Consumer Attention Research on Perceiving Information on Meat Product Labels: Eye-Tracking Study on a Sample of University Students

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Abstract – **Despite the growing interest in eye-tracking research in Slovakia across various domains, a minimum number of research publications, for instance, recorded in the Web of Science, were observed. Even less research is focused on food. Although the sample is limited to university students in Slovakia, it contributes the authors' perspective on the issue and provides an impulse for further research. The respondents were recruited based on their availability for laboratory measurements. Participants were informed about research ethics and signed informed consent. They also completed several questions on a Likert scale. For analysis, a software iMotions® Eye-tracking Solution to track eye movement across the screen was used. The study involved 49 participants. Both correlational and differential analysis using heat map and graph visualization were employed. Understanding consumer attention is crucial in food marketing. It is essential for marketers to determine which information available to consumers during shopping is most relevant. By examining consumers' visual behavior — specifically, what information they acquire and when — the relative importance of different product details can be inferred.**

Consumers selectively process information, often subconsciously prioritizing some elements while disregarding others, even without realizing their presence. In future research, it can be recommended to consider additional variables that may complement the research results with the influence of demographic or socio-economic factors. Similarly, the mood and experiences of the participants can also influence the results.

Keywords – **Eye-tracking, consumer behaviour, areas of interest, meat product**

1. Introduction

Several studies [1], [2], indicate that the traditional method of data collection through questionnaire surveys does not provide accurate and truthful information. The limitation of traditional research lies primarily in the reliance on the will and ability of the subjects under study to describe their feelings when exposed to advertisements or when making purchasing decisions. Research participants must verbalize their responses, which can lead to distorted data due to their expression abilities. [3] mention that concerns about the reliability of traditional surveys have driven the adoption of various methods aimed at capturing physiological responses that accompany consumers' cognitive, emotional, and behavioral processes. These issues are addressed by technologies utilized in neuromarketing [4], [5], [6], [7]. Eye-tracking technology helps to uncover the secrets of consumer decision-making and is one of the neuromarketing tools that allows to peer into the "black box" of the customer's mind. It enables the analysis of processes before, during, and after purchase decisions and provides an overview of how consumers make their choices [8]. To determine precise eye movements on product packaging, eye-tracking technology can be employed either directly in the store or in laboratory conditions, where products are presented to consumers on a computer monitor.

As stated by [9], eye-tracking studies in retail environments are often burdensome for consumers and retailers, thus laboratory studies are preferred.

Visual product features play a significant role in consumer purchasing decisions. In the case of food, this includes packaging design, the actual packaging, and the information on the label. It can be assumed that when it comes to meat products, consumers focus heavily on the appearance of the product, its composition, country of origin, expiration date, and price. In terms of nutritional value and healthy choices, the label serves as an important source of information for consumer decision-making [10]. This research explores consumer attention when selecting meat products and identify points of interest on the packaging of presented products under laboratory conditions. The study builds upon theoretical and practical knowledge of consumer decision-making and eye-tracking technology.

Despite the growing interest in eye-tracking research in Slovakia across various domains, it can be observed a minimum number of research publications, for instance, recorded in the Web of Science, are observed. Even less research is focused on food. Although the sample is limited to university students in Slovakia, it contributes the authors' perspective on the issue and provides an impulse for further research conducted using neuromarketing techniques in Slovakia and globally. In future research, apart from the aforementioned factors that may limit the subject research, it can be focusing on the visual and narrative style (label) of the product. Understanding which information consumers prioritize during food shopping is crucial for effective marketing. Analyzing their visual search behavior reveals information relevance by tracking what information is acquired and when. While price is often assumed to be the primary barrier to organic food purchases, how consumers gather price information remains unclear [11], but in general, consumers selectively process label information, often overlooking much of it without realizing it [12].

2. Background

Consumer behavior is a crucial economic factor, driving extensive research by marketers and academics. While numerous theories and models exist, purchasing decisions generally stem from a combination of needs, preferences, budget, and marketing influence [13]. A review of models and the evolution of consumer behavior and marketing requirements, as well as product labeling, can be found in sources like [14]. Technology has profoundly changed not only how people consume but also how consumption can be studied, bringing new data and better analytical tools to consumer research [15].

A range of neuromarketing techniques, including eye tracking, fMRI, physiological arousal measurements (such as heart rate and sweat), and emotion detectors, are available for measuring automatic reactions [16]. These techniques offer valuable neurological and physiological insights into consumer responses to marketing stimuli, improving understanding of consumer preferences and behavior.

Because they are closely linked to higher-order cognitive processes, eye movements are valuable indicators of visual attention and how information is gathered [17]. The individual's gaze, both its location and duration, is shaped by cognitive processes beyond attention, including perception, memory, language, and decision-making. Though not a perfect mirror of thought, eye movements generally reflect the mental processing of what can be seen [18]. While one consciously chooses what and when to look at, the precise details of eye movement are largely reflexive, with individuals typically unaware of their specific fixations [19].

By measuring eye position, movement, and pupil size in real time, eye tracking systems can pinpoint where a person is looking and for how long, effectively identifying areas of user interest [18]. Eye tracking methodology can capture online cognitive activities, making it invaluable in cognitive science [20]. Eye tracking metrics provide a wealth of data for studying the relationships between behavior, brain functions, and neural mechanisms [14]. Specialized rapidly evolving devices called eye trackers are used to monitor eye activity. Eye tracking technology helps researchers understand visual attention by recording eye movements. This data shows where participants look, how long they look at each location, and how their gaze shifts between different points of interest [21]. Visual stimuli elicit visual behavior and cognitive processing in humans. Observers need to make eye movements for the scene to be rediscovered. Among several types of eye movements generated by the human visual system, fixation and saccade are important indicators [22].

To explain these and other basic concepts related to eye tracking, the following definitions are provided:

- Fixation: A fixation occurs when the eye remains relatively still on a stimulus for a duration of roughly 200-300 milliseconds. Two key assumptions link fixations to cognitive processing: The immediate assumption (words are interpreted as soon as they are seen) and the eye-mind assumption (attention remains on a word until it is understood) [10], [23].
- Saccades: Saccades are rapid eye movements between fixations, typically voluntary and lasting up to 40-50 milliseconds. Microsaccades, small involuntary jerky movements, occur during fixations to refresh visual memory [23].

- Pupil Dilation: Pupil dilation, besides its role in adjusting to low light, also reflects changes in mood, attitude, and cognitive load during complex tasks [23].
- Scanpath: A scanpath is the chronological sequence of fixations, representing an individual's eye movement pattern [23].

Since eye tracking technology allows for the detection of unconscious processes, it is well applicable in consumer behavior research. Research indicates that a significant number of consumer decisions are made outside of conscious awareness. In the food industry, eye tracking techniques are primarily used in packaging research. In today's food market, packaging and labels are crucial for communicating key information (identity, nutrition, price, brand, taste expectations, emotional associations) and are essential for effective marketing [24]. The design of product packaging acts as a silent salesperson in retail environments, influencing shopper behavior and driving sales [25].

The duration and location of consumer gaze, measured by an eye tracker, reveal how packaging captures their attention [26]. [27] examined two types of consumer decision-making: rational and intuitive. Consumers who favor intuitive and experiential thinking styles tend to be more swayed by the aesthetic aspects of labels, such as colors, imagery, and overall design. In contrast, those who rely on rational thinking are more likely to carefully consider detailed and objective information, such as nutritional content and ingredient lists.

Several studies have examined various factors influencing consumers' viewing of product packaging [9], [28]. In these studies, participants were typically presented with food samples alongside varying visual elements, such as different type of cutlery, environments, or packaging contexts. They were then asked to evaluate their perception of the food, their expectations regarding its taste and quality, and their motivation to purchase or consume it [29]. Eye tracking was used in a study to examine packaging design elements. Research involving a fictional snack package (featuring a logo, image, weight, and calorie information) revealed that the visual prominence of these elements significantly affects attention during impulse purchases. Consumers often focus on specific elements based on their individual needs and priorities. For instance, a gluten-sensitive consumer might primarily focus on the nutrition label or "gluten-free" claim [30]. Eye tracking research provides clear evidence that certain packaging elements can capture consumer attention when they are considering buying or consuming a product [27]. Some studies focused on free viewing of products to examine how packaging attributes (e.g., layout, nutrition labeling) influence consumer behavior.

Based on the results, appropriate packaging designs were proposed [31], through eye-tracking analysis of chicken meat packaging, found that a high level of understanding of the product label information can lead to longer visual fixations compared to a label that consumers understand only at a normal or average level. Attention to nutrition information and comprehension is influenced by several factors. The use of nutrition information is influenced by a complex interplay of factors, including packaging design, the presentation of nutrition facts, and consumer motivation. However, eye-tracking research suggests that consumers may not be paying as much attention to this information as they believe [32].

To understand how consumers choose products, it must first be understood what grabs their attention. Examining the factors that attract and hold visual attention is key [8]. Studies show a clear link between visual attention and purchase decisions: Longer and more frequent fixations on a product or its packaging often predict higher perceived importance and increased likelihood of purchase [9].

3. Method

The goal of this study is to identify the key areas of interest within a visual stimulus. To achieve this, eye-tracking to measure fixations, scanpaths, and other relevant parameters is used. The research problem is formulated as the question: What are the areas of interest for Slovak consumers in the age category when deciding to purchase a meat product?

In the research, there is utilized Areas of Interest (AOI) as a tool for selecting areas and extracting metrics. AOIs are important tools in eye-tracking research that leads to quantitative metrics. The Imotions software was used for the research, which calculates the desired metrics within the boundaries of the time of interest. This multimodal software package, supported by science, is currently the most comprehensive tool available on the market for obtaining information about humans [33]. The ongoing debate about the use of AOI (Area of Interest) leads to further limitations regarding the definition and size of individual stimuli. However, modern software with the right eye-tracking technology enhances the quality and accuracy of results. Despite the discussion about result accuracy, these metrics and points of interest are commonly employed and yield valuable outcomes. The aforementioned data acquisition method remains a valuable tool for analyzing responses to visual stimuli, especially in neuromarketing research.

The research sample consisted of 49 participants with a slightly higher proportion of females (53%) than males (47%).

Average age: 21.39 years; minimum age: 18; maximum age: 24. The research sample consists of university students in Slovakia. Data collection was conducted through opportunistic sampling.

Although the sample size may be limiting for drawing conclusions, [34], [35], [36], and others have used a similar or smaller sample. Several authors point out that it is always best to have the largest possible research sample [37], but [38] states that in some cases, a sample of 30 participants may be sufficient for eye-tracking research. For future research, it is recommended considering additional variables that may complement the research results with the influence of demographic or socio-economic factors. Similarly, the mood and experiences of the participants can also influence the results. Considering the original aim of the presented contribution, the selected age group is used - university students in Slovakia, enhancing the research perspective and findings by including a sample that may not be the primary target group for purchasing and consuming meat products.

Measurements were conducted using the remote eye-tracking system Smart Eye AI-X, which is a generation of compact and high-performance eye trackers designed for marketing research. It features a high-resolution sensor that captures participants' eye movements regardless of lighting conditions. The eye tracker has a frame rate of 60 Hz. Smart Eye is a global leader in the field of Human Insight artificial intelligence, which understands, supports, and predicts human behavior in complex environments. The stimuli were presented on 24" UHD IPS monitors (Smart Eye, 2023). According to Shahmehr (2020), AI-X is perfectly suited for studying and analyzing user and consumer behavior in marketing, UX, and media research. AI-X not only measures eye movements with extreme precision but also helps draw conclusions. [37] a representative of the global leader in Imotions behavior research, points out that their company fully accepts and supports the AI-X device. He adds that inside, there is one of the most advanced sensors with high resolution, which brilliantly captures test participants regardless of lighting conditions. Despite this, there is always a risk of measurement error, calibration, or processing that may result in inaccuracies in the results and subsequently in their interpretation.

Participants were presented with various static stimuli, and in the context of this contribution, one stimulus was selected based on the goal and theoretical processing. In the introduction, they were informed about the ethical code of neuromarketing research, and precise instructions were provided to them:

• Imagine a real situation when shopping for the presented stimulus (ham or other meat product).
• Examine the stimulus in detail, read the composition and other information that they would typically observe when purchasing the presented stimulus.
• Answer survey questions on a Likert scale.

Participants were given sufficient time and a calm laboratory environment. Each measurement started with a calibration process based on nine calibration points. Participants who did not pass the calibration process with satisfactory results (Excellent or Good) were excluded from the analysis.

The Imotions platform and eye-tracking studies are gaining increasing attention. With its versatility, the platform has found numerous applications in scientific research, and its use continues to grow with recent studies, such as [38], [39], [40].

[41] conducted a similar study with 30 participants using AOI spatial product metrics. Neuromarketing is better at understanding why individuals buy certain products than at explaining general consumer behavior. This is because most purchase decisions are driven by unconscious processes (over 90%), and neuromarketing can tap into these subconscious factors. [42] also conducted research using eye-tracking on 30 respondents and highlights that neuromarketing brings advantages over traditional marketing, but like any technology, it has its limitations.

4. Results

The aim of the research is to analyze points of interest and other metrics obtained from the eye tracker on the presented stimulus - meat packaging or meat product (Figure 1). The product contains standard information that a typical customer encounters in a store.
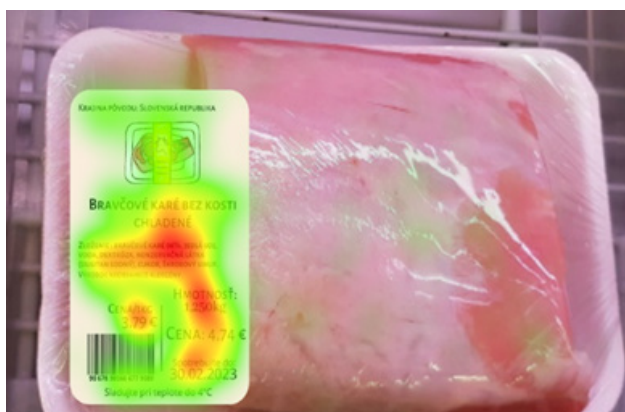

Figure 1. The presented stimulus

Figure 2. The presented stimulus – heat map

The presented stimulus (Figure 1) was displayed on the monitor for a sufficient amount of time or until the research participant clicked to close the presented stimulus after thoroughly reading all the information, thus ending the measurement process. Research participants paid attention to the product and information for a duration ranging from 15.44 to 27.12 seconds, with an average of 21.28 seconds (SD 5.84). With a 95% confidence interval, the expected results can be within the range of 19.65 to 22.92 seconds, which represents the time interval required by Slovak consumers in the age category to obtain important information from a meat product.

In terms of limiting the contribution, in the future, there could be paid closer attention to the selection of participant samples and the acceptance of intervening variables such as cognitive abilities and participants' education, with an emphasis on the application of the results and their representativeness.

Heatmaps provide a quick and effective way to visualize eye-tracking data. These colorful visualizations show where people focus their attention most, allowing us to identify the expected areas of interest (AOI) within a visual stimulus. The heatmap (Figure 2) shows that consumers paid the highest attention to the description and composition of the product, focusing mainly on the meat content. They showed less interest in the weight and price of the product, as well as its country of origin. There are established points of interest based on the heatmap, which provides additional numerical metrics assessed during eye-tracking.

Table 1 presents selected and most important eye-tracking metrics. Based on the heatmap, 9 areas of interest were identified. The description of each abbreviation is presented in Table 1.

Table 1. AOI metric

AOI		TTFF (ms)	Dwell Time (ms)	Ratio (%)	Fixation (count)	Revisits (count)
1.	Country of origin	7 478.5	**736.8**	73.5	3.5	0.6
2.	Product name	**1 072.5**	2 452.2	100	11	**2.7**
3.	Product description	2 824.4	**5 014.7**	100	**16.6**	2.4
4.	Weight	6 369.4	1 795.3	100	5.8	2
5.	Product price	8 303.8	1 271.0	100	5.1	1.6
6.	Consumption	11 000.6	1 578.3	91.8	5.4	1.1
7.	Storage	**13 260.1**	797.2	69.4	3.5	**0.3**
8.	Price per kg	8 754.2	1 180.8	93.9	**3.2**	1.2
9.	Appearance of meat	5 693.8	1 205.3	79.6	5.9	0.6

To gain a more detailed understanding of visual attention, the heatmap can be enhanced by incorporating additional metrics from Table 1. These metrics, which are explained in more detail in the theoretical section, provide further insights into how people engage with the visual stimulus. In the analysis, the focus was on the lowest and highest values in the aggregated data for the 49 research participants. Consumers generally noticed the product name first,

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In the analysis, there were focused on the lowest and highest values in the aggregated data for the 49 research participants. Consumers generally noticed the product name first, while they noticed the storage of the product last. Consumers spent the most time on the product description (with an emphasis on meat content) and the least time on the country of origin. Respondents paid the lowest average attention to the storage of the product (69.4%). The area of interest "Product Description" had the highest number of fixations (16.6).

The results also indicate that although the product name was not dominant in attention, respondents noticed it first and returned their gaze to it the most. The highest and lowest values of the metric results were of primary interest.

Given the usual limitation of research, sample selection and measurement bias, it can be assumed that other areas of interest could also be interesting considering the measurement metrics in Table 1, such as consumption, which was not important in the research due to the age of the respondents.

The original assumption that price would be the dominant area of interest for consumers in the given age category [43], was not confirmed, which can be considered as a positive result, as the price does not reflect the quality of the meat, its content, and other characteristics.

These are important pieces of information when purchasing products that are consumed and have an impact on consumers' health.
As part of this study's objective, the longest time spent on the area of interest (AOI) – the product description – was analyzed, along with the subsequent assessment of the participant's willingness to purchase the product, measured on a scale from 1 (strongly disagree) to 7 (strongly agree). The result is presented in Table 2 and Graph 1.

Table 2. Spearman Correlation Coefficient

		Dwell Time AOI3
would buy the presented product	Corr. Coef.	542**
	Sig.	,000

Table 2 shows a significant positive correlation between time spent on the AOI - product description - and the participant's response regarding whether they buy the specific product. This can be interpreted as a statistically significant relationship, meaning that the longer participants spent on the product description, the more likely they would be to purchase it. This relationship is graphically illustrated in Graph 1.
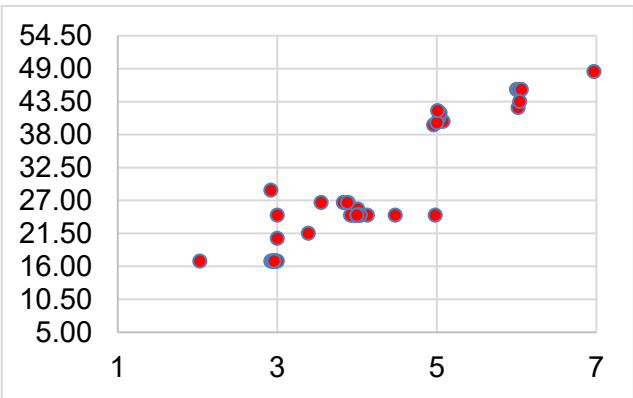
Graph 1. Scatterplot for table 2 - dwell time AOI3

There are multiple aspects to consider regarding the mentioned result. This finding highlights the importance of clear and compelling product descriptions in influencing consumer purchasing decisions. Conversely, for Slovak consumers who paid less attention to the product description, there is a lower tendency to buy it. This means that consumers who spend more time on the product description are more likely to make a purchase because they are aware that there is nothing negative regarding the meat content and composition in the description.

Consumers who pay less attention to the product description may be convinced that the product meets quality guarantees and minimum requirements, and therefore, whether or not this information is available makes no difference to their intention to buy [26]. In the case of adding a seemingly harmful substance to the meat product stimulus for these consumers, it can be assumed that their purchase decision would not change. This indicates a tendency towards consumer behavior where the description and composition do not play a dominant role. These are consumers who are not sufficiently interested and purchase the product based on other convictions or indifference in terms of arranging life necessities or rely automatically on the minimum quality of the product. Sensory properties are a key element in food selection. Some consumers are not willing to pay attention to the product description, even for the sake of improving their health. [44] highlights the issue of insufficient scientific attention in the case of research on meat products. They emphasize that given the low number of publications on this topic, every additional article is enrichment for future research.

5. Discussion

The general public claims to be interested in the production and processing of meat products, but in reality, they do not tend to consider it when purchasing and consuming meat. Consumers who are more concerned about health and nutritional values usually seek more information and have a tendency to trust labels and read them more frequently. As early as 2016, the Ministry of Agriculture and Rural Development of the Slovak Republic issued a report highlighting that many respondents did not pay enough attention to what they purchase, despite several inspections by food authorities revealing deficiencies in over 8.9% of the more than 8,300 conducted inspections. This issue has also been addressed in the media, and the Vice President of Trade and Tourism of the Slovak Republic [45] pointed out that sometimes paying attention to the label itself is not enough because consumers do not know what positive or negative substances are present in the composition.

Furthermore, he adds that the same product with the same packaging must have the same composition in all countries.

However, several inspections have indicated that the compositions of the same products differ. Based on the insufficient attention given to research on meat products [44], the contribution supports and creates space for other experts to study the same or different age categories, which can be mutually compared and subsequently enriched with other age categories, gender differences, and differences caused by the diversification of countries. The contribution focused on a specific age group without analyzing gender differences, despite the sample of women and men being adequate for further statistical analysis. The contribution is focused on an innovative method of scientific research on meat product issues and their composition using eye-tracking on a Slovak sample of respondents in a specific age category. It also combines quantitative and qualitative data.

Despite efforts to use appropriate marketing strategies in creating labels that describe meat products, it can be observed a portion of the population that is not sufficiently interested in paying attention to the composition and other characteristics. On the other hand, it is possible to improve the product description for consumers who are interested in the composition - those are the target consumers. Each consumer's unique beliefs, attitudes, and personality influence their buying decisions.

Over the past 20 years, there have been few comprehensive works published on the labels found on food products. Further research is needed to explore the fundamental conceptual and intellectual framework of this field [46]. Based on findings and other research, consumers who pay less attention to reading ingredient labels are considered risky consumers, as they might purchase meat products even with harmful additives or substances. This can also apply to products other than meat products. It may be due to a lack of interest, lack of time to read labels, insufficient food education, trust in the brand, trust in the store, or simply personal preferences. Like other authors, it is recommended to expand knowledge and scientific research on meat products in terms of marketing strategy and consumer behavior. The limitations of the research lie in the real conditions in each store when purchasing the same product (without the limitation of a laboratory stimulus on a monitor), as well as the accuracy of AOIs and the size of the individual presented stimuli. In general, similar studies may observe several issues with calibration, AOI labeling, and incorrect interpretation of results considering the size of stimuli.

Packaging and label design are vital in the modern food environment, conveying information like identity, nutrition, and brand while shaping consumer perception and influencing marketing success [24].

[27] state that when deciding whether to buy an unfamiliar food product, consumers look for specific information on the label, like the brand, ingredients, and nutritional value. The design of the label does not seem to matter as much. [47] bring additional interesting results. This study highlights a disconnect between attention, preference, and stated importance. While packaging aesthetics initially attract attention, and nutritional information is crucial for evaluation, the most visually appealing package may not be the preferred choice, and consumers may overlook attributes they claim are important. [48], for example, reported that describing hamburgers as having a "juicy taste" made people think about them more positively. Moreover, the relevance and accuracy of information provided on food products seem to act as a protective factor in reducing future impulse purchases [49].

6. Conclusion

The study confirms that while consumers claim to be interested in the production and processing of meat products, their purchasing behavior does not always reflect this interest. Many consumers, particularly those concerned with health and nutrition, tend to seek out and trust food labels more frequently. However, despite various inspections and media coverage, a significant portion of the population does not thoroughly examine product labels. This indicates a gap between perceived importance and actual behavior.

The research highlights the potential for further exploration of consumer behavior concerning meat products, particularly across different age groups, gender differences, and international comparisons. The study also emphasizes the need for innovative research methodologies, such as eye-tracking, to provide deeper insights into consumer decision-making processes.

The findings suggest that marketing strategies can be improved to target consumers who are genuinely interested in product composition. Additionally, the study underscores the necessity for ongoing research in food labeling, marketing, and consumer behavior to enhance public awareness and education.

Ultimately, packaging and labeling play a crucial role in consumer perception and decision-making. While some consumers prioritize nutritional information and branding, others may be influenced by packaging aesthetics. Future research should focus on bridging the gap between consumer intentions and actual purchasing decisions, ensuring that food labeling strategies effectively communicate essential product information.

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