

Mind Over Palate: Unveiling the Role of Neuromarketing in the Food Industry

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Abstract: This scientific paper investigates the application of neuromarketing research in the food industry and its impact on consumer behaviour and perception of food quality. Through a comprehensive review of the relevant literature, this study explores the fundamental concepts and techniques of neuromarketing research, as well as their practical application within the context of the food industry. Furthermore, it analyses the various factors that influence consumer perception of food quality and examines how neuromarketing research can contribute to a better understanding of these factors. By integrating theoretical and empirical findings, this paper offers valuable insights into the potential benefits and advantages of utilising neuromarketing research, while also acknowledging the ethical challenges associated with its implementation in creating effective marketing strategies and enhancing the overall consumer experience in the food industry.

Keywords: neuromarketing, food quality, food industry, marketing, consumer behaviour.

Introduction

Food is a fundamental human necessity, and the right to food is a guaranteed human right. Throughout human history, the motives behind food consumption have evolved. Initially, humans ate solely for survival and to alleviate hunger. While the primary purpose of food consumption remains survival, advancements in scientific knowledge have led to increased understanding of nutrition and the causal relationship between dietary choices and certain diseases (Kilibarda *et al.*, 2018). Consequently, modern individuals place special emphasis on the nutritional composition and value of the foods they choose to consume (Đorđević-Milošević *et al.*, 2021). In contemporary society, there is growing discourse surrounding the hedonic aspects of food, emphasising the pleasure derived from eating. This hedonic approach encompasses the exploration of new flavours, socialising, dining at restaurants and participating in celebratory events (Clingsmith and Sheremeta, 2018). Moreover, food choices in specific contexts serve as status symbols, indicating affiliation with higher social strata. Examples of such behaviours include dining at expensive and renowned establishments, adhering to dietary trends and consuming organic food, which sometimes reflects a status syn-

drome rather than a commitment to a healthy lifestyle (Shin and Mattila, 2020; Knaggs *et al.*, 2022).

The primary driving force behind food consumption is hunger; however, the selection of food is not solely determined by physiological or nutritional needs. Various factors influence our dietary choices, including (EUFIC, 2006):

- Biological factors (hunger, appetite, taste),
- Economic factors (price, availability),
- Physical factors (cooking skills, time required for food preparation),
- Social factors (culture, tradition, family, age, society),
- Physiological factors (mood, stress),
- Attitudes, beliefs and information about food.

The multitude of factors that impact food choices, which subsequently become integral parts of our diets, highlights the complexity of the decision-making process and the influence of personal taste preferences. Among these factors, biological factors, particularly the taste of food, emerge as one of the most significant determinants of food selection (Zrnica *et al.*, 2021a). When referring to food taste, we encompass all sensory stimuli elicited by the consumption of food, including taste, smell, appearance and tex-

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ture (*deMan*, 1999). Certain taste preferences, such as a preference for sweet taste or aversions to bitter and sour flavours, are innate and present from birth. However, specific preferences or aversions towards tastes develop as a result of early-life experiences and are influenced by attitudes, beliefs and expectations, all of which significantly impact consumer behaviour (*Donkin et al.*, 2000; *De Irala-Estevez et al.*, 2000; *Devine et al.*, 2003; *Shaikh et al.*, 2008;).

The modern consumer is increasingly demanding in terms of food (*Živković and Brdar*, 2018; *Sarcevic et al.*, 2018; *Kilibarda et al.*, 2020;). They expect the food they consume to possess desired and consistent quality, ensure their safety and be affordable. Moreover, consumers seek food that aligns with their concept of a healthy lifestyle and possesses an appealing appearance (*Zrnić et al.*, 2021b). Consequently, the food industry faces rigorous criteria that must be met to satisfy consumer expectations, expand market share, boost profits and outperform competitors (*Bertoch*, 2018). To meet consumer demands and secure a competitive edge, the food industry must continuously innovate throughout the entire production process, ranging from raw material procurement to product placement in the market (marketing). These innovations are pivotal for sustained market presence and for retaining existing, as well as attracting new consumers (*Brdar*, 2021). In today's highly competitive business environment, the food industry is constantly evolving to address the needs and desires of consumers. Within this context, marketing strategies play a crucial role in capturing consumer attention and influencing their decisions. A recent approach employed in the food industry is neuromarketing – an interdisciplinary scientific field combining neurology, psychology and marketing to investigate and comprehend consumer perception, emotion and behaviour.

Demystification of neuromarketing — definition and techniques

Neuromarketing is a relatively new research field that combines neuroscience and marketing with the aim of better understanding consumer behaviour and designing more effective marketing strategies. This discipline utilises neuroimaging techniques, measures of brain activity and emotional responses to uncover hidden motives, preferences and consumer reactions (*Pozharliev et al.*, 2015; *Lim*, 2018; *Ramsøy*, 2019; *Mansor and Mohd Isa*, 2020; *Varlese et al.*, 2020; *Russo et al.*, 2021; *Levallois et al.*, 2021; *Siddique et al.*, 2023).

The emergence of neuromarketing as a means of studying and exploring the human brain for the purpose of applying the findings to marketing campaigns and enhancing the profitability of advertising does not have a specific date. The techniques that we now consider as falling under the realm of neuromarketing were utilised before the term itself was coined (*Levallois et al.*, 2021). Nowadays, neuromarketing employs various brain science techniques to measure consumer behaviour. According to *Postma* (2013), these techniques can be classified into three main categories:

- External reflexes (based on physiological signals),
- Input-output models (based on behavioural signals),
- Internal reflexes (based on brain signals).

When it comes to measuring external reflexes, *Bergstrom et al.* (2014) argue that it serves as a supplementary tool or an exclusive method within the field of neuromarketing. Several distinct approaches can be identified in this category. One such approach is empathic design, which involves objectively observing consumers as they interact with products and services in their natural environment, based solely on their behavioural patterns (*Leonard and Rayport*, 1997). Another method utilised is facial coding, which measures facial movements to determine emotions and levels of engagement. This includes capturing visible changes in facial expressions, such as smiling, as well as imperceptible micro-muscle movements. Eye tracking is an additional technique utilised to measure consumers' eye movements and pupil dilation when exposed to various marketing stimuli (*Telpaz et al.*, 2015; *Boerman et al.*, 2015; *Adhikari*, 2023). Moreover, the use of galvanic skin response (GSR) is prominent – an established physiological measure that assesses the electrical conductance of the skin, which undergoes changes in response to emotional arousal and other psychological processes.

The input-output model serves as both an independent tool and a complementary technique in neuromarketing research. Its primary function is to measure the impact of marketing stimuli on individuals' responses, achieved through online panel studies or various types of social media content analysis. According to *Postma* (2013), the objective is to explore the cause-and-effect relationship between input variables (such as photos, prices, words, features, etc. in advertisements and billboards) and specific outcomes, such as consumer behaviour, brand attitude and purchase intention.

Internal reflexes involve the analysis of consumer brain reactions to marketing stimuli and can be categorised into two main groups: blood flow measures and electrical measures. Blood flow measures rely on changes in blood flow to infer brain activity, with functional magnetic resonance imaging (fMRI) being the primary tool. Electrical and magnetic signals directly recorded from the brain constitute the other category. The main tools used in neuromarketing to measure internal reflexes are electroencephalography (EEG), magnetoencephalography (MEG) and fMRI. (Ariely and Berns, 2010; Häusel, 2013; Adhikari, 2023). EEG is a non-invasive procedure where electrodes are attached to subjects' heads to measure fluctuations in electrical activity beneath the scalp caused by nerve activity. Its primary objective is to gauge the intensity of intuitive and irrational consumer responses to marketing stimuli, such as excitement or frustration. MEG, similar to EEG in its electrical approach, utilises highly sensitive devices like a superconducting quantum interference device (SQUID) to examine electrical fields generated above the brain. Compared to EEG, MEG provides superior signal quality and high temporal resolution, offering a more precise scanning in time. MEG investigates brain activity by measuring blood flow, as active brain regions exhibit increased oxygen-rich blood circulation. Since oxygen-rich blood generates a smaller magnetic field than oxygen-poor blood, the resulting magnetic waves provide insights into the brain's active areas. The measurement outcome is a brain scan image with illuminated regions indicating activity during exposure to stimuli. For example, if the scan reveals activation in the hippocampus, it signifies heightened activity in the memory area as the subject stores or retrieves information from their memory.

In general, methods for measuring internal reflexes are highly favoured among researchers, primarily due to their higher accuracy and reliability compared to other techniques (Morin, 2011; Hammou et al., 2013; Bergstrom et al., 2014).

Exploring the implications, use and role of neuromarketing in the food industry

Neuromarketing research has significant implications for the food industry, providing a deeper understanding of consumer behaviour and their perception of food (Javor et al., 2013; Agarwal and Dutta, 2015; Koc and Boz, 2018;). These findings can be applied to various aspects of the food industry to improve business operations in this sector. The

potential implications and applications of neuromarketing in the food industry are discussed below.

Neuromarketing offers the opportunity to explore consumers' emotional reactions to food. Analysing neurological responses enables the identification of brain centres associated with pleasure, reward and emotional experience of food (Lagast et al., 2017). Neurological analysis can reveal how emotions such as happiness, excitement or nostalgia can influence the experience of food and consumer preferences. In this regard, Russo et al. (2022) conducted a study using EEG to determine how two video advertisements for traditional cheeses from southern Italy elicit emotions and memory in consumers. Although both videos contained the same four narrative themes (territory, product, production techniques and natural landscapes), the authors found that the video characterised by an initial negative tone that transitions to positive evoked a stronger emotional response and better memory compared to the first video. Another study by Mengual-Recuerda et al. (2020) utilised EEG, eye tracking and GSR to measure emotional intensity for different dishes and courses in Haute Cuisine during presentations and tastings. The results showed that desserts elicited the strongest emotions, followed by main courses and snacks.

Neuromarketing research also offers valuable insights into the impact of personalisation and individual preferences on food perception. By analysing neurological responses in relation to personal characteristics such as age, gender or previous experiences, researchers can identify how individual differences manifest in the perception of food (Van der Laan and Smeets, 2015). This knowledge can be utilised to tailor food offerings to the specific needs and preferences of different consumers (Howse et al., 2021). Examining brain activity during the food decision-making process allows researchers to identify key factors and brain regions involved in motivation, reward and pleasure. Enax et al. (2015) confirmed in their research the positive effect of marketing strategies targeting children for healthy snacks when accompanied by cartoon characters. However, one should be mindful of potential abuses. Campos et al. (2016) found in their study that children in Spain are exposed to more unhealthy food advertising than healthy food advertising on television, which raises concerns.

Neuromarketing can also help identify the key factors that influence the perception of food quality. Through the analysis of consumers' neurological responses, researchers can pinpoint specific sensory

characteristics such as smell, taste, texture and visual elements that contribute most to the perception of food quality (Piqueras-Fiszman and Spence, 2015; Spence, 2016; Schulte-Holierhoek et al., 2017). For example, Velasco and Spence (2019) conducted a study investigating the influence of typeface on the perception of taste. The results showed that participants associated round letters with the word “sweet”, while they associated more angular letters with the taste words “bitter”, “salty” and “sour”. Based on these findings, food manufacturers can enhance different aspects of their products to align with consumers’ expectations and provide them with a high-quality experience.

The visual aspect of food plays a crucial role in consumer choice and preference. Neuromarketing research has demonstrated that specific colours, shapes, packaging design and food presentation can activate distinct areas of the brain and elicit positive emotional responses in consumers, as well as increase their willingness to purchase and consume food (Clement et al., 2017; Moya et al., 2020; Oswald et al., 2022; Semenova et al., 2023). Through neuromarketing studies, brain activity can be analysed when individuals are exposed to visual food stimuli (Vu et al., 2016; Schlintl and Schienle, 2020; Khan and Lee, 2020; König et al., 2021; Güney et al., 2021; Adhikari, 2023). This allows researchers to identify which visual elements evoke positive reactions, stimulate appetite and enhance the appeal of food. For instance, colours such as red and orange can be associated with freshness and taste, while green and blue are often linked to healthy food (Spence, 2015). Additionally, dishes that are more colourful tend to be more attractive to consumers (Jantathai et al., 2013; König et al., 2021). Understanding these connections enables food manufacturers to adjust the visual elements of their products to attract and satisfy consumers. In terms of packaging, Veflen et al. (2023) found that the shape and colour of cheese packaging improve taste expectations and preferences, with a round shape eliciting the highest level of liking, and a round shape, high color brightness and low color saturation signalling a mild taste, while a triangular shape, low color brightness and high saturation signal a sharper taste.

Odours also play a significant role in our food experience and can evoke strong emotional reactions (Berčík et al., 2016; Spence, 2016; Berčík et al., 2020). Neuromarketing research allows for the identification of how olfactory stimuli of food affect the activity of specific brain regions and consumer

preferences. For example, the smell of freshly baked bread can activate brain areas associated with pleasure and enjoyment, thereby positively influencing the consumer’s perception and preference for a particular type of bread. Another study conducted by Kline et al. (2000) measured frontal lobe activation while consumers were exposed to different odours (pleasant: vanilla, unpleasant: valerian, neutral: plain water). The aroma of vanilla, the most pleasant smell, resulted in significantly higher activation of the left hemisphere of the brain compared to the other smells. Food manufacturers can leverage these insights to create products with specific aromas that will attract consumers and increase their desire to consume. Furthermore, neuromarketing research can provide information about scent combinations that work best and create synergy, which can be valuable when developing new products or enhancing existing ones.

Food taste has a significant impact on consumer preferences. Neuromarketing research employs sensory analysis of taste and combines it with neurological measurements to identify neurological patterns that occur during food tasting. This approach allows researchers to gain a better understanding of how various tastes, such as sweet, salty, sour and bitter, affect brain activity and consumer preferences. For instance, a sweet taste can activate pleasure centres in the brain, while a bitter taste can elicit negative reactions. Additionally, the taste of food plays a pivotal role in determining the acceptability of food products for consumers. It can evoke positive or negative emotions during and after consumption. Moreover, taste significantly influences consumers’ food memory, as highlighted by Ndaro and Wang (2018). Food products that are flavourful tend to be well-received and sustainable in the market. By analysing neurological responses, researchers can identify preferred tastes among consumers and utilise this information to develop new products or modify existing flavours to meet consumer satisfaction.

It is of utmost importance to underscore that sensory stimuli, encompassing visual impressions, odours and tastes, frequently collaborate in unison to shape the overall gastronomic experience for consumers. Neuromarketing research focuses on studying the combination of these stimuli and their impact on consumer preferences. Through the analysis of neurological responses, researchers can identify synergies between sensory stimuli and determine the combinations that best satisfy consumers and pique their interest in specific types of food.

Neuromarketing research has the capacity to unveil consumers' implicit preferences that may not be consciously expressed. Unlike traditional research methods, such as surveys, which can be influenced by biases and subjective responses, the neuromarketing approach grants access to consumers' implicit or unconscious preferences (Sung *et al.*, 2020). Analysis of brain activity can uncover genuine emotional reactions and preferences that consumers may not be cognizant of or able to articulate verbally.

Furthermore, neuromarketing offers an opportunity to evaluate the efficacy of changes in food composition or formulation. Additionally, it enables the testing of new products and food concepts prior to their market launch. By employing neurological techniques, researchers can assess consumer responses to different variations in food composition, including modifications in nutritional value, ingredient additions or substitutions. This allows manufacturers to make well-informed decisions regarding product enhancements and adjust their composition in accordance with consumer preferences.

Neuromarketing research offers valuable insights into the influence of context on food perception. By analysing neurological responses in various settings such as restaurants, shops, or home environments, researchers can uncover how contextual factors like ambience, music, or lighting contribute to the food experience and shape consumer preferences (Spence and Piqueras-Fiszman, 2014; Hsu and Chen, 2019). This knowledge is crucial for adapting the consumption environment to create a positive experience for consumers. A notable study conducted by Tammela *et al.* (2010) examined individuals with binge eating (BE) tendencies and found altered brain activity in frontal regions during food presentation. The results suggest that increased frontal beta activity could serve as an indicator of a dysfunctional disinhibition-inhibition mechanism, making obese individuals with BE more susceptible or sensitive to food and environmental influences.

Neuromarketing research also aids in the adjustment of marketing strategies. Drawing on neurological insights, food manufacturers can develop marketing campaigns that prioritise sensory stimuli known to have the greatest impact on consumers (Harris *et al.*, 2019). EEG has particular utility in this regard, as it can detect pupil dilation, which serves as an index of stimulus interest, and the frequency of blinks, which indicates the emotional valence of the stimulus (Stasi *et al.*, 2018). Thus,

neuromarketing research provides valuable insights into how advertising messages shape the perception of food quality. By analysing neurological responses to marketing campaigns, manufacturers can comprehend how consumers interpret and respond to different messages, slogans and brand narratives (Hamelin *et al.*, 2020). This knowledge enables better targeting of marketing efforts and the creation of messages that effectively convey product quality (Venkatraman *et al.*, 2015).

Neuromarketing plays a pivotal role in enhancing food manufacturers' understanding of consumers' food purchasing decisions. By analysing consumers' neurological responses during the decision-making process, valuable insights into the neural patterns associated with motivation, attention and reward can be obtained. For instance, research conducted by Simmonds *et al.* (2018) demonstrated that transparent packaging increased consumers' willingness to purchase, the expected freshness and perceived food quality compared to packaging featuring food images. This knowledge enables manufacturers to tailor their marketing strategies and sales tactics to attract consumers and influence their purchasing decisions. However, it is important to note that not all measurement techniques are suitable for these purposes. For example, Songsamoe *et al.* (2019) argue that using EEG to measure consumers' motivational tendencies may be inappropriate when comparing foods with minor differences in hedonic ratings.

Moreover, neuromarketing facilitates the monitoring of consumer reactions during interactions with food brands. A study conducted by Fehse *et al.* (2017), which focused on the perception of both organic and non-organic, but popular food brands, contributes to the existing literature by providing converging evidence that the lateral and medial regions of the prefrontal cortex exert distinct and independent influences on decision-making. Brand information significantly influences the processing of food stimuli. Despite not being expensive or particularly rewarding in other aspects, the presentation of popular food brands elicited brain activation, suggesting a potential rewarding nature (high-calorie food). This valuable information sheds light on how consumers perceive brands and enables manufacturers to adapt their strategies to improve brand perception and foster loyalty (Hamelin *et al.*, 2020). By analysing neurological responses over an extended period, researchers can track changes in brand perception, the establishment of an emotional connection with consumers, and the

development of brand loyalty. Consequently, manufacturers can formulate long-term branding strategies that have a positive impact on consumers and foster strong relationships with them.

Neuromarketing research contributes to the understanding of factors that impact consumer satisfaction following food consumption. By analysing neurological responses during the post-consumption phase, researchers can identify elements that contribute to a positive experience, including satisfaction with taste, texture and the fulfilment of expectations. For instance, *Berns and Moore (2012)* discovered a significant positive correlation between reward-related brain areas and future purchase decisions. The neural responses observed can be regarded as predictive indicators of food evaluation, particularly in terms of cultural popularity. These insights are invaluable for food manufacturers seeking to enhance the quality of their products and ensure greater consumer satisfaction.

Additionally, neuromarketing research provides insights into the influence of social factors on food perception. Analysing neurological responses during group interactions or experiments within social contexts enables researchers to comprehend how consumers' opinions, attitudes and preferences are shaped by the influence of others (*Alsharif et al., 2020; Alsharif et al., 2021; Bočková et al., 2021*). This aspect holds significant importance in the food industry, where social aspects, such as communal meals or the influence of friends and family, can serve as key determinants in food choice and perception.

The Duality of Neuromarketing: Benefits and Ethical Challenges

Neuromarketing research is an innovative approach to studying consumer behaviour in the food industry, combining principles from neuroscience, psychology and marketing. These studies provide profound insights into consumer preferences, motivations and reactions to food. By combining objective biometric data with subjective consumer reports, a more comprehensive understanding of how consumers perceive, experience and react to food can be obtained. These insights enable food manufacturers and marketers to develop more effective branding, packaging and promotional strategies that align with consumer preferences and expectations. For instance, a study by *Smidts et al. (2014)* explored the application of neuromarketing research in the context of strategic marketing deci-

sions. Their findings demonstrate that neuromarketing techniques, such as fMRI, can provide insights into the neural activity patterns that occur during marketing decision-making processes. This knowledge is of crucial importance for the development of effective marketing strategies in the food industry. Another example is the research conducted by *Krishna (2012)*, which focused on the application of neuromarketing methods in the field of sensory marketing. The author highlights that by engaging the senses, such as smell, taste and touch, neuromarketing techniques can influence consumers' perception, judgment and behaviour. These findings can be applied in the food industry to enhance the consumer experience and establish a connection between the brand and the positive sensations associated with food.

Another key advantage of neuromarketing research is its ability to obtain objective data on consumer responses to food and study subconscious reactions. Traditional research methods, such as surveys and focus groups, often rely on subjective statements from consumers. In contrast, neuromarketing techniques like fMRI and EEG allow for direct observation of consumers' neurological activity when exposed to specific food stimuli. This enables researchers to gain objective and precise insights into consumer reactions, minimising the influence of subjective factors and facilitating the identification of subconscious processes and emotions that arise during food interactions (*Braeutigam, 2017*).

While the application of neuromarketing research in the food industry offers numerous advantages for understanding consumers, it also raises ethical challenges that require attention and consideration (*Sloan, 2015; Hensel et al., 2017*). As these techniques become increasingly integrated into marketing strategies, it is important for researchers, experts and companies to be aware of the ethical issues that arise from such research. One key ethical concern is the issue of privacy and the rights of research participants. Neuromarketing research often involves measuring the neural activity of consumers, which can be perceived as an invasion of privacy. The collection of brain data raises concerns about data security and its use. Therefore, it is crucial for researchers to obtain informed consent from participants, provide detailed information about the research's nature and the use of data, and ensure that all data are stored and handled in compliance with relevant laws and guidelines (*Clark, 2020*).

The next challenge of neuromarketing research lies in the complexity of analysing and interpreting neuromarketing data. Utilising sophisticated techniques, such as fMRI or EEG, necessitates expertise and experience in data processing and interpretation. Without adequate knowledge and skills, the analysis and drawing of conclusions from research results can be challenging (Murphy *et al.*, 2020). Another challenge pertains to sample limitations and validity. Neuromarketing research often relies on relatively small sample sizes, potentially limiting the generalisability of findings to the broader population (Cenizo, 2022). Moreover, studies are typically conducted under controlled laboratory conditions, which could introduce discrepancies in consumer behaviour compared to real-world settings.

Another crucial ethical concern is research transparency. The outcomes of neuromarketing research can significantly impact marketing strategies and brands in the food industry. Therefore, it is essential for the results to be published and made accessible to the general public, enabling critical evaluation, reproducibility and further comprehension of the findings. Transparency also helps prevent any potential distortion or manipulation of data for marketing purposes (Bartholomew, 2018). For instance, there is a valid concern that utilising neuroscientific methods could lead to the creation of irresistibly appealing foods that cater to consumer needs to such an extent that they contribute to the problem of obesity, one of the major health issues of today (Joy, 2018).

Moreover, ethical considerations encompass questions regarding targeting and manipulation of consumers. Neuromarketing techniques possess the ability to influence consumers' emotions, attitudes and behaviour. To ensure the ethical application of these techniques, marketers should be aware of and acknowledge the limits of manipulating and exploiting consumers. Companies should take care to ensure that their marketing strategies, based on neuromarketing research, are honest, informative and fair to consumers (Lee *et al.*, 2017; Stanton *et al.*, 2017; Samson and Buijzen, 2019; Cenizo, 2022).

Furthermore, ethical aspects also pertain to the accurate interpretation of neuromarketing research

results. In this realm, challenges exist in interpreting neural activity and connecting it to specific consumer behaviour (Lynch, 2004). Hence, it is crucial for researchers and marketers to present results transparently, avoiding exaggeration or excessively one-sided interpretations of the data (Zuo *et al.*, 2019).

Conclusion

Neuromarketing research holds significant potential for understanding consumer behaviour and food perception. Its advantages lie in the objective nature of data, the exploration of subconscious consumer reactions, and the deeper comprehension of the connections between visual stimuli and food perception. However, challenges arise in data analysis and interpretation, limitations in sample size and the external validity of research findings. Despite these challenges, neuromarketing serves as a vital tool for studying consumers and enhancing marketing strategies in the food industry. Through the analysis of neurological data, food manufacturers can gain better insights into consumer preferences, emotions and behaviours. This knowledge enables them to adapt their products, packaging and marketing campaigns to attract consumers and gain a competitive edge in the food market. However, it is crucial to use neuromarketing responsibly, while respecting ethical and moral principles. Additionally, it is essential to recognise that neuromarketing represents only one of the many factors influencing consumer decisions. Future research directions could focus on refining neuromarketing methods and techniques to overcome existing challenges and provide even more reliable insights. For instance, integrating multiple techniques, such as combining fMRI with EEG or with measuring emotional responses, can yield richer and more comprehensive data on consumer food perception. Furthermore, research can delve into studying individual differences in consumer perception of food. Each consumer is unique with their own preferences and reactions, and understanding how different factors influence consumers with distinct characteristics is crucial for personalising marketing strategies.

Um iznad nepca: Otkrivanje uloge neuromarketinga u industriji hrane

Ivana Brdar

A p s t r a c t: Ovaj naučni rad istražuje primenu neuromarketinških istraživanja u industriji hrane i njihov uticaj na potrošačko ponašanje i percepciju kvaliteta hrane. Kroz pregled relevantne literature, istražuju se osnovni koncepti i tehnike neuromarketinških istraživanja, kao i primena tih metoda u kontekstu industrije hrane. Takođe se analiziraju faktori koji utiču na potrošačku percepciju kvaliteta hrane i kako neuromarketinška istraživanja mogu doprineti razumevanju tih faktora. Kroz integraciju teorijskih i empirijskih nalaza, rad daje uvid u mogućnosti i prednosti upotrebe, ali i etičke izazove neuromarketinških istraživanja u kreiranju marketinških strategija i unapređenju iskustva potrošača u industriji hrane.

Ključne reči: neuromarketing, kvalitet hrane, industrija hrane, marketing, ponašanje potrošača.

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References

- Adhikari, K. (2023). Application of selected neuroscientific methods in consumer sensory analysis: A review. *Journal of Food Science*, 88, A53–A64.
- Agarwal, S. & Dutta, T. (2015). Neuromarketing and consumer neuroscience: Current understanding and the way forward. *DECISION*, 42 (4), 457–462.
- Alsharif, A. H., Salleh, N. Z. M., Baharun, R. & Mehdi, S. (2020). Neuromarketing approach: An overview and future research directions. *Journal of Theoretical and Applied Information Technology*, 98 (7), 991–1001.
- Alsharif, A. H., Salleh, N. Z., Baharun, R. & Yusoff, M. E. (2021). Consumer behaviour through neuromarketing approach. *Journal of Contemporary Issues in Business and Government*, 27 (3), 344–354.
- Ariely, D. & Berns, G. S. (2010). Neuromarketing: the hope and hype of neuroimaging in business. *Nature Reviews Neuroscience*, 11 (4), 284–292.
- Bartholomew, M. (2018). Neuromarks. *Minnesota Law Review*, 103 (2), 521–585.
- Berčík, J., Mravcová, A., Gálová, J. & Mikláš, M. (2020). The use of consumer neuroscience in aroma marketing of a service company. *Potravinárstvo Slovak Journal of Food Sciences*, 14, 1200–1210.
- Berčík, J., Palúchová, J., Vietoris, V. & Horská, E. (2016). Placing of aroma compounds by food sales promotion in chosen services business. *Potravinárstvo Slovak Journal of Food Sciences*, 10 (1), 672–679.
- Bergstrom, J. R., Duda, S., Hawkins, D. & McGill, M. (2014). Physiological response measurements. In: Eye tracking in user experience design, Eds. A. Schall & J. R. Bergstrom, Morgan Kaufmann, Waltham, pp. 81–108.
- Berns, G. S. & Moore, S. E. (2012). A neural predictor of cultural popularity. *Journal of Consumer Psychology*, 22, 154–160.
- Bertoch, M. (2018). Prospects for the restoration in Europe for 2018 (Perspectivas de la restauración en Europa para 2018), The NPD Group, Washington, DC, USA.
- Bočková, K., Škrabánková J. & Hanák, M. (2021). Theory and practice of neuromarketing: analyzing human behavior in relation to markets. *Emerging Science Journal*, 5 (1), 44–56.
- Boerman, S. C., Van Reijmersdal, E. A. & Neijens, P. C. (2015). Using eye tracking to understand the effects of brand placement disclosure types in television programs. *Journal of Advertising*, 44 (3), 196–207.
- Braeutigam, S. (2017). Invited Frontiers commentary. Tier climbing article: Redefining neuromarketing as an integrated science of influence. *Frontiers in Neuroscience*, 11, 22.
- Brdar, I. (2021). Cook slow, eat fine — consumer attitudes on food quality in new gastronomic trends. *Meat Technology*, 62 (1), 77–88.
- Campos, D., Hernández-Torres, J. J., Agil, A., Comino, M., López, J. C., Macías, V. & Campoy, C. (2016). Analysis of food advertising to children on Spanish television: probing exposure to television marketing. *Archives of Medical Science*, 12 (4), 799–807.
- Cenizo, C. (2022). Neuromarketing: concept, historical evolution and challenges. *ICONO 14, Revista de Comunicación y Tecnologías Emergentes*, 20 (1).
- Clark, K. R. (2020). A field with a view: Ethical considerations for the fields of consumer neuroscience and neuromarketing. In: Developments in neuroethics and bioethics. Eds. I. Bárd & E. Hildt, Academic Press, Cambridge, pp. 23–61.
- Clement, J., Smith, V., Zlatev, J., Gidlöf, K. & van de Weijer, J. (2017). Assessing information on food packages. *European Journal of Marketing*, 51 (1), 219–237.
- Clingingsmith, D. & Sheremeta, R. M. (2018). Status and the demand for visible goods: experimental evidence on conspicuous consumption. *Experimental Economics*, 21, 877–904.
- deMan, J. M. (1999). Flavor. *Food Science Text Series*, 263–309.

- Devine, C. M., Connors, M. M., Sobal, J. & Bisogni, C. A. (2003). Sandwiching it in: spillover of work onto food choices and family roles in low- and moderate-income urban households. *Social Science & Medicine*, 56 (3), 617–630.
- Donkin, A. J., Dowler, E. A., Stevenson, S. J. & Turner, S.A. (2000). Mapping access to food in a deprived area: the development of price and availability indices. *Public Health Nutrition*, 3 (1), 31–38.
- Dorđević-Milošević, S., Mastilović, J., Stanišić, S. & Kilibarda, N. (2021). Food, nutrition, and health in Serbia. In: Nutritional and health aspects of traditional and ethnic foods, nutritional and health aspects of food in the Balkans, Eds. A. Gostin, D. Bogueva & V. Kakurinov, Academic Press, Cambridge, pp. 187–205.
- Enax, L., Weber, B., Ahlers, M., Kaiser, U., Diethelm, K., Holtkamp, D., Faupel, U., Holzmüller, H. H. & Kersting, M. (2015). Food packaging cues influence taste perception and increase effort provision for a recommended snack product in children. *Frontiers in Psychology*, 6, 882.
- European Food Information Council (EUFIC), (2006). The Factors That Influence Our Food Choices (<https://www.eufic.org/en/healthy-living/article/the-determinants-of-food-choice#:~:text=Biological%20determinants%20such%20as%20hunger,family%2C%20peers%20and%20meal%20patterns>)
- Fehse, K., Simmank, F., Gutyrchik, E. & Sztrokay-Gaul, A. (2017). Organic or popular brands-food perception engages distinct functional pathways: An fMRI study. *Cogent Psychology*, 4, 11.
- Güney, S., Arslan, S., Duru, A. D. & Göksel, D. (2021). Identification of food/nonfood visual stimuli from event-related brain potentials. *Applied Bionics and Biomechanics*, 2021, 6472586.
- Hamelin, N., Thaichon, P., Abraham, C., Driver, N., Lipscombe, J., Naik, M. & Pillai, J. (2020). Storytelling, the scale of persuasion and retention: A neuromarketing approach. *Journal of Retailing and Consumer Services*, 55, 102099.
- Hammou, K. A., Galib, M. H. & Melloul, J. (2013). The contributions of neuromarketing in marketing research. *Journal of Management Research*, 5 (4), 20–33.
- Harris, J., Ciorciari, J. & Gountas, J. (2019). Consumer neuroscience and digital/social media health/social cause advertisement effectiveness. *Behavioral Sciences*, 9 (4), 25.
- Häusel, H. G. (2013). Neuromarketing: Erkenntnisse der Hirnforschung für Markenführung, Werbung und Verkauf, Haufe-Lexware, Berlin, Germany.
- Hensel, D., Iorga, A., Wolter, L. & Znanewitz, J. (2017). Conducting neuromarketing studies ethically-practitioner perspectives. *Cogent Psychology*, 4 (1), 1320858.
- Howse, E., Hankey, C., Bauman, A. & Freeman, B. (2021). Are young adults' discussions of public health nutrition policies associated with common food industry discourses? A qualitative pilot study. *Australian and New Zealand Journal of Public Health*, 45 (2), 171–180.
- Hsu L. & Chen Y.-J. (2019). Music and wine tasting: An experimental neuromarketing study. *British Food Journal*, 122 (8), 2725–2737.
- Irala-Estévez, J. D., Growth, M., Johansson, L., Oltersdorf, U., Prättälä, R. & Martínez-González, M. A. (2000). A systematic review of socioeconomic differences in food habits in Europe: consumption of fruit and vegetables. *European Journal of Clinical Nutrition* 54 (9), 706–714.
- Jantathai, S., Danner, L., Joechl, M. & Dürschmid, K. (2013). Gazing behavior, choice and color of food: Does gazing behavior predict choice? *Food Research International*, 54 (2), 1621–1626.
- Javor, A., Koller, M., Lee, N., Chamberlain, L. & Ransmayr, G. (2013). Neuromarketing and consumer neuroscience: Contributions to neurology. *BMC Neurology*, 13 (1), 13.
- Joy, M. M. (2018). The potential and challenge of using neuromarketing as a marketing tool. Conference proceedings of National Conference New-age marketing, Cochin University of Science and Technology, Kochi, India.
- Khan, H. & Lee, R. (2020). Does packaging influence taste and quality perceptions across varying consumer demographics? *Food Quality and Preference*, 84, 103932.
- Kilibarda, N., Brdar, I., Baltic, B., Markovic, V., Mahmutovic, H., Karabasil, N. & Stanic, S. (2018). The safety and quality of sous vide food. *Meat Technology*, 59 (1), 38–45.
- Kilibarda, N., Djokovic, F. & Suzic, R. (2020). Food waste management – reducing and managing food waste in hospitality. *Meat Technology*, 60 (2), 134–142.
- Kline, J. P., Blackhart, G. C., Woodward, K. M., Williams, S. R. & Schwartz, G. E. R. (2000). Anterior electroencephalographic asymmetry changes in elderly women in response to a pleasant and an unpleasant odor. *Biological Psychology*, 52, 241–250.
- Knaggs, J., Pruitt, J. R., Anderson, L., Palma, M. (2022). Influence of social status, physical activity, and socio-demographics on willingness to pay for a basket of organic foods. *Agricultural and Food Economics*, 10, 25.
- Koc, E. & Boz, H. (2018). How can consumer science be used for gaining information about consumers and the market? The role of psychophysiological and neuromarketing research. In: Woodhead publishing series in food science, technology and nutrition, case studies in the traditional food sector, Eds. A. Cavicchi & C. Santini, Woodhead Publishing, Sawston, pp. 129–152.
- König, L. M., Koller, J. E., Villinger, K., Wahl, D. R., Ziesemer, K., Schupp, H. T. & Renner, B. (2021). Investigating the relationship between perceived meal colour variety and food intake across meal types in a smartphone-based ecological momentary assessment. *Nutrients*, 13 (3), 755.
- Krishna, A. (2012). An integrative review of sensory marketing: Engaging the senses to affect perception, judgment and behavior. *Journal of Consumer Psychology*, 22 (3), 332–51.
- 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 in Food Science and Technology*, 69 (Part A), 172–189.
- Lee, N., Broderick, A. J. & Chamberlain, L. (2017). What is 'neuromarketing'? A discussion and agenda for future research. *International Journal of Psychophysiology*, 63 (2), 199–204.
- Leonard, D. & Rayport, J. F. (1997). Spark innovation through empathic design. *Harvard Business Review*, 75, 102–115.
- Levallois, C., Smidts, A. & Wouters, P. (2021). The emergence of neuromarketing investigated through online public communications (2002–2008), *Business History*, 63 (3), 443–466.

- Lim, W. M. (2018).** Demystifying neuromarketing. *Journal of Business Research*, 91, 205–220.
- Lynch, Z. (2004).** Neurotechnology and society (2010–2060), *Annals of the New York Academy of Sciences*, 1013, 229–233.
- Mansor, A. A. & Mohd Isa, S. (2020).** Fundamentals of neuro-marketing: What is it all about? *Neuroscience Research Notes*, 3 (4), 22–28.
- Mengual-Recuerda, A., Tur-Viñes, V. & Juárez-Varón, D. (2020).** Neuromarketing in Haute Cuisine Gastronomic Experiences. *Frontiers in Psychology*, 11, 1772.
- Morin, C. (2011).** Neuromarketing: the new science of consumer behavior. *Society*, 48 (2), 131–135.
- Moya, I., García-Madariaga, J. & Blasco, M.F. (2020).** What can neuromarketing tell us about food packaging? *Foods*, 9 (12), 1856.
- Murphy Niedziela, M. & Ambroze, K. (2020).** The future of consumer neuroscience in food research. *Food Quality and Preference*, 92, 104124.
- Ndaro, N. Z. & Wang, S.Y. (2018).** Effects of fatigue based on electroencephalography signal during laparoscopic surgical simulation. *Minimally Invasive Surgery*, 2018, 2389158.
- Oswald, C., Adhikari, K. & Mohan, A. (2022).** Effect of front-of-package labels on consumer product evaluation and preferences. *Current Research in Food Science*, 5, 131–140.
- 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.
- Postma, P. G. (2013).** De anatomie van de verleiding — Neuro-marketing succesvol toegepast. Amsterdam, Adfo Groep, The Netherlands.
- Pozharliev, R., Verbeke, W. J. M. I., Van Strien, J. W. & Bagozzi, R. P. (2015).** Merely being with you increases my attention to luxury products: Using EEG to understand consumers' emotional experience with luxury branded products. *Journal of Marketing Research*, 52 (4), 546–558.
- Ramsøy, T. Z. (2019).** Building a foundation for neuromarketing and consumer neuroscience research: How researchers can apply academic rigor to the neuroscientific study of advertising effects. *Journal of Advertising Research*, 59 (3), 281–294.
- Russo, V., Bilucaglia, M., Circi, R., Bellati, M., Valesi, R., Laureanti, R., Licitra, G. & Zito, M. (2022).** The role of the emotional sequence in the communication of the territorial cheeses: A neuromarketing approach. *Foods*, 11, 2349.
- Russo, V., Milani Marin, L.E., Fici, A., Bilucaglia, M., Circi, R., Rivetti, F., Bellati, M. & Zito, M. (2021).** Strategic communication and neuromarketing in the fisheries sector: Generating ideas from the territory. *Frontiers in Communication*, 6, 49.
- Samson, L. & Buijzen M. (2019).** Craving healthy foods?! How sensory appeals increase appetitive motivational processing of healthy foods in adolescents. *Media Psychology*, 23 (2), 159–183.
- Sarcevic, D., Lilic, S. & Vranic, D. (2018).** Redukcija soli u ishrani ljudi – globalna strategija u 21. veku. *Meat Technology*, 55 (2), 162–168.
- Schlintl, C. & Schienle, A. (2020).** Effects of coloring food images on the propensity to eat: a placebo approach with color suggestions. *Frontiers in Psychology*, 11, 589826
- Schulte-Holierhoek, A., Verastegui-Tena, L., Goedegebure, R. P. G., Piqueras Fiszman, B. & Smeets, P. A. M. (2017).** Sensory expectation, perception, and autonomic nervous system responses to package colours and product popularity. *Food Quality and Preference*, 62, 60–70.
- Semenova, D., Kulikova, S., Zaripova Shamgunova, Y. & Molodchik, M. (2023).** Measuring effects of packaging on willingness-to-pay for chocolate: Evidence from an EEG experiment, *Food Quality and Preference*, 107, 104840.
- Shaikh A. R., Yaroch A. L., Nebeling L., Yeh M. C. & Resnicow K. (2008).** Psychosocial predictors of fruit and vegetable consumption in adults: A review of the literature. *American Journal of Preventive Medicine*, 34 (6), 535–543.
- Shin, J. & Mattila, A. S. (2020).** Healthy taste of high status: Signaling status at restaurants. *Cornell Hospitality Quarterly*, 61 (1), 40–52.
- Siddique, J., Shamim, A., Nawaz, M. & Abid, M.F. (2023).** The hope and hype of neuromarketing: a bibliometric analysis. *Journal of Contemporary Marketing Science*, 6 (1), 1–21.
- Simmonds, G., Woods, A. T. & Spence, C. (2018).** “Show me the goods”: Assessing the effectiveness of transparent packaging vs. product imagery on product evaluation. *Food Quality and Preference*, 63, 18–27.
- Sloan, C. M. (2015).** Neuroeconomics and neuromarketing. *International Journal of Business Management and Economic Research*, 6 (2), 133–136.
- Smidts, A., Hsu, M., Sanfey, A.G., Boksem, M.A.S., Ebstein, R.B., Huettel, S.A., Kable, J.W., Karmarkar, U.R., Kitayama, S., Knutson, B., Liberzon, I., Lohrenz, T., Stallen, M. & Yoon, C. (2014).** Advancing consumer neuroscience. *Marketing Letters*, 25 (3), 257–267.
- Songsamoe S., Saengwong-ngam R., Koomhin P. & Matan N. (2019).** Understanding consumer physiological and emotional responses to food products using Electroencephalography (EEG). *Trends in Food Science and Technology*, 93, 167–173.
- Spence, C. (2015).** On the psychological impact of food colour. *Flavour*, 4, 21.
- Spence, C. (2016).** Multisensory Packaging Design: Color, Shape, Texture, Sound, and Smell. In: Integrating the Packaging and Product Experience in Food and Beverages: A Road-Map to Consumer Satisfaction, Ed. P. Burgess, Woodhead Publishing, Sawston, pp. 1–22.
- Spence, C. & Piqueras-Fiszman, B. (2014).** The Perfect Meal: The Multisensory Science of Food and Dining. John Wiley and Sons, Hoboken, USA.
- Stanton, S., Sinnott-Armstrong, W. & Huettel, S. (2017).** Neuromarketing: Ethical implications of its use and potential misuse. *Journal of Business Ethics*, 144 (4), 799–811.
- Stasi, A., Songa, G., Mauri, M., Ciceri, A., Diotallevi, F., Nardone, G. & Russo, V. (2018).** Neuromarketing empirical approaches and food choice: A systematic review. *Food Research International*, 108, 650–664.
- Sung, B., Wilson, N. J., Yun, J. H. & Lee, E. J. (2020).** What can neuroscience offer marketing research? *Asia Pacific Journal of Marketing and Logistics*, 32 (5), 1089–1111.

- Tammela, L. I., Pääkkönen, A., Karhunen, L. J., Karhu, J., Uusitupa, M. I. & Kuikka, J. T. (2010).** Brain electrical activity during food presentation in obese binge-eating women. *Clinical Physiology and Functional Imaging*, 30 (2), 135–140.
- Telpaz, A., Webb, R. & Levy, D. J. (2015).** Using EEG to predict consumers' future choices. *Journal of Marketing Research*, 52 (4), 511–529.
- Van der Laan, L. N. & Smeets, P. A. (2015).** You are what you eat: a neuroscience perspective on consumers' personality characteristics as determinants of eating behavior. *Current Opinion in Food Science*, 3, 11–18.
- Varlese, M., Misso, R., Koliouka, C. & Andreopoulou, Z. (2020).** Food, internet and neuromarketing in the context of well-being sustainability. *International Journal of Technology Marketing*, 14 (3), 267–282.
- Veflen, N., Velasco, C. & Kraggerud, H. (2023).** Signalling taste through packaging: The effects of shape and colour on consumers' perceptions of cheeses, *Food Quality and Preference*, 104, 104742.
- Velasco, C. & Spence, C. (2019).** The Role of Typeface in Packaging Design. In: *Multisensory Packaging*. Eds. C. Velasco & C. Spence, Palgrave Macmillan, Cham, pp. 79–101.
- Venkatraman, V., Dimoka, A., Pavlou, P. A., Vo, K., Hampton, W., Bollinger, B., Hershfield, H. E., Ishihara, M. & Winer, R. S. (2015).** Predicting advertising success beyond traditional measures: New insights from neurophysiological methods and market response modeling. *Journal of Marketing Research*, 52 (4), 436–452.
- Vu, T. M. H., Tu, V. P. & Dürschmid, K. (2016).** Design factors influence consumer's gazing behaviour and decision time in an eyetracking test: A study on food images. *Food Quality and Preference*, 47 (Part B), 130–138.
- Zrnić, M., Brdar, I. & Kilibarda, N. (2021a).** The importance of traditional food quality — the viewpoint of the tourism. *Meat Technology*, 62 (1), 69–76.
- Zrnić, M., Kilibarda, N., Brdar, I., Vujić, M. & Stojanović, Đ. (2021b).** Food safety and eating habits during pandemic COVID-19 in the Republic of Serbia. *Ekonomika Poljoprivrede*, 68 (4), 895–910.
- Zuo, X.-N., Biswal, B. B. & Poldrack, R. A. (2019).** Reliability and reproducibility in functional Connectomics. *Frontiers in Neuroscience*, 13, 117.
- Živković, R. & Brdar, I. (2018).** Ponašanje i zaštita potrošača u turizmu. Univerzitet Singidunum, Beograd, Srbija.