The goal is to investigate the differences in valence and arousal when selecting cakes with and without the Nutri-Score label.

Figure 1 The course of research.
Note: Source: Authors' documentation based on research, 2024.

Face reading and Eye-tracking

A popular neuroscience tool for marketing research that focuses on customer behaviour and perception is Face Reader. It is categorized as a somatic biometric technique that uses pupil dilation and nonverbal facial muscle movements to record secondary brain activity. This enables implicit feedback to be gathered **[41]**. According to Yu and Ko **[42]**, the software uses facial muscle analysis to recognize six primary emotional expressions: happiness, sorrow, anger, surprise, fear, and disgust. According to estimates, its accuracy in identifying emotions is 90%, guaranteeing dependable and prompt outcomes **[43]**. Face Reader uses a computer screen to record a participant's face when exposed to particular stimuli. The algorithm automatically recognizes emotion-sensitive elements, including the mouth, nose, and eyebrows, by applying a virtual grid of 500 points to the facial image. Factors that obscure these important features, such as hats, spectacles, facial hair, or face jewelry, can affect data accuracy.

Additionally, due to calibration restrictions, specific facial recognition systems may exhibit bias toward particular age or ethnic groups **[44]**. The software may extract metrics such as gaze direction (e.g., left, right, up, or down), gaze angles (horizontal or vertical), head orientation and position, and, in some situations, emotional arousal in addition to fundamental emotional analysis **[45]**. To offer comprehensive insights into the recorded emotional expressions, a sophisticated image processing algorithm analyses the grid points over 44 facial muscles **[46]**. Based on facial activity, this technique interprets microexpressions and provides insights into unconscious and subconscious reactions.

The pupil center corneal reflection (PCCR) eye-tracking approach of the Tobii Eye Tracker 2, a binocular system focused on both eyes with a sampling rate of 120 Hz, was utilized to measure eye movements **[47]**. The Tobii Pro Lab software version 1.83.11324 was used to process the primary data captured using this method **[48]**.

The validity of the recorded data on eye movements caused by visual stimuli depends on many additional factors, including the size and quality of the stimuli **[49]**, their complexity and variety **[50]**, **[51]**, and the previously mentioned clear and consistent instructions given to the respondents **[52]**.

RESULTS AND DISCUSSION

After uncovering samples of the three chocolate cakes, the respondents were asked to evaluate their visual attractiveness by arranging them in order. As seen in Table 2, most respondents (18) ranked the EGGC sample first. This sample differed from the others in the decoration of banana filling or the addition of nuts. The second most respondents (13) marked the ENGA sample, which was by far the lowest among the cake samples compared. Respondents (10) ranked the EGLO sample based on conscious visual attractiveness, and the ENGA sample tied for third place.

Table 2 Ranking of samples based on visual attractiveness - conscious evaluation.

Cake identification	1	2	3
EGLO	9	11	10
ENGA	7	13	10
EGGC	18	5	7

Regarding willingness to taste the different samples, most respondents (12) said they would like to see the EGLO sample. Figure 2. Paradoxically, in terms of visual attractiveness, they ranked it third with the EGGC sample. Another interesting finding is that this sample did not contain any additional decoration. The least number of respondents (8) would like to taste the EGGC sample first, which was rated as the most attractive at the conscious level, probably because it contained additional decoration.

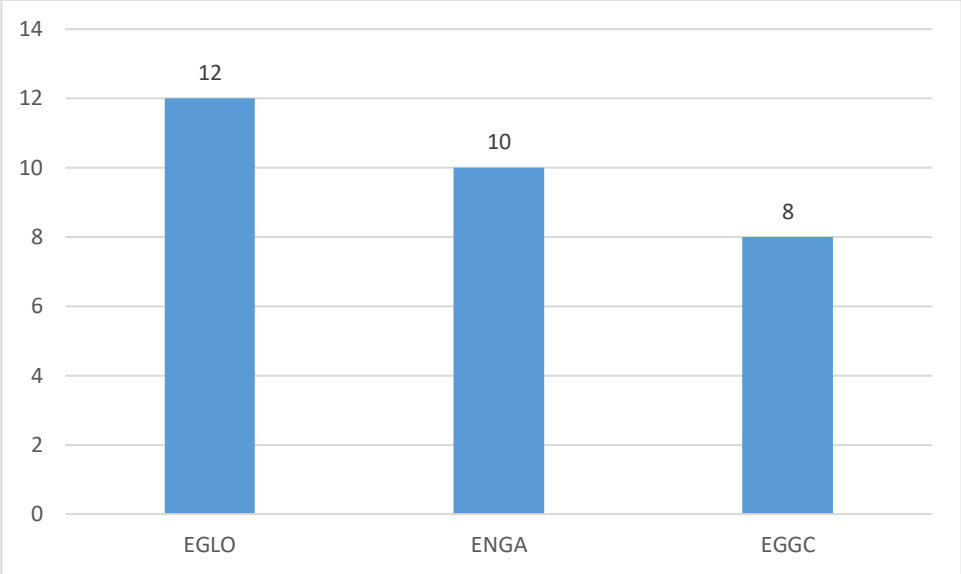

Figure 2 Explicit feedback collected via questionnaire.

Regarding rating the health aspect purely based on appearance, most respondents (20) rated the EGGC sample as the healthiest and the most nutritious regarding nutritional composition. However, respondents did not know this at this stage of the research. Conversely, the most significant number of respondents identified the least healthy sample (16) as EGLO, ironically the sample most wanted to taste first.

Table 3 Ranking of samples based on perceived health (based on appearance only).

Cake identification	1	2	3
EGLO	3	11	16
ENGA	7	17	6
EGGC	20	2	8

In terms of visual attention recorded by the mobile eye camera, it can be noted that most visual attention was focused on the EGGC sample located in the center, which is probably related to the complementary decoration see Figure 3. In contrast, the ENGA sample on the left attracted approximately the same level of visual attention as the EGLO sample on the right. The individual samples' labels also attracted a significant level of visual attention.

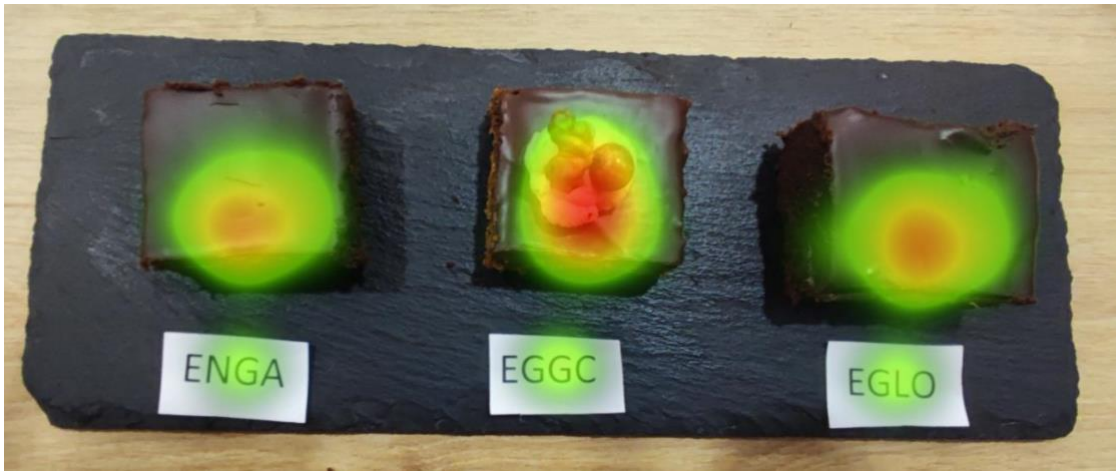

Figure 3 Respondents' visual attention to the compared cake samples.

After adding the Nutri-Score, it can be seen in Figure 4 that visual attention was focused to a significant degree on the nutritional indicators themselves. In terms of the cake samples themselves, respondents again paid the most attention to the EGGC sample, which was also the most nutritionally balanced based on the Nutri-Score indicator (C). Conversely, the least noticeable in this case was the EGLO sample, which was the least nutritionally balanced based on the Nutri-Score (E) indicator. Bossuyt **[53]**, and **[54]**, confirms that based on visual attention data, the longer respondents looked at Nutri-Score, the more likely they are to choose a product with a better Nutri-Score label.

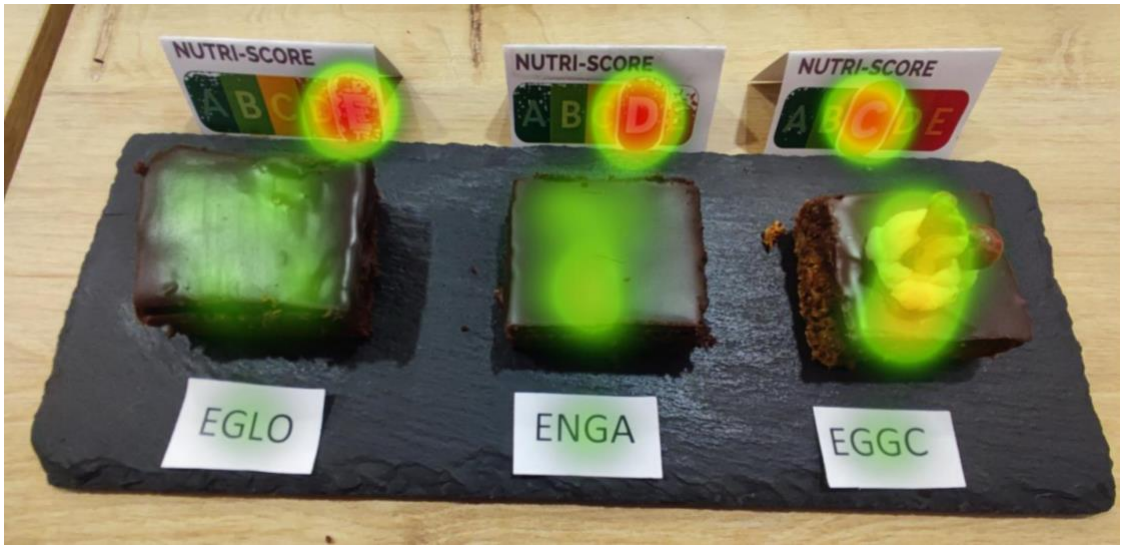

Figure 4 Respondents' visual attention to the compared cake samples after adding the Nutri-Score.

The nutritional information alone did not significantly influence the decision of which sample respondents wanted to taste first. Also, **[55]** found a low correlation between nutritional label viewing and food selection in his study. Despite the nutritional information, most respondents (11) first preferred to taste EGLO, the least nutritionally balanced sample. A more significant change occurred for the EGGC sample, in which 10 respondents wanted to taste first, after seeing the Nutri-Score, an increase of two compared to when respondents did not know the nutritional information of the samples. Based on **[56]**, **[57]**, **[58]**, **[59]**, **[60]**, and **[61]**, Nutri-Score can modify consumer choice and improve the ability to perceive and choose healthier food options.

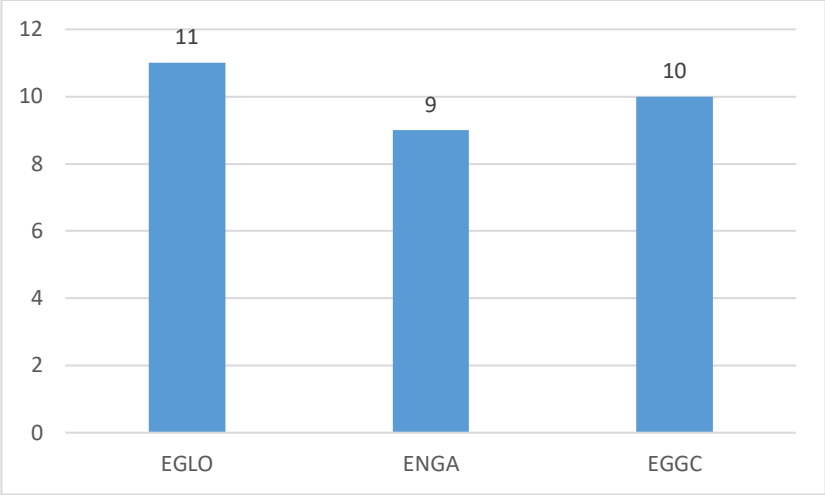

Figure 5 Sample tasting preference based on nutritional composition.

At the same time, in both sample views (without and with the nutritional indicator), the respondents' emotional response was also monitored through face reading. The differences in emotional response (valence) can be seen in Figure 6. The graph visualizes the difference in valence between cake monitoring without Nutri-Score (0.14) and with Nutri-Score (0.05). The graph clearly shows a lower valence (less positive emotional response) for cakes with Nutri-Score, suggesting that Nutri-Score affects changing the polarity of the emotion. This change may have been due to the increased cognitive load associated with thinking about the nutritional composition of each sample being compared. Changes in the polarity of emotions might be related to customers' eventual purchase of a healthier product because they are dissatisfied with its taste, implying that the perception is inconsistent with the nutritional label **[62]**, and **[63]**. Research indicates that respondents' ratings of cakes' visual attractiveness reveal gender differences in emotional expressivity **[64]**, **[65]**, and **[66]**. Women exhibited greater emotional expressivity than men in their evaluations. These findings align with King et al., **[67]**, who explored the connection between acceptability and emotion across various products and categories, concluding that women, on average, rated emotional intensity higher than men **[68]**.

We also decided to test this assumption statistically using a paired t-test at the 0.05 significance level. The t-value (27.72) and p-value (2.82×10^{-27}) are very low ($p < 0.001$), confirming a statistically significant difference between the valence for cakes without Nutri-Score and with Nutri-Score.

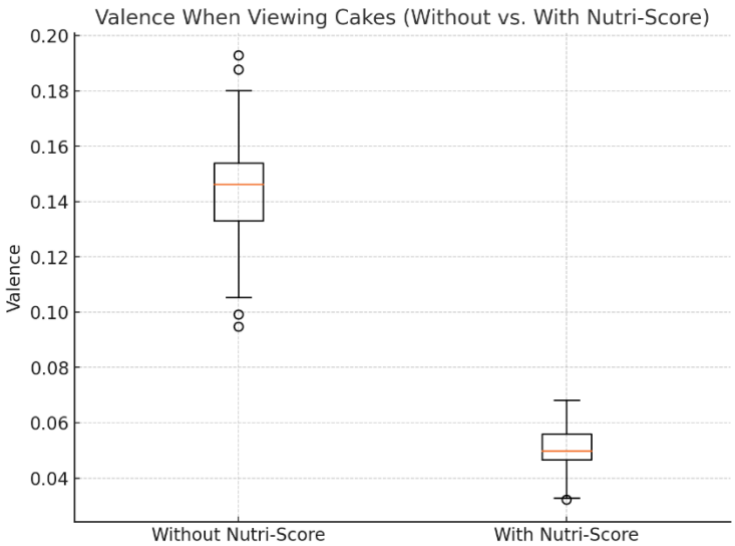

Figure 6 Emotional response (valence) comparison when looking at cake samples without and with Nutri-Score.

We also focused on comparing the level of arousal between the stretches when respondents saw the cake samples without and with the Nutri-Score. As shown in Figure 7, there was also a difference in this emotion. A higher mean arousal value (0.31) was recorded for respondents when they saw the Nutri-Score samples, and conversely, a lower mean arousal value (0.29) when they saw the samples alone. According to the findings of King **[69]**, a consumer's emotion can vary based on whether the consumer is a user of the product. Product users/consumers have positive emotional reactions to products while non-users have more negative reactions. Again, we verified this assumption statistically using a paired t-test at the 0.05 significance level. In this case, the T-value (22.94) and p-value (2.97×10^{-24}) are also very low ($p < 0.001$), indicating that the difference in arousal between the two conditions is not random but statistically significant.

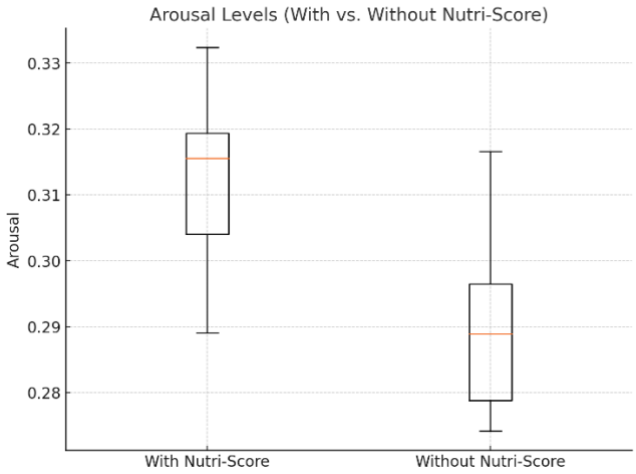

Figure 7 Graph comparing emotional response (arousal) when looking at cake samples without and with Nutri-Score.

From a practical point of view, this suggests that the Nutri-Score has an effect on the way people react emotionally to cakes, and this effect should be taken into account e.g. in marketing, research or consumer behaviour. A study aimed at identifying the impact of the Nutri-Score nutritional indicator in a catering company provides a surprising outcome for implementing such labelling in the gastro industry, because the addition of nutrition labels on food products usually indicates that these products are relatively healthier than others **[70]**. The data suggest that Nutri-Score could be successfully implemented in food service settings, extending its positive impact on public health. Several studies confirm that front-of-pack nutritional indicators can lead consumers to purchase healthier **[71]**. Future research should aim to confirm these results and explore other aspects of implementing this system **[19]**. Also, the analysis by Navarro **[1]**, showed that although more than half of the meals evaluated met the recommended nutritional limits, there is still room for improvement. We focused on meals that exceeded the limits for critical nutrients and identified specific ingredients that could be replaced with healthier alternatives. In addition, we found that many of the dishes meeting the criteria could be labelled with nutrition and health claims, which could help consumers make healthier food choices. Studies carried out by **[16]**, **[72]**, **[73]**, and **[74]**, confirm that the effects of FoPL can produce a small but significant beneficial effect on the nutritional quality of shopping and food choices. In particular, an interpretive system such as Nutri-Score has a major impact.

The study's findings show that while choosing cakes, customers' subconscious emotional reactions are greatly influenced by Nutri-Score labelling. In particular, cakes with Nutri-Score (0.05) had lower emotional valence than cakes without (0.14), indicating that the availability of nutritional information alters emotional polarity (Figure 6). The presence of Nutri-Score was also associated with considerably higher arousal levels (0.31) compared to its absence (0.29), suggesting greater cognitive involvement (Figure 7). Our finding is corresponding with studies **[75]**, **[76]**, and **[77]** that declare, that nutrition labeling has little impact on consumers' sensory and emotional perceptions. A paired t-test at the 0.05 significance level was used to corroborate these results statistically, and the t-values for valence and arousal were 27.72 ($p < 0.001$) and 22.94 ($p < 0.001$), respectively. Additionally, respondents with and without Nutri-Score mostly concentrated on the EGGC sample, according to visual attention analysis (Figure 3, Figure 4). Nevertheless, following the launch of Nutri-Score, focus turned to the labels themselves, enhancing their influence on customer perception. 11 respondents still selected EGLO first, despite it being the least nutritionally balanced option, indicating that Nutri-Score labelling did not significantly change

consumers' willingness to eat certain cake samples despite these changes in emotional and visual engagement (Figure 5).

Practically speaking, these findings imply that although Nutri-Score labelling successfully alters emotional reactions and visual attention, its direct influence on judgments about consumption or purchases is still little. This finding has implications for public health policy, product positioning, and marketing initiatives that seek to improve the efficacy of front-of-pack labelling. Julia C. et al., **[78]**, confirm that Nutri-Score has a positive effect on increasing sales and choice of healthy products and foods with Nutri-Score B and reducing sales of unhealthy foods and products with Nutri-Score E. The study's weaknesses could be addressed in future research by increasing the sample size to enhance generalizability, integrating a multi-channel EEG setup for a more thorough neural response analysis, and considering elements like texture, consistency, and food neophobia. Additionally, as changes in cognitive load may affect emotional reactions, timing effects associated with testing sessions throughout the day should be considered. Examining Nutri-Score's long-term behavioral effects in practical contexts would help us better understand how well it works to promote healthy eating choices.

CONCLUSION

The results of this study show that while choosing cakes, customers' emotional reactions are greatly influenced by nutritional labels, particularly Nutri-Score. Cakes with and without Nutri-Score differed in valence and arousal, suggesting that these labels affect how customers view and feel about items. Cakes with Nutri-Score showed higher arousal and lower valence, indicating that nutritional labelling may introduce cognitive processing or draw attention to health-related factors, which could impact the product's emotional appeal. Nutri-Score's impact on emotional reactions underscores its potential as a tool in marketing and product positioning tactics, notwithstanding its limited capacity to reverse consumer preferences. Businesses trying to balance product appeal and health-conscious messaging will find this helpful knowledge. This study's incorporation of neuroscience tools, like Face Reader and eye-tracking, offers a more profound comprehension of subconscious consumer behaviour with practical ramifications for product development and marketing.

Future studies could examine other product categories and the long-term impacts of nutritional labelling on customer behaviour to determine the broader applicability of these findings. The findings highlight how crucial it is to use both explicit and implicit feedback to maximize customer involvement in the changing field of health-conscious decision-making.

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Competing Interests:

No potential conflict of interest was reported by the author(s).

Ethical Statement:

The entire testing process was carried out in accordance with the Code of Ethics of the Laboratory of Consumer Studies (Neuromarketinglab.eu 2023) and the Neuromarketing Science and Business Association (NMSBA 2023) at the Slovak University of Agriculture in Nitra's Faculty of Economics and Management. The rules set forth in the ICC/ESOMAR International Code on Market, Opinion and Social Research and Data Analytics (ESOMAR 2016) were also followed. Each respondent completed two GDPR-compliant forms after being briefed on the experimental procedure and the techniques (eye tracking and facial expression recognition using FaceReader). One of these forms gave their consent to biometric testing and the processing and storage of their personal data, while the other confirmed their participation in a brief training.

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AI Statement:

This study utilized artificial intelligence (AI) tools, including ChatGPT-4.0 for boxplot visualization, FaceReader (Noldus) for facial expression analysis, and Tobii Studio for eye-tracking heatmap visualization, to enhance data processing and interpretation. While AI facilitated automation and efficiency in data analysis, all outputs were subject to human validation to ensure accuracy and methodological rigor.

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