Visual attention to nitrite-free and plant-based sausages alternatives: Effect of information and cross-cultural differences between Ireland and Finland

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Declarations of interest: none

Note: This is the final, accepted manuscript of the paper that will be published in Food Quality and Preference, Volume 136, February 2026, 105737, https://doi.org/10.1016/j.foodqual.2025.105737

Abstract

Consumers encounter various visual cues while shopping, which influence their food choices. Additionally, concerns related to the use of nitrites in cured meats and the overall impact of animal breeding on the environment are transforming the European sausage market. The aim of this study was to evaluate the differences in consumer (n = 66) visual attention to three sausages (conventional, nitrite-free, and plant-based) under both blind and informed (health risk, health benefit, and health plus environmental benefit) conditions in Ireland and Finland, using a wearable eye-tracker in combination with a food choice task and Flash Profile. Significant differences were observed in consumer visual attention between the countries. Consumers in Ireland were navigating between products, whereas those in Finland tended to focus on each product (or text) for longer periods without revisiting it. In both countries, most consumers in the blind condition chose the conventional product, followed by the plant-based alternative. In the informed condition, the conventional product remained the most preferred in Ireland, while in Finland, the plant-based alternative became the most popular. In Ireland, visual attention differences between products were minimal, but the nitrite-free sausage information text attracted the most attention. In Finland, however, under the blind condition, the plant-based alternative had significantly more dwells with fixation and revisit count. Lastly, dwell time, was the only measure found to be significant in predicting product choice. These results highlight the need for culture-specific approaches underscoring aspects of visual attention and information provision in driving healthier and sustainable consumer food choices.

Keywords

Eye-tracking, wearable, sustainability, cross-cultural, health benefit, health risk, meat, meat alternatives.

1 Introduction

The European sausage market has grown by 2.4% since 2016, with some countries showing significant growth and others reporting declines (ReportLinker, 2022). In Ireland, the sausage market is projected to grow annually by 5.83% (compound annual growth rate) over the next few years (statista, 2025), while in Finland, forecasts suggest an annual decline of 1.8% (ReportLinker, 2024).

Recently, concerns have been raised regarding the use of nitrites in sausage manufacturing. These compounds are added to sausage formulations not only for their antimicrobial properties but also to enhance desirable sensory qualities such as colour, flavour, and texture (Stergios Melios, Simona Grasso, Declan Bolton, & Emily Crofton, 2024c). However, the International Agency for Research on Cancer (IARC), a specialized cancer agency of the World Health Organization, classified processed meats as carcinogenic to humans (Group 1) due to evidence linking nitrites to the formation of carcinogens (IARC, 2015). This, together with other environmental considerations, has led internationally set dietary guidelines, such as the Nordic Nutrition Recommendation, to suggest only a limited amount of processed meat in human diet (Blomhoff et al., 2023). Currently, food researchers and manufacturers actively explore alternative to nitrites compounds that pose no risk to consumer health.

On the other hand, animal protein consumption is generally decreasing among consumers, influenced by various factors (Melios & Grasso, 2024). In Ireland, consumers are becoming more environmentally conscious and seeking to reduce their meat consumption (O'Connor, 2022). A study conducted in the Republic of Ireland reported that 78% of respondents belonged to the meat reducers consumer segment (Doherty, Cassidy, Huybrechts, & Mullee, 2021). Additionally,

consumers in Ireland were shown to be more likely to use products specifically designed to replace certain types of meat, such as sausages (O'Connor, 2022). Similarly, a recent study in Finland revealed that 52% of current meat eaters identified as flexitarians (van Dijk, Jouppila, Sandell, & Knaapila, 2023). Flexitarians follow a semi-vegetarian diet where animal products are included occasionally within a plant-based meal plan (Frey, 2019). Another study reported that 64.8% of respondents who currently consume beef had recently decreased or intended to decrease their consumption. Moreover, 46.3% of the consumers reported that they had increased or intended to increase their consumption of plant-based protein products (Niva & Vainio, 2021).

In recent years, sensory and consumer research has focused on exploring the sensory characteristics, consumer perceptions, and choices related to healthier alternatives to conventional meat products, whether made without nitrites (Stergios Melios, Simona Grasso, Declan Bolton, & Emily Crofton, 2024a; Stergios Melios, S. Grasso, D. Bolton, & E. Crofton, 2024b; Melios et al., 2024c) or using alternative protein sources (Melios, Gkatzionis, et al., 2025; Melios & Grasso, 2024; van Dijk et al., 2023; Y. Wang et al., 2022). While cured meats made without nitrites seem to successfully replicate the sensory profiles of their conventional counterparts, plant-based products fall short. Even when they share some traits with conventional products (e.g., smoky flavour), these are often perceived as artificial (Melios et al., 2024a; Melios et al., 2024b; Melios, Grasso, Bolton, & Crofton, 2025; Jan Roland G. Molina et al., 2025). Similarly, when consumers evaluate them, plant-based products receive low liking scores, which are not significantly improved even when information about their health and environmental benefits is provided (Melios, Bolton, & Crofton, 2025b). Additionally, although it could be hypothesized that consumers with healthier eating habits would be more willing to accept either type of cured meat alternatives or be more responsive to information provision, evidence shows that eating habits do

not interact with product type or information provision in terms of liking (Melios, Bolton, & Crofton, 2025a). Therefore, more research is needed that employs more sophisticated tools and combines implicit and explicit measures to gain deeper insights into the decision process. Since appearance, especially colour, is a crucial factor in meat product choice and can strongly influence decisions (Anagnostou, Ferragina, Crofton, Frias Celayeta, & Hamill, 2025), eye-tracking measures combined with explicit data offer the potential to uncover decision-making patterns not previously identified.

Previous research evaluating the role that attention plays in the control of action suggested that attention is mainly important for starting actions but not for carrying them out (Norman & Shallice, 1986). Schneider and Shiffrin (1977) proposed a theory of information processing that emphasizes the roles of automatic and controlled processing. Automatic processing occurs when a well-practiced task runs on its own. It does not require conscious control, does not strain mental capacity, and happens automatically when triggered. Controlled processing requires deliberate focus, takes effort, has limits on how much can be handled at once, and depends on attention. Consumers encounter various visual cues while shopping, which catch their attention and could potentially influence their food choices. These visual cues can include the food products themselves, or elements related to packaging and labelling (K. Motoki, Saito, & Onuma, 2021). Therefore, eye-tracking technologies have been extensively used to study the relationship between attention, as measured with eye-trackers, and food choices (e.g. Svetlana Bialkova, Grunert, and van Trijp (2020); Chen et al. (2024)). However, most food-related research using eye-tracking technology has primarily focused on labels rather than the sensory attributes of food products (e.g. Ares, Mawad, Giménez, and Maiche (2014); Giray, Yon, Alniacik, and Girisken (2022); Tortora, Machin, and Ares (2019)). Food label evaluations often rely on digital formats using screen-based

eye-trackers (Ares et al., 2014). Only a few studies examine real products displayed on shelves in commercial settings (e.g., grocery stores) (Svetlana Bialkova et al., 2020) or controlled lab environments (Fenko, Nicolaas, & Galetzka, 2018) through wearable eye-tracking solutions. There are controversial results on if the settings under what a study takes place can affect the results. It was previously reported that while eye-tracking data obtained in a virtual setting supported that dwell time to a product is associated with preferences, the setting was not able, to fully capture the more complex cognitive processes underpinning real-life settings. More specifically, non-significant differences were reflected in dwell time for selected versus unselect foods (Peng, Browne, Cahayadi, & Cakmak, 2021). However, other authors, exploring the relationship between visual attention and food choice, observed similar pattern of consumer behaviour in both lab and real life settings (Svetlana Bialkova et al., 2020). Wearable eye-trackers, though, can be considered to enable the measurement of eye movements in real-world settings with actual products, making them particularly valuable, especially, in sensory evaluation (Puurtinen, Hoppu, Puputti, Mattila, & Sandell, 2021).

Health concerns about nitrites in sausages as well as a rise of meat reducers are driving demand for alternatives that are either nitrite-free or plant-based (De Cianni, Mancuso, Rizzo, & Migliore, 2024; Giacalone, Clausen, & Jaeger, 2022; Melios & Grasso, 2024; Melios et al., 2024c). While these alternatives are placed in the market for their health and sustainability benefits, research on real-world scenarios, where they are presented along with conventional products and with information related to their benefits remain limited. To know that a plant-based alternative is preferred over other plant-based products or it is considered in general acceptable is not enough (Giacalone, 2025).

Additionally, except of the product itself, communicating health or environmental benefits or risk, emphasising the gain and losses of different products consumption, can shape consumer perceptions and food choices, even when it is not accurate (Melios, Asimakopoulou, Greene, Crofton, & Grasso, 2025; Menozzi et al., 2023; Sogari, Caputo, Joshua Petterson, Mora, & Boukid, 2023). Based on prospect theory people evaluate options based on perceived gains or losses, influencing how they respond to such information (Kahneman & Tversky, 1979; Tversky & Kahneman). Therefore, tailored communication that aligns with different consumer motivations and the extend it effectively captures their attention should be further explored, particularly in the context of promoting protein transition or the adoption of healthier, nitrite-free options.

Taking part in different social practices leads to shifts in perception (Nisbett & Miyamoto, 2005). Therefore, a given stimulus can trigger different processes in different cultures (Nisbett, Peng, Choi, & Norenzayan, 2001). Ireland and Finland are two European Union (EU) countries located in the Northern Europe, with similar population sizes (5,285,679 in Ireland and 5,620,798 in Finland (Worldometer, 2025a, 2025b)). In the international literature, Europe (or the EU) is often presented as a common area with uniform culture and consumption practices. However, this does not appear to be the case. Ireland and Finland both show differences in sausage market growth but also similarities in meat reduction trends among consumers. Shaped by different historical events and influenced by different forces over time, these two countries have developed distinct identities that are also reflected in their consumption practices. This aspect worth further exploration. Examining how food choice is shaped through visual attention in these two countries, as well as how consumers respond to information about health risks, health benefits, and combined health–environmental benefits, can provide valuable insights. Such findings can better inform not only the food industry but, more importantly, regulatory authorities in the EU on whether universal

solutions at the European level are sufficient or country-specific interventions are needed to address health and environmental challenges. This study aimed to explore, for the first time, differences in visual attention to conventional, nitrite-free, and plant-based sausages between consumers in Ireland and Finland using wearable eye-trackers in a buffet-style arrangement. Additionally, it attempted to examine how visual attention is influenced by information regarding health risks (for nitrite-containing sausages), health benefits (for nitrite-free sausages), and health plus environmental benefits (for plant-based alternatives) under blind and informed conditions. To gain conscious insights into the unconscious aspects revealed by the eye-tracking task, a food choice task and Flash Profile were conducted. Finally, a logistic regression analysis was used to identify potential visual attention predictors of food choice.

2 Materials and Methods

2.1 Ethics approval

The Irish part of the study was approved by the Human Research Ethics Committee at University College Dublin as a low-risk study (reference number LS-C-24-283-Melios-Grasso), while the Finnish part was approved by Ethics Committee for Human Sciences at the University of Turku, Humanities and Social Sciences Division (reference number 37/2021). Before participation, all consumers provided voluntary written consent after reading an information sheet. As a gesture of appreciation, participants received a box of chocolates or dates after data collection.

2.2 Participants

A total of 66 consumers (30 in Ireland and 36 in Finland) were recruited through social media posts and posters distributed on the respective campuses. The recruitment was divided into three phases,

and the study was conducted at three different locations. The first phase took place at the Flavoria research platform, University of Turku, Finland, where 11 consumers participated over two weeks in May 2024. The second phase was conducted at the Teagasc facilities in Dublin, Ireland, with 30 participants over two weeks in October 2024. The third phase took place at the Sensory laboratory (ISO 8589) of the University of Helsinki, Finland, where 25 consumers participated over two weeks in January 2025. Recruitment criteria included being 18 years or older, residing in either Ireland or Finland, consuming meat at least occasionally, and having normal or corrected to normal vision. The demographic profile of the consumers in the two countries is presented in Table 1.

Table 1. Demographic characteristics of the consumers participated in the study.

	Ireland (n = 30)		Finland (n = 36)		
	n	%	n	%	Chi-square
Man	14	47	14	39	0.405
Woman	16	53	22	61	
Non-binary	0	0	0	0	
Other	0	0	0	0	
Prefer not to say	0	0	0	0	
20-29	15	50	14	39	4.283
30-39	11	37	15	42	
40-49	4	13	3	8	
50-59	0	0	4	11	
Didn't complete secondary education	0	0	0	0	10.847*
Completed secondary school	1	3	0	0	
Third level, non-degree education	2	7	2	6	
Bachelor's degree	9	30	9	25	
Master's degree	8	27	22	61	
PhD or higher	10	33	3	8	

* Chi-square test with statistical significance of $p < 0.05$.

2.3 Sausages samples

The samples used in each country were commercially available and selected to ensure cultural relevance and consumer familiarity. The study aimed to investigate how information affects product choice and whether this effect differs between countries. Therefore, it was considered more relevant for consumers in each country to encounter products they were already familiar with, so that their focus would be on the information provided rather than on a pure evaluation of the products themselves. As explained in Section 2.6 (Food choice task and Flash Profile), the selection of the Flash Profile method also had the same goal: capturing consumers' perspectives rather than the products' intrinsic characteristics. Accordingly, breakfast sausages were chosen in Ireland, as they are deeply integrated into Irish society and represent an important component of the traditional Irish breakfast. In Finland, frankfurter-type sausages were selected, as they are commonly consumed during barbeques and are highly popular; therefore, this product category was available in conventional, nitrite-free, and plant-based versions. In both Ireland and Finland, conventional sausages were evaluated alongside nitrite-free and plant-based alternatives, with selections based on market availability. In Finland, the chosen plant-based sausage was the one that most closely resembled a conventional product in appearance, while the nitrite-free sausage was the only available option of its kind. A similar approach was taken in Ireland for selecting the plant-based product. However, currently, most of the sausages on the Irish market, commonly referred to as "breakfast sausages", do not contain nitrites as a preservative but instead use sodium metabisulfite (J. R. G. Molina, Frias-Celayeta, Bolton, & Botinestean, 2024), making the selected nitrite-containing product the only available option. In Fig. 1 are provided images of the products and the set-up in each country.

SUGGESTED POSITION FOR FIGURE 1

2.4 Experimental set up

A summary of the experimental procedure is presented in Fig. 2. Two experimental conditions were conducted; one blind and one informed, as further explained in Section 2.5. The three products were presented in a buffet-style arrangement, as shown in Fig. 1. In Ireland, eight sausages of each type were placed on white porcelain plates and labelled with three-digit codes. The plates were arranged the one next to the other on a table, with their positions changed for each consumer using a Williams Latin square design. A similar setup was used in Finland; however, only four sausages were placed on each plate, as they were larger in size. Moreover, A4-sized stands were positioned behind the plates. During the blind condition, these stands contained only blank white A4 sheets, while in the informed condition, they contained the text providing product information. A mark was placed 70 cm away from the table to ensure that all participants evaluated the products from the same distance.

SUGGESTED POSITION FOR FIGURE 2

In this study, the products served primarily as props rather than as the main focus of evaluation. The focus was on how consumers in each country altered their choices after receiving information, and how these changes compared across countries. Visual attention was measured to assess how attention was distributed across products and information texts and how it related to subsequent choices. Therefore, products were selected based on their cultural relevance to ensure that familiarity did not influence evaluations, while lighting was not considered a factor.

2.5 Experimental conditions and data collection

As previously mentioned, each part in each location was conducted over two weeks. The blind condition took place during the first week, followed by the informed condition in the second week.

After completing the blind condition, consumers were required to schedule a second session usually at the same time and day as their first session. For the informed condition, information in text form was placed on stands above the plates, detailing either a health risk (for the conventional product), a health benefit (for the nitrite-free product), or health and environmental benefit (for the plant-based alternative). The information was presented in English in Ireland and either in English or in Finnish in Finland. The specific texts can be found in Appendix A. Although neither a manipulation check was conducted nor qualitative feedback obtained from participants regarding the effectiveness of the information, the texts were adapted from Melios, Bolton, et al. (2025b), where the health benefit information significantly increased both overall liking and purchase intent for a nitrite-free cooked ham product, as well as purchase intent for a plant-based cooked ham alternative. Therefore, these texts were considered an effective case study to explore their impact on visual attention and product choice for sausages and their alternatives. Each session lasted approximately 20 minutes. Participants were first given an information sheet to read and a consent form to sign. Before starting, the researcher briefed the participant on the procedure and instructed them to minimize head movement during the eye-tracking task, focusing on mostly moving their pupils rather than their head.

At the beginning of the session, participants stood at a distance (in Dublin and Turku) or in a different room (in Helsinki) from the buffet setup to avoid direct contact with the products before evaluation. They were then asked to complete a questionnaire covering demographic information (gender, age, highest level of education) and frequency of sausages, and other food products, consumption. Next, participants were guided to the buffet setup, where they stood at a marked position and with the assistance of the researcher they wore the eye-tracking glasses. They had to hold the recording unit in one hand and a calibration card in the other, which was used for a one-

point calibration procedure. Once the glasses were calibrated, they were instructed to turn their head down toward the sausages and take as much time as needed to decide which of the three products they preferred, based on their own criteria. When they had made their choice, they let the researcher know, who then stopped the recording. Afterward, participants returned to the questionnaire and indicated their product preference and a Flash Profile task (see section 2.6). During the informed condition (week 2), the same procedure was followed, except participants did not complete demographic or general questions again. Additionally, A4 sheets containing product information were placed inside the stands on the table (see Fig. 1).

2.6 Food choice task and Flash Profile

Directly after the eye-tracking task, food choice and Flash Profile tasks were conducted, both based on product appearance. For the food choice task, participants were asked to indicate their preferred product among the three options. Flash Profile with consumers has been suggested as a useful approach for understanding consumer perceptions, emphasizing consumers' perspectives rather than strict product characterization (J. Delarue, 2015). Therefore, a Flash Profile task was chosen to explore the reasons behind consumer choices rather than conducting a strict product characterization. Following a brief introduction to Flash Profile, consumers generated descriptors explaining their choice, focusing on product characteristics that were comparable. Consumers were encouraged to generate as many descriptors as they wished, using any type of terms that came to mind, with no restrictions and to be either in English or in Finnish. Then, for each descriptor, consumers ranked the three products on a comparative 3-point scale from "low" to "high" (Julien Delarue & Sieffermann, 2004; Moussaoui & Varela, 2010). Participants were given as much time as needed to complete the task.

2.7 Apparatus and software used.

To record participants' gaze, Tobii Pro Glasses 2 (wireless; with a 50 Hz recording frequency) were used in Ireland, and Tobii Pro Glasses 3 (wireless; with a 50 Hz recording frequency) were used in Finland. All questionnaire data were collected through Compusense® Cloud (Compusense Inc., Guelph, Canada), presented on either a computer or a tablet screen, and consumers had the option to select either an English or a Finnish version of the questionnaire.

2.8 Data handling and analysis

2.8.1 Data handling

The data collection in the two countries, under two conditions, resulted in 132 videos. For eye movement data, dependent measures were analysed based on Areas of Interest (AOI), with each item constituting a single, non-overlapping AOI. During the blind condition, each product (sausages on a plate) was defined as an oval AOI. In the informed condition, the same AOI were maintained, and three trapezoid-shaped AOI covering the information texts were added. AOI sizes were kept similar and adjusted dynamically during the video (Spielvogel, Matthes, Naderer, & Karsay, 2018). For visual attention indicators, multiple measures were extracted for each AOI to ensure comparisons between products and across countries. These included average fixation duration, dwell time (fixation, %), dwell time (fixation, ms), dwell time (gaze, %), dwell time (gaze, ms), duration of average saccade, dwells with fixations (average of how often the respondents looked at the AOI and fixated on it at least once), dwells with saccades (average of how often the respondents looked at the AOI with at least one whole saccade detected between entry and exit), first dwell duration, first fixation duration, fixation count, last dwell duration, last fixation duration, revisit count (fixation dwells), revisit count (gaze dwells), and saccade count. Dwell time represents total viewing time within an AOI, accounting for both fixations and saccades

(measured in milliseconds). First fixation duration indicates the length of the initial visual contact with an AOI. Fixations, characterized by prolonged visual focus on specific AOIs, were detected and categorized. To ensure accuracy, dwells lasting less than 100 ms were excluded, as they were considered typical ocular movements rather than true indicators of interest. The sequence of fixations and saccades was analyzed to explore consumer visual behavior, revealing how they navigated the products and information texts (Escandon-Barbosa, Salas-Paramo, López-Ramírez, & Pava-Cárdenas, 2023; Y. M. Lee & Wei, 2024; Spielvogel et al., 2018). Video analysis and data extraction were conducted using iMotions (10.1.7, Copenhagen, Denmark).

2.8.2. Data analysis

Data analysis was conducted using XLSTAT Premium (Annual version 2024.4.01424). Unless otherwise indicated, statistical significance was set at $p < 0.05$. Chi-square tests were performed to compare categorical demographic variables between countries (McHugh, 2013). For Flash Profile, all descriptors were considered, those give in Finnish were translated to English by a researcher fluent both in Finnish and in English (F.T) and similar terms (e.g. red and redness, uniform and uniformity) were grouped, whereas terms that referred to different aspects of the same concept such as, environmentally friendly and sustainability, or health (general) and healthy (product) were kept separately. A researcher fluent in English (S.M.) combined spelling variations, synonyms, and typo differences. Rankings were assigned numerical values: the product rated at the “high” end received a score of 3, the middle-ranked product a 2, and the “low” end product a 1. For each country, descriptors mentioned by multiple consumers were summed, and a contingency table was created with products (under both blind and informed conditions) as rows and descriptors as columns. Correspondence analysis (CA) was then performed to identify patterns and relationships between descriptors and products.

To assess differences between AOIs for each eye-tracking measure, two-way ANOVAs were conducted, with AOI as a fixed factor and Consumer as a random effect. Tukey post-hoc test was applied to compare mean differences among AOIs. Similarly, to analyse differences between countries, three-way ANOVAs were conducted with country, AOI, and condition as fixed factors, followed by Tukey post-hoc tests. Logistic regression was used to examine the relationship between product choice and visual attention, allowing for the evaluation of multiple independent variables on a binary dependent variable (Freeman, 1987). In n this case, logistic regression assessed the influence of eye-tracking measures (explanatory variables) on the probability of a consumer selecting a product (response variable). The statistical significance of independent variables was confirmed using the chi-square test (Oliveira et al., 2016).

3 Results

3.1 Consumer choice and visual attention in Ireland

3.1.1 Visual attention

The effect of product differences on consumers' visual attention in Ireland was found to be minimal (Table 2) during the blind condition. For most measures, only the Consumer factor was significant, indicating substantial variation in visual attention among consumers. During the informed condition, consumers spent statistically significant more time on the provided text rather than on the products, as expected. Regarding the products, a similar pattern to the blind condition was observed for almost all measures, except for dwell time (measured through gaze and expressed as ms), which was significantly higher for the conventional and plant-based alternatives compared to the nitrite-free product. When analysing visual attention towards the provided text, consumers

exhibited a significantly higher revisit count (measured through both fixation and gaze dwells) and dwells with fixations for the nitrite-free product compared to the conventional one. However, no significant differences were observed between the plant-based alternative and the other two.

Table 2 Results for eye-tracking measures, obtained by a mobile eye-tracker, following 2-way ANOVA with areas-of-interest (AOI) (conventional, nitrite-free, and plant based) as fixed factor, and Consumer as random effect. Within response variables, explained % of type III sum of square. Model goodness-of-fit indicated by R2 and post-hoc results for AOI effects performed using Tuckey post hoc tests (within rows, AOI with the same letter are not significantly different at the 5 % level of significance; alphabetical ordering of letters used to indicate larger values for 'A' than 'B').

Measure	Goodness-of-fit (R2)	Variance (%) AOI	Variance (%) Consumer	AOI		
				Conventional	Nitrite-free	Plant-based
Products during blind condition						
Duration of average fixation	0.651***	2.7	97.3***			
Dwell time (fixation, %)	0.393					
Dwell time (fixation, ms)	0.202					
Dwell time (gaze, %)	0.342					
Dwell time (gaze, ms)	0.195					
Duration of average saccade	0.407					
Dwells with fixations	0.859***	0.7	99.3***			
Dwells with saccades	0.766***	0.8	99.2***			
First dwell duration	0.735***	2.2	97.8***			
First fixation duration	0.603***	1.4	98.6***			
Fixation count	0.764***	2.6	97.4***			
Last dwell duration	0.407					
Last fixation duration	0.358					
Revisit count (fixation dwells)	0.859***	0.7	99.3***			
Revisit count (gaze dwells)	0.810***	1.5	98.5***			
Saccade count	0.525*	3.5	96.5*			
Products during informed condition						
Duration of average fixation	0.625***	1.7	98.3***			
Dwell time (fixation, %)	0.712***	0.7	99.3***			
Dwell time (fixation, ms)	0.540**	41.4***	58.6			
Dwell time (gaze, %)	0.396					
Dwell time (gaze, ms)	0.531*	39.4***	60.6	A	B	A
Duration of average saccade	0.505*	4.9	95.1*			

Dwells with fixations	0.762***	0.1	99.9***			
Dwells with saccades	0.718***	0.5	99.5***			
First dwell duration	0.454					
First fixation duration	0.356					
Fixation count	0.715***	0.5	99.5***			
Last dwell duration	0.399					
Last fixation duration	0.446					
Revisit count (fixation dwells)	0.762***	0.1	99.9***			
Revisit count (gaze dwells)	0.737***	0.1	99.9***			
Saccade count	0.586**	5.7	94.3**			
Text during informed condition						
Duration of average fixation	0.577**	0.3	99.7***			
Dwell time (fixation, %)	0.471					
Dwell time (fixation, ms)	0.393					
Dwell time (gaze, %)	0.314					
Dwell time (gaze, ms)	0.380					
Duration of average saccade	0.511*	0.7	99.3*			
Dwells with fixations	0.522*	18.2**	81.8*	B	A	AB
Dwells with saccades	0.505*	10.9	89.1*			
First dwell duration	0.509*	7.2	92.8*			
First fixation duration	0.315					
Fixation count	0.589***	0.3	99.7***			
Last dwell duration	0.463					
Last fixation duration	0.338					
Revisit count (fixation dwells)	0.522*	18.2**	81.8*	B	A	AB
Revisit count (gaze dwells)	0.522*	16.4*	83.6*	B	A	AB
Saccade count	0.601***	0.4	99.6***			

Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

3.1.2 Product choice and Flash Profile before and after the provision of information

As shown in Table 3, during the blind condition, the majority of consumers (76.7%) chose the conventional product, followed by the plant-based alternative (20.0%), while only 3.3% selected the nitrite-free sausage. After being informed about the risks and benefits associated with the products, the conventional product remained the most preferred. However, preference for the plant-based alternative increased to 36.7%, while the nitrite-free product was chosen by 20% of consumers.

When analysing the terms consumers used to explain their choice, the first factor of the CA plot, which accounted for 68.58% of the variation, differentiated products based on whether the terms referred to appearance or to health and environmental considerations (Fig. 3). Products presented under the blind condition were placed on the positive direction of Factor 1. Those products were described based on their appearance, with terms such as “casing”, “tasty” (stating expectation), and “appealing to look at”. In contrast, when products were presented under the informed condition, consumers chose them primarily based on their attributes as described in the provided information, using descriptors such as “healthy”, “no nitrites”, and “environmentally friendly”. Regarding the second factor, which explained 14.45% of the total variation, the terms provided by consumers did not strongly differentiate the products under the blind condition. However, in the informed condition, the plant-based alternative was positioned on the positive direction of Factor 2, and it was associated with both environmental and health considerations. The conventional and nitrite-free sausages were chosen (or not chosen) primarily based on health considerations.

Table 3 Consumer preference in Ireland (n = 30) between three sausages (conventional, nitrite-free, and plant-based) before and after the provision of health risk (for the conventional product),

377 health benefit (for the nitrite-free product), and health plus environmental benefit (for the plant-
378 based alternative) information, based on their appearance.

	Blind		Info	
Products	n	%	n	%
Conventional	23	76.7	13	43.3
Nitrite-free	1	3.3	6	20.0
Plant-based	6	20.0	11	36.7
Total	30	100	30	100

379

380 SUGGESTED POSITION FOR FIGURE 3

381 3.2 Consumer choice and visual attention in Finland

382 3.2.1 Visual attention

383 Product differences appeared to influence consumer visual attention in Finland during the blind
384 condition, as shown in Table 4. Compared to the nitrite-free sausage, the plant-based alternative
385 had significantly more dwells with fixations as well as revisit count, measured both as fixations
386 and as gaze. The conventional product showed no significant differences compared to the other
387 sausages. After consumers received product-related information, a similar pattern was observed,
388 but only for dwells with fixations. Regarding the provided text, the text referring to the plant-based
389 alternative had significantly more dwells with fixations and revisit count (measured only with
390 fixations) compared to the text referring to the nitrite-free product. Last, the text referring to the
391 conventional product had the highest last dwell duration, significantly higher than that of the plant-
392 based alternative but not significantly different from the nitrite-free product.

393 **Table 4** Results for eye-tracking measures, obtained by a mobile eye-tracker, following 2-way
394 ANOVA with areas-of-interest (AOI) (conventional, nitrite-free, and plant based) as fixed factor,
395 and Consumer as random effect. Within response variables, explained % of type III sum of square.
396 Model goodness-of-fit indicated by R2 and post-hoc results for AOI effects performed using
397 Tuckey post hoc tests (within rows, AOI with the same letter are not significantly different at the

398 5 % level of significance; alphabetical ordering of letters used to indicate larger values for 'A' than
399 'B').

Measure	Goodness-of-fit (R2)	Variance (%) AOI	Variance (%) Consumer	AOI		
				Conventional	Nitrite-free	Plant-based
Products during blind condition						
Duration of average fixation	0.651***	1.9	98.1***			
Dwell time (fixation, %)	0.265					
Dwell time (fixation, ms)	0.245					
Dwell time (gaze, %)	0.338					
Dwell time (gaze, ms)	0.230					
Duration of average saccade	0.611***	0.1	99.9***			
Dwells with fixations	0.539**	9.3*	90.7**	AB	B	A
Dwells with saccades	0.561**	4.8	95.2**			
First dwell duration	0.562**	4.5	95.5**			
First fixation duration	0.411					
Fixation count	0.615***	5.0	95.0***			
Last dwell duration	0.412					
Last fixation duration	0.378					
Revisit count (fixation dwells)	0.539**	9.3*	90.7**	AB	B	A
Revisit count (gaze dwells)	0.590***	7.4*	92.6***	AB	B	A
Saccade count	0.641***	1.9	98.1			
Products during informed condition						
Duration of average fixation	0.733***	0.2	99.8***			
Dwell time (fixation, %)	0.650***	2.4	97.6***			
Dwell time (fixation, ms)	0.474*	9.9	90.1			
Dwell time (gaze, %)	0.318					
Dwell time (gaze, ms)	0.471*	11.5*	88.5*	AB	B	A
Duration of average saccade	0.363					

Dwells with fixations	0.675***	1.2	98.8***			
Dwells with saccades	0.685***	2.2	97.8***			
First dwell duration	0.526**	1.2	98.8**			
First fixation duration	0.541**	0.2	99.8**			
Fixation count	0.692***	1.6	98.4***			
Last dwell duration	0.492*	9.5	90.5			
Last fixation duration	0.436					
Revisit count (fixation dwells)	0.675***	0.2	98.8***			
Revisit count (gaze dwells)	0.696***	1.0	99.0***			
Saccade count	0.654***	1.4	98.6***			
Text during informed condition						
Duration of average fixation	0.830***	0.0	100.0***			
Dwell time (fixation, %)	0.328					
Dwell time (fixation, ms)	0.467*	2.6	97.4*			
Dwell time (gaze, %)	0.618***	4.8	95.2***			
Dwell time (gaze, ms)	0.480*	2.3	97.7*			
Duration of average saccade	0.636***	1.7	98.3***			
Dwells with fixations	0.647***	5.2*	94.8***	AB	B	A
Dwells with saccades	0.695***	3.0	97.0***			
First dwell duration	0.625***	0.0	100.0***			
First fixation duration	0.335					
Fixation count	0.721***	0.6	99.4***			
Last dwell duration	0.698***	4.9*	95.1***	A	AB	B
Last fixation duration	0.300					
Revisit count (fixation dwells)	0.647***	5.2*	94.8***	AB	B	A
Revisit count (gaze dwells)	0.683***	1.7	98.3***			
Saccade count	0.691***	0.3	99.7***			

Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

3.2.2 Product choice and Flash Profile before and after the provision of information

Similarly to Ireland, the highest percentage (50%) of consumers in Finland chose the conventional product during the blind condition, though to a lesser extent than in Ireland (Table 5). This was followed by the plant-based alternative (36.1%), while the nitrite-free product was the least preferred (13.9%). However, after consumers were informed about the risks and benefits associated with the three products, the largest proportion (52.8%) chose the plant-based alternative. The percentage of consumers choosing the conventional product dropped to 30.6%, while only one consumer changed their preference in favour of the nitrite-free product.

As shown in Fig. 4, and similarly to the results from Ireland, the first factor (explaining 67.56% of the total variation) in the CA plot, based on the terms provided by consumers to express their preferences, separated the products according to whether the terms referred to appearance or to health and environmental considerations. This suggests that, after receiving information, consumers primarily based their choices on the provided details rather than the actual appearance of the sausages. In Finland, the second factor (accounting for 12.96% of the total variation) separated the conventional product from the nitrite-free and plant-based products in both conditions. The conventional product was associated with attributes highlighting “discoloration”, “wrinkles”, and “deformation”, whereas the nitrite-free and plant-based products were linked to higher “consistency”, “uniform shape”, “colour”, and overall “quality”.

Table 5 Consumer preference in Finland (n = 36) between three sausages (conventional, nitrite-free, and plant-based) before and after the provision of health risk (for the conventional product), health benefit (for the nitrite-free product), and health plus environmental benefit (for the plant-based alternative) information, based on their appearance.

	Blind	Info

Products	n	%	n	%
Conventional	18	50.0	11	30.6
Nitrite-free	5	13.9	6	16.7
Plant-based	13	36.1	19	52.8
Total	36	100	36	100

SUGGESTED POSITION FOR FIGURE 4

3.3 Differences in visual attention between Ireland and Finland

Table 5 Results for eye-tracking measures, obtained by a mobile eye-tracker, following 3-way ANOVA with Country (Ireland and Finland), area of interest (AOI) (conventional, nitrite-free, and plant-based), and Condition (blind and informed) as fixed factors. Within response variables, explained % of type III sum of square. Model goodness-of-fit indicated by R2 and post-hoc results for AOI effects performed using Tuckey post hoc tests (within rows, countries with different letter are significantly different at the 5 % level of significance; alphabetical ordering of letters used to indicate larger values for 'A' than 'B').

Significance levels: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Measure	Goodness-of-fit (R^2)	Variance (%) Country	Variance (%) AOI	Variance (%) Condition	Country	
					Ireland	Finland
Duration of average fixation	0.031*	0.0	72.4*	27.6**		
Dwell time (fixation, %)	0.482***	1.2**	45.2***	53.6***	B	A
Dwell time (fixation, ms)	0.025					
Dwell time (gaze, %)	0.034**	5.8	87.9**	6.2		
Dwell time (gaze, ms)	0.026*	0.1	98.4*	1.50		
Duration of average saccade	0.037**	71.0***	4.9	24.1*	A	B
Dwells with fixations	0.135***	81.5***	10.6**	7.9*	A	B
Dwells with saccades	0.098***	84.4***	9.0	6.6*	A	B
First dwell duration	0.218***	6.4**	92.8***	0.8	B	A
First fixation duration	0.012					
Fixation count	0.513***	0.1	98.4***	1.4**		
Last dwell duration	0.201***	8.5*	91.2***	0.3	B	A
Last fixation duration	0.014					
Revisit count (fixation dwells)	0.135***	81.5***	10.6**	7.9*	A	B
Revisit count (gaze dwells)	0.109***	81.6***	10.4	8.0*	A	B
Saccade count	0.484***	0.0	99.3***	0.7		

As can be seen in Table 5, significant differences in visual attention were observed between Ireland and Finland. Consumers in Ireland exhibited higher values for average saccade duration, dwells with fixations, dwells with saccades, and revisit count (measured as both fixation and gaze dwells). In contrast, consumers in Finland had higher values for dwell time (measured as fixation percentage), first dwell duration, and last dwell duration.

3.4 Relationship between product choice and visual attention

The results of a logistic regression, using product preference as the response variable and eye-tracking measures as explanatory variables, and using the results of both countries are illustrated in Fig. 5. Dwell time, measured through fixations and expressed as a percentage, was the only measure found to be significant in predicting product choice. In contrast, several other measures, with dwells with fixations showing the highest value, presented negative coefficients, indicating a negative prediction of product preference; however, none of these reached a significant level.

SUGGESTED POSITION FOR FIGURE 5

4. Discussion

The visual attention and choice of three sausages (conventional, nitrite-free, and plant-based) under blind and informed conditions in Ireland and Finland were studied. Differences in visual attention emerged both between countries and across products, while information provision influenced consumer attention and final choices.

4.1. Cultural differences

Despite the basic assumptions about human cognition and perception, that information-processing is fixed and universal, there is evidence that cognitive and perceptual processes are constructed in

part through participation in cultural practices (Nisbett & Miyamoto, 2005). A given stimulus often triggers quite different processes in one culture than in another (Nisbett et al., 2001), as participating in different social practices leads to both chronic and temporary shifts in perception (Nisbett & Miyamoto, 2005).

Linking attention to information processing, as mentioned above, while automatic processing is effortless, unconscious, and capacity-free, controlled processing, is effortful, attention-dependent, and limited in capacity (Norman & Shallice, 1986; Schneider & Shiffrin, 1977). While there are going to be references to other frameworks of cognitive processes, to better understand cross-cultural differences, those will be attempted to be structure around these two concepts (automatic vs. controlled processing) to link them with attention and to make sense out of them. In this study, consumer visual attention differed between the countries, with consumers in Ireland navigating between products, exhibiting more dwells with fixations and revisit counts, whereas in Finland, they tended to focus on each product (or text) for longer periods, as indicated by high dwell time as well as first and last fixation durations. Rational and intuitive cognitive processing systems exist in parallel in all people (Epstein, 1994). The intuitive system is, among other things, pleasure-pain oriented, with behaviour mediated by past experiences and oriented toward immediate action. On the other hand, the rational system is characterized by slower processing, reason orientation, logical connections, and behaviour mediated by the conscious appraisal of events, while it is experienced actively and consciously (Epstein, 1994). Consumers who predominantly rely on analytical-rational thinking engage in greater information search and a more thoughtful analysis of nutritional information when making their choices than those who rely on intuitive-experiential thinking (Ares et al., 2014). Linking this to attention, consumers who rely on rational thinking emphasize controlled information processing, which is closely associated with attention and

requires deliberate focus and effort. The differences observed between consumers in Finland and Ireland suggest that, even when presented with the same information, Finnish consumers tend to base their decisions on controlled, analytical processing, while Irish consumers may rely more on automatic, intuitive processing. Further research is needed, though, to explore how these visual attention patterns relate to rational and intuitive processes during decision-making.

As individuals always rely on both automatic and controlled processing when encountering visual cues, general cognitive processes, linked not only to responses to specific triggers but also to broader conceptualizations of information, are important. For example, "holistic" and "analytic" information processing differ in focus: holistic processing involves attending to the entire field and assigning causality across it, whereas analytic processing focuses primarily on specific objects and the categories to which they belong (Nisbett et al., 2001; B. Zhang & Seo, 2015). . The results presented here could open avenues for exploring similar differences in cognitive processes even within the same continent. A latent approach should be used, first to uncover general patterns in decision-making and then to examine responses to specific stimuli exploring the automatic and controlled processing.

Most consumers in Ireland insisted on their preference for the conventional product, despite its potential risk to their health. Beyond the distinction between automatic and controlled processing, individuals' decision-making can also be influenced by how they process information in relation to its broader context. This can link to differences around the field dependence-independence construct, which represents two opposite ways of processing information (Guisande, Paramo, Tinajero, & Almeida, 2007; Riding & Cheema, 1991; L.-f. Zhang, 2004). In a study on yogurt labels by Mawad et al. (2015), field-dependent consumers tended to engage in less thoughtful information processing than field-independent consumers and made fewer fixations on traditional

nutritional information. Moreover, cognitive style significantly affected the relative importance of fat and sugar content in consumer choices and modulated the influence of the traffic light system. Field-dependent consumers placed less importance on the nutritional composition of the yogurts than field-independent consumers when selecting their preferred label (Mawad, Trias, Gimenez, Maiche, & Ares, 2015). This could explain why most consumers in Ireland, regardless of the health risk associated with the conventional product, chose it, even after the provision of information. However, since no scale was used to evaluate the level of field-(in)dependence among consumers in the two countries, no robust conclusions can be drawn, and further research is warranted to address these questions.

Both in the blind and informed conditions, consumers in Finland chose the plant-based product to a greater extent than consumers in Ireland. This might be explained by sausage consumption forecasts. While consumption is expected to increase in Ireland, it is projected to decline in Finland. Thus, Finnish consumers may be more familiar with the appearance of plant-based products, making them more likely to choose them even without the information (ReportLinker, 2024; statista, 2025). Moreover, the fact that a higher portion of consumers in Finland (52.8%) chose the plant-based product compared to Ireland (36.7%) during the informed condition could be explained by the low food neophobia in Finland. A recent study found that consumers in Finland had lower food neophobia and meat attachment, as well as higher sustainability knowledge, compared to consumers in the Netherlands (van Dijk et al., 2023). Additionally, another study found that children in Finland were the least neophobic compared to those in Italy, Spain, Sweden, and the UK (Proserpio et al., 2020). On the other hand, consumers in Ireland were significantly more reluctant than those in France when it came to insect consumption (Ranga, Vishnumurthy, &

524 Dermiki, 2024). However, to the authors' knowledge there is no literature comparing food
525 neophobia between Ireland and Finland.

526 4.2. Information provision, visual attention, and product choice

527 As previously mentioned, attention is crucial for initiating actions but less so for executing them
528 (Norman & Shallice, 1986; Schneider & Shiffrin, 1977). In this study, decisions made during the
529 blind conditions could rely mostly on automatic processing, while those made during the informed
530 condition could depend on controlled processing. It has been suggested that with enough practice,
531 we can become better at noticing important details automatically, making it easier to divide our
532 attention (Shiffrin & Schneider, 1977). Thus, more effort should be directed toward familiarizing
533 consumers with food-related information so that informed behaviours become easier and
534 automatic, leading to healthier and more sustainable choices.

535 Generally, it has been suggested that consumers tend to spend more time looking at labels for foods
536 they purchase compared with foods they decide not to purchase (Graham & Jeffery, 2012).
537 Although presented last in the results section, the capacity of dwell time, measured as fixation
538 percentage, to predict choice is an important finding that helps the reader interpret the remaining
539 results. In general, eye-trackers provide information on location (where consumers look), duration
540 (how long they look), and movement (the path their eyes follow) during a task. It has been argued,
541 though, that information processing mainly occurs during fixations (Van Loo, Grebitus, Nayga,
542 Verbeke, & Roosen, 2018), which may explain why dwell time measured as fixation (%), and not
543 as gaze (%), was the only predictor of choice. Other measures focusing on saccades may play a
544 secondary role in information processing, which could in turn influence measures that combine
545 fixations and saccades. Previous research on various food products similarly found strong

correlations between choice and fixation counts, total dwell duration, and dwell counts. No correlations were reported for first fixation, time to first fixation, or first fixation duration, though (Danner et al., 2016). Comparable patterns for first and last fixation were also observed in the present study.

It has been suggested that in both a lab setting and a buffet arrangement, visual attention could be a key predictor for the selection of savoury food (S. Bialkova et al., 2014; E. Wang, Cakmak, & Peng, 2018). However, the literature on the topic is contradictory with other researchers suggesting that food preferences do not influence automatic visual attention (Fenko et al., 2018; Kosuke Motoki, Saito, Nouchi, Kawashima, & Sugiura, 2018). In this study, although, during the informed condition, consumers in Ireland had significantly more dwells on the nitrite-free product information, and even though its preference increased, it remained the least preferred option. Other studies reported similar findings. For example, in a study conducted in Spain, exploring the use of eye-tracking methods to investigate what underlies perceptions of the healthiness of different fish products, the first fixation was found not to be an important variable in explaining responses (Mitterer-Daltoé, Queiroz, Fiszman, & Varela, 2014). Similarly, in this study, first fixation was not a predictor of food choice. Additionally, other strategies that try to attract consumer attention in order to change food choice behaviours, like “Dish of the Day” labelling or altering the sequence of main dishes were reported ineffective in encouraging Finnish consumers to replace red meat with a fava bean-based alternatives (Nykanen, Hoppu, Loyttyniemi, & Sandell, 2022).

In contrast, in a study testing several nutritional claims on yogurt packages, consumers who visually attended more to certain nutritional claims were more likely to choose the yogurt that carried them (Ballco, de-Magistris, & Caputo, 2019). This could be more aligned with the results from Finland, where, during the informed condition, the information related to the plant-based

product had the most dwells with fixations and revisit counts (fixation dwells), followed by the conventional sample. The same order appeared in product preference.

The results of different studies employing eye-tracking technology and information are controversial. It has been reported that information about food taste, an intrinsic product characteristic, appears to capture automatic visual attention more than health-related information (Kosuke Motoki et al., 2018). However, another study suggested that, between an intrinsic product characteristic (fresh) and an extrinsic one (local) added to a product menu, there was a relationship between fixation counts on the extrinsic cue word and subsequent choices, but no relationship between visual attention to the intrinsic cue word fresh and subsequent menu choice (Conoly & Lee, 2023). Similarly, among several items (names, prices, images, country of origin, etc.), the nutritional table, which expresses intrinsic product characteristics, was the least frequently checked in a menu (Min, Lee, & Chung, 2024).

It could be considered that consumers in each country, were more familiar with the conventional products rather than the healthier alternatives, Thus, the fact that most consumers chose the conventional products during the blind condition could be explained by their familiarity with them. However, while it has been suggested that human vision is biased toward familiar objects (S. Lee, Kim, Kim, Kim, & Yoo, 2010), and even though it was initially hypothesized that consumers, being more familiar with the conventional product, would also fixate on it more, this was not the case. Additionally, although the presence of food risk information for the conventional sausage led many people to change their product preference, the conventional product (associated with health risk) remained the most preferred by consumers in Ireland and the second most chosen by those in Finland. While this partially aligns with previous research suggesting that nutritional warnings on labels can significantly discourage consumer choices (Tortora et al., 2019), it contradicts the claim

592 that such warnings are effective in attracting consumer attention. In this study, health risk
593 information did not capture consumer attention, neither in the text nor in the products during the
594 informed condition. Additionally, in both Ireland and Finland, a large portion of consumers shifted
595 their preference toward the plant-based alternative during the informed condition. In contrast, a
596 study with Gen Z consumers, who were presented with different products with or without an eco-
597 label, a local label, or a bio-label, found that while they did notice the labels, these had little to no
598 effect on their behaviour (Fiala, Toufarová, Mokrý, & Souček, 2016).

599 When the information was provided, consumers spent more time on the information rather than on
600 the products themselves and, as observed from the Flash Profile, based their decisions on the
601 information. Similarly, it has been reported that health-related factors played a more significant
602 role in consumer decision-making when studying food selection in a vending machine. Consumers
603 demonstrated a higher level of visual engagement and engaged in a more analytical decision-
604 making process when considering healthier snack alternatives (Escandon-Barbosa et al., 2023).
605 Similarly, it has been suggested that in small-scale (takeaway) restaurants, the upper board, where
606 the menu is usually placed, receives a higher level of attention compared to the food display (Jeon,
607 Cho, & Oh, 2021).

608 Additionally, the significant shift toward the plant-based sausage can be interpreted through the
609 lens of the Inner Treasure Framework we recently introduced (Melios, Bolton, et al., 2025b).
610 According to this framework, the "inner treasure" of a food product, such as its health or
611 environmental benefits, serves as a justification of a "higher goal" to the consumers rather than the
612 main driver of desirability. In other words, these benefits may validate the consumption of a
613 product but cannot compensate for a lack of sensory appeal. For a food product to be truly
614 desirable, it must first deliver pleasure. In this study, the plant-based sausage was already well-

liked in the blind condition, selected by 5 consumers in Ireland and 13 in Finland. After the provision of information, these numbers increased to 11 and 19 respectively, with the product becoming the top choice in Finland. In contrast, the nitrite-free sausage, which was not preferred in the blind condition, also failed to gain preference after health benefit information was provided.

4.3. Limitations and future considerations

Consumers with different goals within the sample of this study may have paid attention to different aspects, highlighting the importance of larger sample sizes and consumer clustering in future food choice studies. Different consumer segments have different criteria when purchasing food, as they tend to prioritize stimuli with higher (individual) goal relevance (Svetlana Bialkova et al., 2020). Although labelling cues promote attention, in the absence of personal motivational relevance, information tends to be discounted from the evaluation process (Tanner, McCarthy, & O'Reilly, 2019).

Moreover, while the information provided in this study was long and informative, other factors should also be taken into consideration when providing the information. In particular, the manner in which information is presented can significantly affect its effectiveness (Botinestean, Melios, & Crofton, 2025), while the information alone is not always sufficient to change consumer decisions (Helmert, Symmank, Pannasch, & Rohm, 2017). Although health claims might be processed minimally by consumers, graphic design could play a major role in associating the product with healthiness (Oliveira et al., 2016). Salience, size, and distance (so-called bottom-up factors), as well as the colour, can increase the likelihood that consumers fixate on a food item and most likely influence their purchase decision (Ruppenthal, 2023)(Helmert et al., 2017). The interplay between colour and emotions could play a significant role as well. After positive emotional stimuli,

consumers fixate longer on light colours to express their positive emotions. On the other hand, after negative emotional stimuli, consumers express their negative emotions by focusing on dark colours (Ismael & Ploeger, 2019). Other considerations should include the questions used alongside the eye-tracking task (Vu, Tu, & Duerrschmid, 2016).

Last but not least, to collecting and analysing the data, the use of wearable eye-tracking systems presents significant challenges. The free movement of participants can weaken the predictive power of gaze behaviour, as these devices are typically calibrated for a single viewing distance (Fenko et al., 2018). Additionally, as previously highlighted, annotating fixations to AOIs in a real environment is an exceedingly complex task (Meißner, Pfeiffer, Pfeiffer, & Oppewal, 2019; K. Motoki et al., 2021). Furthermore, those AOIs are usually manually defined by researchers; thus, studies using wearable eye-trackers must ensure that the setting facilitates reliable data pre-processing (Puurtinen et al., 2021). These limitations, together with the difficulty of recruiting consumers who will come to the premises twice when conducting more than one conditions make it difficult to include a large sample of participants. While the sample in each country exceeds the suggested minimum of 30 consumers, required to achieve approximately 80% statistical power, the minimum recommended for a typical study (Van Voorhis & Morgan, 2007), larger sample sizes would be needed to generalize the results to the broader populations.

As previously highlighted, this study was highly demanding, involving two countries and two experimental conditions, with six weeks of intensive data collection and the extraction and analysis of 132 eye-tracking videos. Additionally, data collection, extraction, and analysis are time- and resource-intensive, requiring expensive equipment, long-term use of dedicated space, and substantial labour. While this demonstrates the practicability limitations of wearable eye-trackers in sensory and consumer science, and eating behaviour research, it highlights opportunities for

collaborative studies to achieve broader generalizability. Sensory and consumer science can benefit from more complex designs, employing real-world stimuli, that not only generate more data but also higher-quality data. Such designs allow the inclusion of sensory elements, which could clearer demonstrate the distinction between sensory and consumer science and ordinary consumer science and its competitive advantage in addressing food choice.

Another limitation of this study is the predominantly young and educated profile of the participants, which may further limit generalizability. However, it should be noted that the primary goal was to obtain comparable samples between countries rather than fully representative samples within each country. Finally, the effort to ensure cultural relevance of the sausage samples may have reduced their comparability across countries.

5. Conclusion

The visual attention and choice of three sausages (conventional, nitrite-free, and plant-based) under blind and informed conditions in Ireland and Finland were studied. In both countries, most consumers in the blind condition chose the conventional product, followed by the plant-based alternative. In the informed condition, the conventional product remained the most preferred in Ireland, while the plant-based alternative became the most popular in Finland. However, these differences were only minimally captured in the consumer visual attention.

Although not all the eye-tracking measures reveal clear patterns linked to product choice, they provided important insights into how information provision drives attention, influencing food choices, and how this differs between countries/cultures. Several cognitive frameworks were explored to interpret these differences; however, as their use was speculative rather than a direct test of hypotheses, further research is needed to clarify these observations. The need for culture-

specific approaches in sensory and consumer science is emphasized. Additionally, although it is often argued that information alone cannot drive behavioural change, growing evidence suggests the opposite. This argument typically assumes that consumers do not follow rational processes in their decision-making. However, it overlooks the fact that information processing is not exclusively rational and can indirectly influence final choices by shaping unconscious perceptions.

The results presented here can motivate the food industry to develop new product formulations that benefit both consumers and society in terms of health and the environment, while also leveraging marketing and especially labelling strategies to create a competitive advantage. The demonstrated impact of information provision on food choice can further encourage transparency and support informed consumer decisions. Moreover, the results should be considered by regulators to develop policy frameworks and public health interventions that increase consumer food literacy and require the food industry to provide clear, easy-to-understand labelling that guides consumers toward healthier and more sustainable food choices.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process

During the preparation of this work the authors used ChatGPT only in order to improve readability and language. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication

Acknowledgements

This research was supported by the European union, under the COMFOCUS project (number: 101005259) and the Department of Agriculture, Food and Marine, Republic of Ireland, under the No-2-Nitrates (2021R426) project and did not receive any other grants from funding agencies in the commercial or not-for-profit sectors. We would like to thank the consumers for their time in participating in this study. We would also like to extend our appreciation to Anni Kerttula for her invaluable support in organizing the research visit and the trials at Flavoria.

CRediT Author Statement

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.foodqual.2025.105737.

Data availability

Data will be made available on request.

8. References

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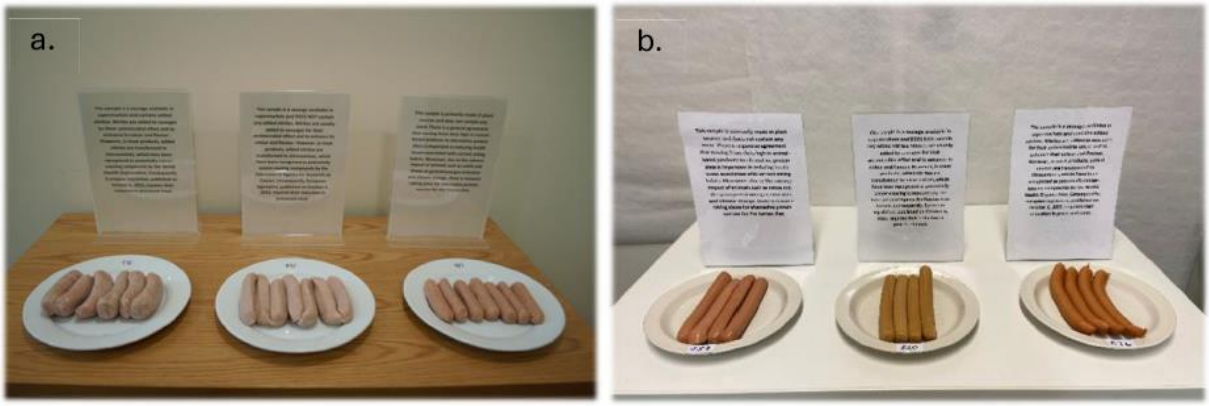

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958 Fig. 1. The sausages and setup used in (a) Ireland and (b) Finland for the eye-tracking study. The
959 images represent the informed condition; during the blind condition, the stands contained only
960 blank white A4 sheets. The type of each sausage in the figure is indicated under the picture.

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963 Fig. 2. Visual representation of the experimental procedure.

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Fig. 3. Correspondence analysis of consumer attributes (n = 30, Ireland) from Flash Profile, combined with product rankings for three sausages (conventional, nitrite-free, and plant-based in bold), assessed before (blind) and after (info) providing health risk, health benefit, and health plus environmental benefit information, respectively.

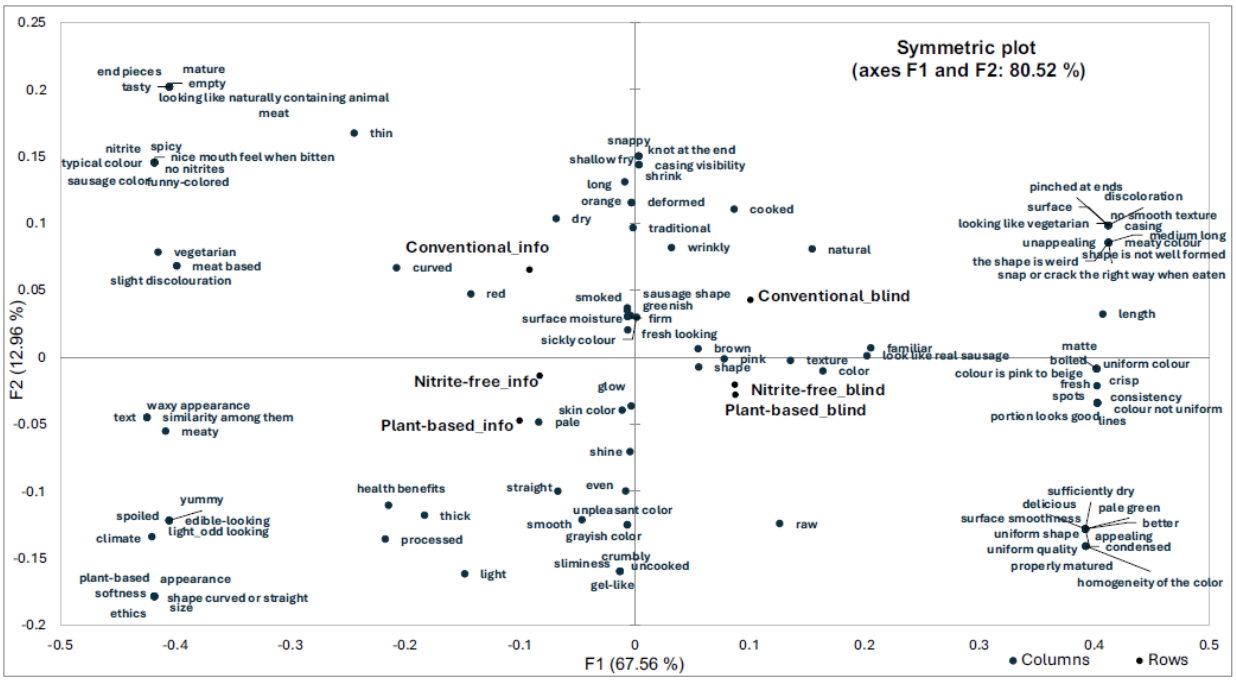
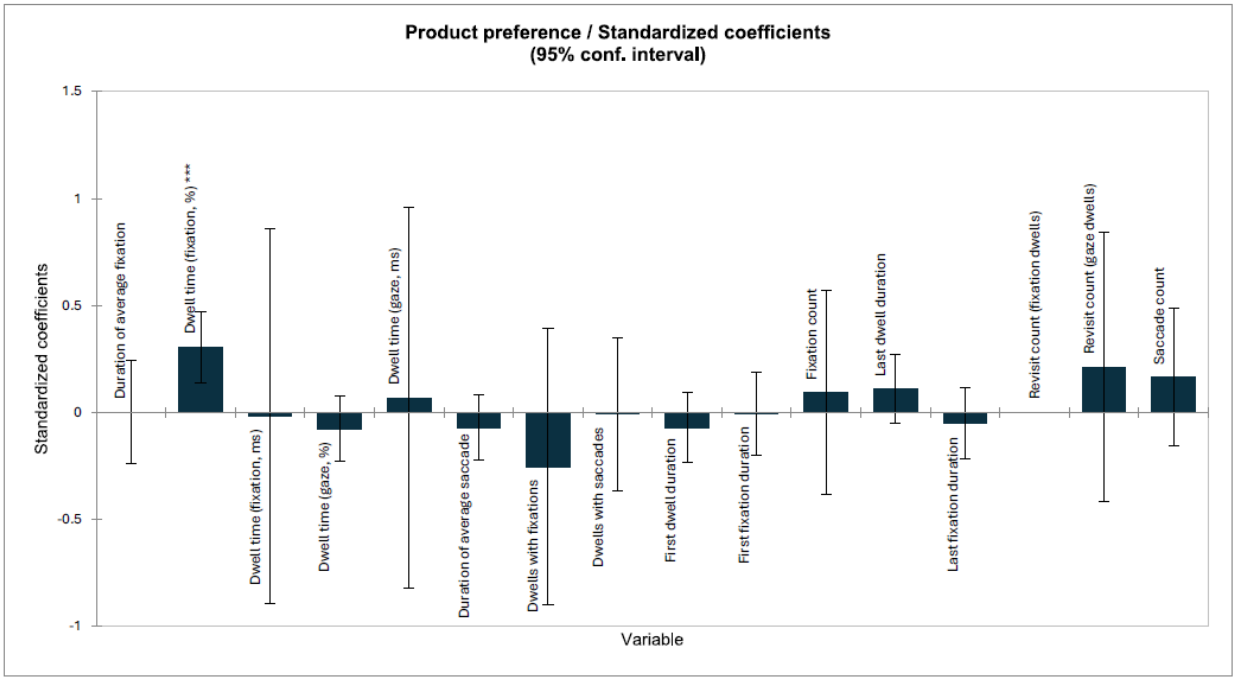


Fig. 4. Correspondence analysis of consumer attributes (n = 36, Finland) from Flash Profile, combined with product rankings for three sausages (conventional, nitrite-free, and plant-based in bold), assessed before (blind) and after (info) providing health risk, health benefit, and health plus environmental benefit information, respectively.



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978 Fig. 5. Logistic regression of product preference (response) on eye-tracking measures
979 (explanatory variables) for three sausages (conventional, nitrite-free, plantbased), tested under
980 blind and informed conditions in Ireland and Finland. Results shown as mean ± SE. *** p <
981 0.001.