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Bottom-up and top-down factors influencing consumer responses to food labels: a scoping review of eye-tracking studies

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Abstract

Eye-tracking technology has become vital for exploring consumers' preferences for food labels. This paper carried out a scoping literature review to comprehensively summarize the main findings in the food labelling research from 1999 to 2023. We selected 52 studies conducted using eye tracking for the analysis of consumers reactions to food labels. In particular, the review focuses on the role that bottom-up factors and top-down factors may have on consumers' visual attention. The results show that consumers' visual responses are influenced by both top-down and bottom-up factors but often rely on heuristics to reduce cognitive load. Simple formats like color-coded labels, labeling claims, or signs are generally preferred. Consumers tend to use these shortcuts particularly for health-oriented choices or due to time-constrains. The role of certification schemes and sustainability claims seem to be not fully considered in the reviewed research and may be worth further investigation.

Keywords: Visual attention, PRISMA, Eye tracking, Nutri score, Eco-labels, Food labels, Nutrition labels, Food labels, Traffic light labels

Introduction

Over the last few years, food labels on food packaging have become a key element in informing consumers, and the World Health Organization (WHO) recommends front-of-pack (FOP) nutrition labelling to provide dietary information. Visual attention to labels is considered an essential aspect, allowing consumers to understand labels (Song et al. 2021), and indeed, in a supermarket environment, consumers rely on food labels to receive information when they make a food decision (Verbeke 2005). On the other hand, the food industry uses information reported in the packaging to reduce information asymmetry between the producers and the consumers (Rousseau and Vranken 2013). However, the overabundance of food labels in supermarkets could prevent consumers from properly using the information reported on the food packaging (Grunert 2011; Verbeke 2005). Indeed, consumers selectively allocate attention only to some stimuli (Grunert 2011; Verbeke 2008). Consumers use visual attention instinctively to acquire information from their surroundings (Meyerding and Merz 2018). In this sense, visual attention is the starting point in consumers' decisions since ignored information cannot

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be part of the decision-making process (Van Loo et al. 2018). In the past, theories of consumer decision-making have considered attention to have little or no influence on consumers' buying process (Wedel and Pieters 2008). Recently, modern theories such as drift–diffusion models pointed out that visual attention has predictive validity, meaning that what consumers see helps them to reach a decision (Orquin and Mueller Loose 2013; Wedel and Pieters 2008). Traditionally, three methodologies have been applied to understand how consumers use food labels: qualitative studies (i.e., focus groups), experiments and cross-sectional surveys (Grunert and Wills 2007). The main drawback of the abovementioned methodologies is that individuals tend to over-report their use of food labels (Graham and Jeffery 2011; Grunert et al. 2010). Moreover, the self-report measure might not capture attention to food labels since consumers' decisions are not necessarily conscious and might lack awareness (Ares et al. 2014; Wedel et al. 2023).

Eye tracking technology has emerged as a suitable alternative for studying consumers' behaviour in the food area. This technology involves recording consumers' gazes during food selection, and its precision and technical nature make it a proper tool for exploring consumers' behaviour (Meyerding and Merz 2018).

The relevance of food labels has been related to their capacity to attract consumers' visual attention (Grunert and Wills 2007). Over the last few years, many studies have focused on analyzing the difference in visual attention and consumers' preferences towards food labels using eye-tracking technology. These studies explore which factors are more effective in increasing consumers' visual attention to food labels. Indeed, two kinds of processes could guide consumers' visual attention: bottom-up attention and top-down attention (Orquin and Mueller Loose 2013). Bottom-up attention is an automatic type of attention capture that depends on the characteristics of the stimuli itself (e.g., surface size, location) (Corbetta and Shulman 2002; Theeuwes 2010). Bottom-up attention plays a crucial role, primarily when consumers must localize a specific product in the supermarket (Wedel et al. 2023). Consumers' first fixation is captured by what stands out in the environment due to a single visual design feature (Wedel and Pieters 2008). For instance, large food labels may capture consumers' attention first than a smaller version of the same food label (Proi et al. 2023). Top-down attention is relative to the consumers' characteristics (e.g. expectation, goals) (Pieters and Wedel 2007; Wedel and Pieters 2006). Indeed, consumers could enter the supermarket already motivated to look for specific information (e.g. "I will look for sustainable information") (Chun et al. 2001). In the case of top-down attention, consumers voluntarily decide where to put visual attention.

Even though food labels are considered an effective tool for assisting consumers in making food decisions, it may be difficult for some people to pay attention to them visually due to the sheer number of labels and their unique qualities (such as the quantity of information, colour, and shape) (Nohlen et al. 2020). Moreover, different features of the food labels are associated with different cognitive mechanisms; for instance, people process the colours and the numbers differently, which could lead to different ways of understanding and behaving (Muller and Prevost 2016). These considerations raise the question: which factors influence consumers' visual attention? Given the plethora of published papers regarding visual attention to food labels, an updated literature review may be helpful to summarize the field's latest and most

important findings. Previous literature reviews in this field have focused on visual attention to nutritional labelling (Graham et al. 2012; Ma and Zhuang 2021) or changing consumers' behaviours according to colour-coded labels (Song et al. 2021). However, food labels include other labelling schemes related to the production process, such as the so-called certification scheme or ecolabels (Bush et al. 2013; Sirieix et al. 2012). Ecolabels helps consumers with environmental concerns easily find these food products thanks to certification schemes covering various production techniques, from organic to sustainable food production (Bush et al. 2013). Consumers are increasingly interested in all sustainability aspects of food production (Maesano et al. 2020), and many labelling programs have recently emerged that enlighten consumers about the production process (Songa et al. 2019).

This review differs in various ways from earlier literature reviews. Firstly, this review considers only studies that use eye-tracking methods to analyze consumers' responses to food labels. Secondly, following Motoki et al. (2021), this scoping review classifies studies about the process of development of consumers' attention to food labels from two alternative perspectives: top-down (i.e. based on prior knowledge and expectations of consumers) and bottom-up (i.e. on stimulation of attention through labels' features). We intend to contribute to the research in this field by improving the review from Motoki et al. (2021) using the systematic method for scoping reviews (Arksey and O'Malley 2005; Peterson et al. 2017) and following the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) extension for scoping reviews (Tricco et al. 2018) approach. This scoping review answers the following research questions: how do top-down factors influence consumers' visual attention and preferences for food labels? How do bottom-up factors influence consumers' visual attention and preferences for food labels? The answers to these research questions allow us to discuss the primary outcomes of scientific literature and to identify potential gaps related to the usage of food labels.

Materials and methods

Due to the complexity and variety of the concepts and items considered in the visual analysis of labels for food products, we choose a scoping review approach to summarize the findings of studies focused on the role of bottom-up or top-down factors in the food labels area. While a systematic literature review should be preferred in case of a clearly defined research question that requires a detailed synthesis, aiming at a quantitative summary of existing evidence, a scoping review is preferred to systematic reviews when more flexibility is required in selecting and interpreting relevant studies. Scoping reviews aim to provide a focused synthesis of a broad conceptual framework and identify possible gaps in the existing literature (Arskey and O'Malley 2005; Peterson et al. 2016). Scoping reviews are explorative and support mapping the key concepts, theories, and sources of evidence on a broad topic where the literature is diverse or fragmented. Scoping reviews may be effective, particularly in fields that are relatively new or rapidly evolving, with a need to identify the range of available evidence and research, or when the topic is interdisciplinary, requiring an overview of diverse perspectives and methodologies rather than a synthesis of specific research questions.

Our study is based on the extended PRISMA guidelines for scoping reviews (Tricco et al. 2018), which provide a scheme for identifying and screening potentially relevant research documents and criteria for eligibility for the final selection.

Regarding identification criteria, we only considered studies concerning consumers' visual attention and preferences towards food labels determined by bottom-up or top-down attention. No time limit had been imposed, and only scientific papers in English had been included. Only studies using eye-tracking techniques were considered for all countries and food products. We focused on food labelling, including nutritional labelling, eco-labelling, and sustainability labelling. Scopus and Web of Science databases were used for the search process in May 2023. The searching procedure was based on the following search rules: eye AND track* AND eco-labels; eye AND track* AND nutrition* AND label*; eye AND track* AND sustainab* AND label*; eye AND track* AND visual attention AND nutrition* AND label*; eye AND track* AND visual AND attention AND sustainab* AND label*; eye AND track* AND visual AND behaviour AND food AND label*.

The screening of eligible studies was carried out independently by two reviewers. Different evaluations about the opportunity of excluding the studies in the different screening stages were discussed after individual selection. The unanimity of both reviewers was required for the final exclusion decisions. Titles, abstracts and keywords of eligible studies were screened against the following exclusion criteria: studies in which the subject under investigation was not the consumers' response to food labels; studies focused on the perception of food labels among farmers and producers; studies focused on the effect of menu labelling on consumers with experiments conducted in fast-food or restaurants; studies not focused on bottom-up/top-down processes in the case of visual attention to food labels.

From the 559 studies initially identified in the database for the scoping review, we obtained a final selection of 50 studies. Two additional studies were included based on the bibliographies of the studies already selected. As a result, 52 papers were ultimately reviewed. The selection process is shown in Fig. 1.

Results of the scoping review

The results of this scoping review are analyzed based on two research questions: how do top-down factors influence consumers' attention? How do bottom-up factors influence consumers' attention? A summary of the top-down and bottom-up factors identified in the scoping review is shown in Tables 1 and 2, while details of the specific studies are reported in Tables 3 and 4.

Key characteristics of the studies on top-down factors

The analysis of top-down factors (Table 1) in consumers' attention reveals distinct patterns in research. The most explored top-down factors were motivation and attitude. Meanwhile, the role of emotions in visual attention has received little attention. Most research focuses on FOP labels, nutritional information, brand and label background, and sustainability or process-related claims. Studies are geographically diverse but concentrated in South America, Europe, North America (USA), and Asia (Japan). This geographical concentration may be due to a consolidated use of eye-tracking research and

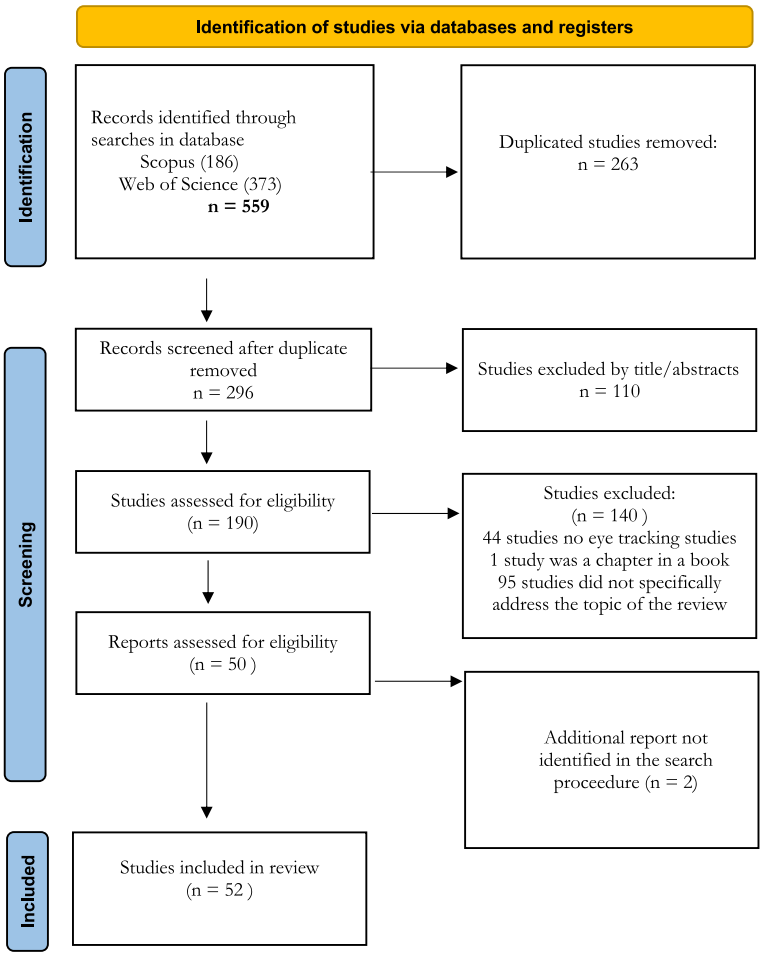


Fig. 1 Selection process of the studies considered for the analysis

more substantial funding for cognitive and consumer behaviour research (Wilkinson and Mitchell 2014).

In terms of methodology, most studies adopt experimental designs using choice tasks and visual attention measures, often employing remote eye-tracking methodologies, with mobile eye-tracking being less frequently used. The primary products examined include dairy, cereals, grain-based products, and meat and protein-based products (chicken and meat). These product categories are often used as stimuli in experimental tasks, providing a familiar and relevant context for consumers' decision-making.

Fixation count, total fixation duration (TFD), gaze duration, and dwell time (DT) are frequently used for visual attention measurements. These metrics provide valuable insights into how long and how often consumers visually engage with specific product elements or labelling features.

Key characteristics of the studies on bottom-up factors

The analysis of bottom-up factors (Table 2) in consumers' visual attention shows clear patterns in the research. Label format emerges as the most studied factor, while visual saliency and size are the least studied. Regarding label types, most studies focus on FOP

Table 1 Top-down factors identified and key characteristics of the studies (relative frequencies—%)

Top-down factor	Authors	Country	Products	Stimuli	Tasks	Eye-tracking measures	Methods
Thinking Style: 10%	Ares et al. (2014); Mawad et al. (2015)	South America (Uruguay): 100%	Dairy: 100%	FOP Labels: 40% Brand & Label Background: 30% Nutritional Information: 30%	Choice Task:100%	AOIs:30% FC:40% TFD:30%	Remote eye-tracking: 100%
Emotions: 5%	Motoki et al. (2019)	Asia (Japan): 100%	Hedonic Foods (Chips, Chocolate): 50% Healthy Foods (Yogurt, Salad): 50%	Hedonic vs. Healthy Food Images: 50% Nutritional Information: 30% Colour-Coded Labels: 20%	Free viewing task: 100%	TFD: 60% FC: 40%	Remote eye-tracking: 100%
Motivation: 35%	Bialkova et al. (2020); Bialkova et al. (2014); Fenko et al. (2018); Tanner et al. (2019); Turner et al. (2014); Van Herpen and van Trijp (2011); Visschers et al. (2010)	Europe (Germany, Netherlands, Switzerland, Ireland, Turkey, Denmark, Poland): 70% North America: 20% Other (mixed European settings): 10%	Dairy: 20% Cereals & Grain-based Products: 50% Meat & Protein-based Products: 10% General Food Packaging: 20%	FOP Labels: 35% Nutritional Information: (40%) Product Images (e.g., shelf displays, packaging): (25%)	Choice Tasks: 60% Simulated Shopping Tasks: 20% Free viewing task: 10% Other (e.g., Open-ended evaluation): 10%	TFD: 26% FC: 23% NFs: 17% DT: 14% AOIs: 11% GD: 9%	Remote Eye-Tracking: 70% Mobile Eye-Tracking: 30%
Attitude: 30%	Gidlöf et al. (2021); Grebitus and Van Loo (2022); Oselinsky et al. (2021); Songa et al. (2019), Takahashi et al. (2018); Van Loo et al. (2015)	Europe (Sweden, Belgium, Denmark, Netherlands): 40% North America (USA): 50% Asia (Japan): 10%	Beverages: 20% Cereals & Grain-based Products: 20% Dried Fruits & Snacks: 10% General Packaged Food: 40% Dairy: 10%	Sustainability Labels: 40% GMO Labels: 30% Certification Logos: 30%	Choice Tasks: 70% Self-reported Evaluations (e.g., Emotional ratings, attitude surveys): 20% Free viewing task: 10%	TFD: 26% FC: 23% GD: 20% DT: 17% VC: 14%	Remote Eye-Tracking: 80% Mobile Eye-Tracking: 20%
Previous Knowledge & Label Understanding: 20%	Miller and Cassady (2012); Pennings et al. (2014); Samant and Seo (2016); Sørensen et al. (2012)	North America (USA): 60% Europe (Denmark, Belgium): 30% Asia (Japan): 10%	Cereals & Grain-based Products: 50% Meat & Protein-based Products: 20% General Food Packaging: 30%	FOP Labels:35% Nutrition Facts Panels: 40% Sustainability/Process-related Claims: 25%	Choice Tasks: 40% Free viewing task: 40% Educational Intervention: 20%	FC: 40% FS: 30% ADF: 20% AOIs: 10%	Remote eye-tracking: 100%

Legend (stimuli)—BOP, Back of packaging; FOP, Front of Packaging; FUF Facts Upon Front; GDA, Guided Daily Amount; GMO, Genetically Modified Organisms; NFP, Nutritional Facts Panel; TSL, Traffic light System

Legend (eye-tracking measures)—AFD, Average Fixation Duration; AOIs, Percentage of individuals who fixated their gaze on Area of interests; CFT, Complete Fixation Time; DT, Dwell Time; FA, Fixation Accuracy; FC, Fixation Count; FD, Fixation Duration; FL, Fixation Latency; Fs, General fixation occurrences; FF, Frequency of fixations; GD, Duration of gaze on an object; GF, Frequency of gazes; Label Viewing, Observation of labels; MFD, Mean Fixation Duration; Milliseconds of Visual Attention, Time spent visually attending an area; NFs, Number of Fixations; PD, Pupil Dilation; Saccades, Rapid eye movements between fixations; TFD, Total Fixation Duration; TVD, Total Viewing Duration; TTFFs, Time to First Fixations; TS, Time spent; VC, Visit Count

Table 2 Bottom-up factors identified and key characteristics of the studies (relative frequencies—%)

Bottom-up factors	Authors	Country	Products	Stimuli	Tasks	Eye-tracking measures	Methods
Label positioning: **15%**	Antúnez et al. (2013); Bartels et al. (2018); Bix et al. (2015); Graham and Jeffery (2011); Mansfield et al. (2020); Varela et al. (2014)	USA: **50%** South America (Uruguay):**25%** **Europe (**Switzerland)**:25%** Snack Foods**:30%** Other Products:**20%**	Cereals & Grain-based Products: **50%**	FOP Labels**: 50%** BOP Labels: **20%** NFP: **30%**	Choice Task:**40%** Visual Search Task:**30%** Free Viewing Task:**20%** Projective Mapping Task:**10%**	FD: **40%;** TTFF: **30%;** AOIs: **30%**	Remote Eye Tracking**: 70%** Mobile Eye-Tracking**: 30%**
Colour: **26%**	Antúnez et al. (2015); Bialkova et al. (2014; 2020); Bix et al. (2015); Graham et al. (2015); Jones and Richardson (2007); Koenigstorfer et al. (2014); Oswald et al. (2022); Rramani et al. (2020); Siegrist et al. (2015)	Europe (Germany, UK, Switzerland)**:65%** USA: **20%** South America (Uruguay): **15%**	Dairy: **35%** Mayonnaise: **25%** Other Packaged Foods:**40%**	Traffic Light (TL) Labels: **55%** Colour-Coded GDA Labels: **30%** Nutri-Score Labels: **15%**	Choice Task:**35%** Free Viewing Task:**30%** Visual Search Task:**20%** Rating Task:**15%**	FC: **35%** DT: **35%** TVD: **30%**	Remote Eye- Tracking**:60%** Mobile Eye- Tracking:40%
Visual saliency and size: **8%**	Neuhofer et al. (2020); Peschel et al. (2019); Proi et al. (2023)	Europe (Denmark, Italy, Czech Republic:**30%** USA**: 20%**	Organic/Ecolabeled Items: **40%** Aquaculture Products: **30%** Beverages: **30%**	Sustainability labels: **40%** Nutritional Labels: **30%** Modified Label Designs for Visual Prominence: **30%**	Choice Task: **50%** Free Viewing Task: **30%** Visual Search Task: **10%** Word Association Task:**10%**	FD: **40%**; TVD: **30%**; FL: **30%**	Remote Eye Tracking: **50%** Mobile Eye- Tracking: **50%**

Table 2 (continued)

Bottom-up factors	Authors	Country	Products	Stimuli	Tasks	Eye-tracking measures	Methods
Label format: **40%**	Alonso-Dos-Santos et al. (2019); Antúnez et al. (2013); Ballco et al. (2019); Bartels et al. (2018); Bialkova et al. (2014; 2020); Bix et al. (2015); Centurion et al. (2019); Dang and Nichols (2022); Gabor et al. (2020); Graham et al. (2015); Machín et al. (2019); Mansfield et al. (2020); Puerta et al. (2022); Tòrtora et al. (2019); Van Loo et al. (2021)	South America (Uruguay, Chile): **45%** USA: **25%** Europe (Spain, Germany, Croatia): **30%**	Mixed Packaged Foods: **45%** Cereals and snack items: 3**5%** Dairy: **15%**	Warning Labels: **50%** Health/Nutrition Claims: **30%** Directive vs. Semi-Directive vs. Non-Directive Labels: **20%**	Choice Task: **45%** Free Viewing Task: **25%** Rating Task: **15%** Visual Search Task: **15%**	FC:**40%;** GD: **30%** TTFF: **30%**	Remote Eye Tracking: **65%** Mobile Eye- Tracking: **35%**
Information density: **10%**	Centurión et al. (2019); Goldberg et al. (1999); Oliveira et al. (2016); Visschers et al. (2010)	Europe (Switzerland): **50%** South America (Uruguay): **50%**	Cereals & Grain-based Products: **40%** Dairy: **40%** Other Products: **20%**	High-Density Labels (Detailed Nutrition Facts, Ingredient Lists, Health Claims): **60%** Simplified Labels (Minimal Text, Key Warnings, Icons): **40%**	Choice Task: **40%** Free Viewing Task: **40%** Rating Task: **20%**	FD: **50%** AOIs: **30%** **DT**: 20%	Remote Eye Tracking: **80%** Mobile Eye-Tracking: **20%**

Legend (stimuli)—BOP, Back of packaging; FOP, Front of Packaging; FUF Facts Upon Front; GDA, Guided Daily Amount; GMO, Genetically Modified Organisms; NFP, Nutritional Facts Panel; TSL, Traffic light System

Legend (eye-tracking measures)—AFD, Average Fixation Duration; AOIs, Percentage of individuals who fixated their gaze on Area of interests; CFT, Complete Fixation Time; DT, Dwell Time; FA, Fixation Accuracy; FC, Fixation Count; FD, Fixation Duration; FL, Fixation Latency; Fs, General fixation occurrences; FF, Frequency of fixations; GD, Duration of gaze on an object; GF, Frequency of gazes; Label Viewing, Observation of labels; MFD, Mean Fixation Duration; Milliseconds of Visual Attention, Time spent visually attending an area; NFs, Number of Fixations; PD, Pupil Dilation; Saccades, Rapid eye movements between fixations; TFD, Total Fixation Duration; TVD, Total Viewing Duration; TTFFs, Time to First Fixations; TS, Time spent; VC, Visit Count

Table 3 Characteristics of the studies concerning top-down factors

Authors	Country	Nr. of participants (male/ female)	Products	Top-down factor	Methods	Tasks	Stimuli	Eye-tracking measures	Main outcomes
Ares et al. (2014)	Uruguay	71(f = 48, aged 18–45)	Yoghurt	Thinking style	Experiment; remote-eye-tracking	Choice task	Labels associated with health or with novelty; presence/ absence of a TLS	AOIs, VC, TTFFs, TFD, FC, MFD	Analytical-rational thinkers process information more deeply than intuitive-experiential thinkers
Bialkova et al. (2020)	Germany	150 (f = 111, aged 19–69)	Muesli bars	Motivation	Remote Eye-tracking and Mobile eye-tracking (lab and store settings)	Choice Task	Nutritional labelling varies in format	NFs, FD, TTFFs	Consumers with health goals would look for longer at the label information
Bialkova et al. (2014)	Europe: Netherlands, Denmark, Poland	Study 1: 80(age < 35); Study 2: 80 (age < 35)	Yoghurt	Motivation	Experiment; remote-eye-tracking	Choice task (healthiest option vs. the preferred product)	FOP nutrition labels: directive, semi-directive colour-coded, non-directive monochrome) and fat content	NFs, TFD	Products with color-coded and monochrome labels garnered greater visual attention
Fenko et al. (2018)	Netherlands	48(f = 26, aged 18–63)	Twelve Yoghurt packages	Motivation	Field experiment was conducted in a real shopping environment with mobile eye-tracking	Choice task	TL label, the choices logo, or no health label	NFs, FD	Participants fixated longer and more frequently on TL labels than choices logos; the degree of visual attention was a poor predictor of ultimately choosing a healthier product
Gidlöf et al. (2021)	Sweden	Study 1: 60 (f = 29, mean *age* = 24.25) Study 2: 100 (f = 58; mean age = 25 years)	Products in the category pasta, rice and cereals Pasta	Attitude	Mobile eye-tracking study (field and lab experiments)	Choice task	Study 1- pasta options: eco-labeled and non-eco-labeled Study 2- Planograms depicting supermarket shelves with various food products	TFD	There is no correlation between environmental attitude and visual attention

Table 3 (continued)

Authors	Country	Nr. of participants (male/ female)	Products	Top-down factor	Methods	Tasks	Stimuli	Eye-tracking measures	Main outcomes
Grebitus and Van Loo (2022)	USA	117 (f = 66, avg. age = 30.5)	Medjool date	Attitude	Experiment; remote-eye-tracking	Choice; questionnaire	GMO–free label; pesticide-free label; region–of–origin information	TVD	Consumers who worry about production practices are fixated longer on the food labels
Mawad et al. (2015)	Uruguay	133 (f = 86, aged 18–46)	Yoghurt	Thinking style	Experiment; remote-eye-tracking	Choice task; questionnaire	Different labels formats	AOsI, FC, TFD	Field-dependent individuals were more influenced by external cues (e.g., the label format)
Miller and Cassady (2012)	USA	67 (aged 19–7). No information on gender distribution	Bread, soup, meat	Previous knowledge	Experiment; remote-eye-tracking	Visual search task	NFPs	FS	Consumers with higher knowledge made more comparisons among food labels
Motoki et al. (2019)	Japan	68 (f = 32, avg. age = 21)	Hedonic foods: chips, chocolate; Healthy foods: yoghurt, salad	Emotions	Laboratory study; remote eye-tracking system	Free viewing task	Food labels/images are presented with pictures and nutrient information	TFD	Consumers with incidental anxiety look longer at labels
Oselinsky et al. (2021)	USA	Study 1: 203 (f = 125, avg. age = 19) Study 2: 231(f = 141, avg. age = 19)	Assortment of packaged food products (64 items across 15 categories)	Attitude	Experiment; remote-eye-tracking	Choice task	Some items were marked "GMO-Free," some "Contains GMOs," and others had no GMO label (control)	Milliseconds of visual attention	Consumers' attitude influenced their visual attention but not their choices
Pennings et al. (2014)	USA	32 (f = 20, aged 17–24)	Different products (e.g., bread, muffins)	Previous knowledge and label understanding	Experiment; remote-eye-tracking	Free viewing task	Label image: Nutrition facts	ADF	Participants who received the nutrition booklet significantly increased their gaze duration on nutrition labels

Table 3 (continued)

Authors	Country	Nr. of participants (male/ female)	Products	Top-down factor	Methods	Tasks	Stimuli	Eye-tracking measures	Main outcomes
Samant and Seo (2016)	USA	58 (f = 31, avg. age = 40)	Chicken	Previous knowledge and label understanding	Experiment; remote-eye-tracking	Free viewing task; purchase intent; trust; liking ratings	Packaging sustainability and process-related label claims	FC	Better knowledge of labels led to paying attention to sustainability labels and considering buying a product
Songa et al. (2019)	Belgium	89 (f = 69, aged 20–25)	Yoghurt	Attitude	Experiment; remote-eye-tracking	Free viewing task; questionnaires	Label image (logos that indicate recyclability, non-recyclability, or no logo)	FD, TTFFs, PD	Consumers with a positive attitude towards recyclability found the label faster and processed it longer
Sørensen et al. (2012)	Denmark	46 (gender and age not reported)	Different products (e.g., bread)	Previous knowledge and label understanding	Experiment; remote-eye-tracking	Choice task; questionnaire	Signpost labels	NFs, TTFFs	The study identified two consumer profiles: one group using broad food knowledge and another relying on signpost label cues
Takahashi et al. (2018)	Japan	246 (f = 116, avg. age = 21)	Coffee	Attitude	Experiment; remote-eye-tracking	Choice task	Certified forest coffee, regular coffee, and mocha coffee, with varying label designs	TFD	Consumers' attitudes did not influence visual attention and choices
Tanner et al. (2019)	Ireland	16 (f = 8, aged 36–64)	Yoghurt	Motivation	Study with remote-eye-tracking	Choice task; questionnaire	Different FOP label formats	FCs, AOIs	Consumers' personal goals influenced engagement with visual stimuli
Turner et al. (2014)	USA	90 (f = 51, avg. age = 20)	Different products (e.g., chicken, panini crackers)	Motivation	Experiment; remote-eye-tracking	Choice task (health vs. taste motivation)	Authentic images of food packages, with an FOP nutrition symbol and the nutrition facts label	GD	Health-motivated consumers paid more visual attention to food labels

Table 3 (continued)

Authors	Country	Nr. of participants (male/ female)	Products	Top-down factor	Methods	Tasks	Stimuli	Eye-tracking measures	Main outcomes
Van Herpen and van Trijp (2011)	Turkey, Denmark	Study 1 = 309 (f = 201, aged 17–32)	Cereals	Motivation	Experiment; remote-eye-tracking	Choice task (personal preferences vs. health-related goals)	Different FOP label formats	DT, number of labels attended	Health-motivated consumers spend more time evaluating various nutritional labelling
Van Loo et al. (2015)	USA	6500 (f = 3445, aged 18–60)	Coffee	Attitude	Experiment; remote-eye-tracking	Choice task, combined with a questionnaire	Sustainability labels on coffee	TFD, FC	Consumers who value sustainable products would look for longer at sustainability labels
Visschers et al. (2010)	Switzerland	32(f = 15, avg. age = 25)	Cereal product	Motivation	Experiment; remote-eye-tracking	Choice task (health vs. taste motivation)	BOP Labeling; FOP Labels; health and nutrition claims; ingredient list	GD, AOIs	Consumers with health goals looked longer at the nutritional information

Legend (stimuli)—BOP, Back of Packaging; FOP, Front of Packaging; FUF Facts Upon Front; GDA, Guided Daily Amount; GMO, Genetically Modified Organisms; NFP, Nutritional Facts Panel; TLS, Traffic light System

Legend (eye-tracking measures)—AFD, Average Fixation Duration; AOIs, Percentage of individuals who fixated their gaze on Area of interests; CFT, Complete Fixation Time; DT, Dwell Time; FA, Fixation Accuracy; FC, Fixation Count; FD, Fixation Duration; FL, Fixation Latency; Fs, General fixation occurrences; FF, Frequency of fixations; GD, Duration of gaze on an object; GF, Frequency of gazes; Label Viewing, Observation of labels; MFD, Mean Fixation Duration; Milliseconds of Visual Attention, Time spent visually attending an area; NFs, Number of Fixations; PD, Pupil Dilation; Saccades, Rapid eye movements between fixations; TFD, Total Fixation Duration; TVD, Total Viewing Duration; TTFFs, Time to First Fixations; TS, Time spent; VC, Visit Count

Table 4 Characteristics of the studies concerning on bottom-up factors

Authors	Country	Number of participants	Products	Bottom-up factors	Methods	Task	Stimuli	Eye-tracking measures	Main outcomes
Alonso-Dos-Santos et al. (2019)	Chile	180(f = 90, aged 18–61)	Different types of products	Label format	An experiment with remote eye-tracking	Visual Search Task	Three FOP formats	Complete fixation time (CFT), TTFF, NFs	Consumers process warning messages faster and with less effort
Antúnez et al. (2013)	Uruguay	52 (f = 30, aged 18–30)	Pan bread	Label format	An experiment with remote eye-tracking	Free viewing task; a classification task	Nutrition information format; the TLS	AOIs, VC, TFD, FC, MFD, TTFF	The TLS facilitated the visual processing of the ingredients
Antúnez et al. (2015)	Uruguay	64 (f = 7, aged 23–48)	Mayonnaise	Colour	Remote eye-tracking study	Classification task	Different FOP label conditions	MFD, VC	Colour-enhanced visual attention to labels
Ballco et al. (2019)	Spain	100 (f = 52) age -mode: > 55 (40%)	Yoghurt	Label format	An experiment with remote eye-tracking	Choice task	FOP nutritional claims (e.g., fat-free)	Fs, TS, FC	Nutritional claims enhanced visual attention
Bartels et al. (2018)	USA	60 (f = 37, 62% aged 35–54)	Different types of products	Label format	Field study with mobile eye-tracking	Choice task; questionnaire	FOP claims/symbols; Nutrition Facts label	TTFF, FC, FD	FOP and claims receive the most visual attention
Bialkova et al. (2014)	Different European countries	80 (age < 35)	Yoghurt	Colour	An experiment with remote eye-tracking	Choice task	Different FOP label formats	FD, NFs	Consumers are more visually attracted by a color-coded label
Bialkova et al. (2020)	Germany	150 (f = 111, aged 19–69)	Muesli bars	Colour	Remote and Mobile eye-tracking	Choice task	Nutritional labelling varies in format	NFs, FD, TTFF	Colour-coded GDA labels were fixated more than monochrome GDAs
Bix et al. (2015)	(USA)	55(f = 31, aged 18–72)	Crackers/Cereal	Label format	Remote eye-tracking study	Free viewing task	Different FOP label conditions	TTFF, TVD	Consumers processed FOP nutrition information with colours faster and for longer

Table 4 (continued)

Authors	Country	Number of participants	Products	Bottom-up factors	Methods	Task	Stimuli	Eye-tracking measures	Main outcomes
Centurión et al. (2019)	Uruguay	100 (f = 75, aged 18–56)	Cereal bars	Label format	Experiment; remote-eye-tracking	Healthiness ratings	Nutrient claims; nutritional warnings	AOIs: TTFF, FC	The warning labels visually attract consumers when selecting a product
Dang and Nichols (2022)	USA	695 (f = 372; aged 18–65)	Yogurt drinks/Ice cream	Label Format	Experiment; remote-eye-tracking	Free viewing task; healthiness ratings; purchase intention questions	FOP labels manipulation of nutrients	Saccades, Fs	Positive nutrients attract more attention than harmful ones in unhealthy foods
Drexler et al. (2018)	Czech Republic	Experiment group: 88 (f = 63) Control group: 59 (f = 41)	Different types of products	Label format	Experiment; remote-eye-tracking	Free viewing task; questionnaire	Food packages with/without organic (eco) labels	FD, AOIs	The most significant visual attention was directed toward the organic labelling claims
Gabor et al. (2020)	Croatia	76 (f = 42; avg. age = 22)	Snack bars	Label format/ colour	Remote eye-tracking study	Free viewing task; healthiness ratings; questionnaire	Labelling format (e.g., Nutri score)	TTFF, DT, NFs, AFD	Colour-enhanced visual attention to labels
Goldberg et al. (1999)	USA	10 (f = 8, aged 19–41)	Standard food nutrition label	Label positioning/ Information density	Experiment; remote-eye-tracking	A visual search task	Nutritional labelling	NFs, FA, FD	Central label elements were harder to find and took more time
Graham et al. (2015)	USA	Parent/ child pairs 155 (parent avg. age 38; child aged 6–9)	Snack items	Label format / colour	Experiment; mobile-eye-tracking	Free viewing task; survey	FOP nutrition labels; Traditional Nutrition Facts labels	Label viewing	Compared to Nutrition Facts labels, FOP nutrition labels were more likely to be viewed
Graham and Jeffery (2011)	USA	203 (f = 178 aged > 18)	64 foods meals (e.g., snacks)	Label positioning	Remote Eye-tracking study	Choice task combined with a questionnaire	Food images, ingredient list, and Nutrition Facts label	TS	Labels near the middle of the screen received more attention

Table 4 (continued)

Authors	Country	Number of participants	Products	Bottom-up factors	Methods	Task	Stimuli	Eye-tracking measures	Main outcomes
Jones and Richardson (2007)	UK	92 (f = 67, avg. age 31.5)	No product	Colour	A remote eye-tracking study	Free viewing task; healthiness ratings	Label with text-only nutrient facts and a color-coded TL	TS	The TLS helped consumers to find nutritional information better
Koenigstorfer et al. (2014)	Germany	160 (f = 103, aged 19–64)	15 snack items	Colour	Mobile Eye-tracking; questionnaire	Taste and health importance rating task	Different FOP nutrition labels	GD, GF	Colour-enhanced visual attention to labels
Machín et al. (2019)	Uruguay	100	15 snack items	Label format	Experiment; remote-eye-tracking	Choice task combined with a questionnaire	Different FOP label conditions	FF, FD	Nutritional warnings promote healthier choices
Mansfield et al. (2020)	Canada	625	Different food types	Label format / label positioning	Experiment; mobile-eye-tracking	Choice task	Different FOP nutrition labels	TTFFs, FD	Consumers looked more at the FOP label
Neuhofer et al. (2020)	USA	164 (f = 103; avg. age = 46)	Different types of beverages	Size of label	Experiment; remote-eye-tracking	Beverage choice task, followed by a survey	Nutrition facts label	TVD	Larger text boosted visual attention
Oliveira et al (2016)	Uruguay	60S (f = 40, aged = 18–45)	Probiotic and regular milk	Density of information	Experiment; remote-eye-tracking	Word association task; Flicker change detection task	Two distinct label backgrounds	TTFF, AOIs, TFD, FC, TTFF	Consumers prefer simple cues in high-information settings
Oswald et al. (2022)	USA	304 (f = 203, age -mode: 24–30 (88%))	Different types of products	Colour	Experiment; remote-eye-tracking	Choice task; free viewing task; questionnaire	Different FOP label conditions	TFD, AOIs	Colour-coded labels are more efficient in attracting consumers' attention
Peschel et al. (2019)	Denmark	127 (f = 72, aged 18–24 (75%))	Different types of products	Size of labels/ visual saliency	Experiment; remote-eye-tracking	Free viewing task and choice task	Danish organic logo	FL	A large, high-saliency organic logo condition produced the highest fixation likelihood

Table 4 (continued)

Authors	Country	Number of participants	Products	Bottom-up factors	Methods	Task	Stimuli	Eye-tracking measures	Main outcomes
Proi et al. (2023)	Italy	61 (f = 33, aged 18–64)	Aquaculture products	Label format/ size of labels/ visual saliency	Experiment; remote-eye-tracking	Choice task; questionnaire; word association task	Different types of eco-labels	DT, FD, TTFF, TS, AFD	Visual attention increased with larger ecolabels and was influenced by saliency only when combined with label size and type
Puerta et al. (2022)	Spain	86 (f = 71; aged = 16–73)	Gluten-free breads	Label format	Experiment; mobile-eye-tracking	Expected Acceptability; and Trust Rating Task	Gluten-free certification logo	NFs	Certification logos attracted more attention than nutrition labels
Rramani et al. (2020)	Germany	50 (f = 40; aged 18–60)	Different types of products	Colour	Experiment; remote-eye-tracking	Liking ratings; willingness to pay task	TL or GDA nutrition labels	DT	TL attracted more visual attention than the other labels
Siegrist et al. (2015)	Switzerland	98 (f = 68, aged 16–74)	Different types of products	Colour	Experiment; remote-eye-tracking	Free viewing task; healthiness ratings	Different FOP label conditions	FD, DT, AOIs	TL was processed more efficiently than GDA
Tòrtora et al. (2019)	Uruguay	124 (f = 91, aged 18–55)	Snack items	Label format	Experiment; remote-eye-tracking	Choice task	Different FOP nutrition labels	AOIs, TTFF, TFD	Nutritional warning was better at attracting visual attention
Van Loo et al. (2021)	USA	115 (gender and age not reported)	Granola bar concept	Label format	Experiment; remote-eye-tracking	Choice task	Nutrition claims; sustainable production claims; ecolabels	TVD	Sustainability claims influenced visual attention
Varela et al (2014)	Uruguay	50 (f = 30, aged 21–60)	Cereals	Label positioning	Mobile eye-tracking in a quasi–supermarket setting	Projective mapping task; provided verbal descriptors	Breakfast cereal packages with different labels	AOIs	Few consumers attended to nutritional information and health claims

Table 4 (continued)

Authors	Country	Number of participants	Products	Bottom-up factors	Methods	Task	Stimuli	Eye-tracking measures	Main outcomes
Visschers et al. (2010)	Switzerland	32(f = 15, age: 25)	Cereal product	Density of information	Experiment; remote-eye-tracking	Choice task	BOP Labeling; FOP Labels	GD, AOIs	Simple package designs helped consumers locate nutrition information more quickly

Legend (stimuli)—BOP, Back of packaging; FOP, Front of Packaging; FUF Facts Upon Front; GDA, Guided Daily Amount; GMO, Genetically Modified Organisms; NFP, Nutritional Facts Panel; TSL, Traffic light System

Legend (eye-tracking measures)—AFD, Average Fixation Duration; AOIs, Percentage of individuals who fixated their gaze on Area of interests; CFT, Complete Fixation Time; DT, Dwell Time; FA, Fixation Accuracy; FC, Fixation Count; FD, Fixation Duration; FL, Fixation Latency; Fs, General fixation occurrences; FF, Frequency of fixations; GD, Duration of gaze on an object; GF, Frequency of gazes; Label Viewing, Observation of labels; MFD, Mean Fixation Duration; Milliseconds of Visual Attention, Time spent visually attending an area; NFs, Number of Fixations; PD, Pupil Dilation; Saccades, Rapid eye movements between fixations; TFD, Total Fixation Duration; TVD, Total Viewing Duration; TTFFs, Time to First Fixations; TS, Time spent; VC, Visit Count

labels, which are examined far more often than Back-of-Pack (BOP) or Nutritional Facts Panels (NFP).

Concerning the study design, only one study (Golberg et al. 1999) is based on a sample size of 10 participants, whereas the other studies have sample sizes larger than 30 participants, as detailed in Table 4. Geographically, studies are primarily conducted in a few countries (e.g., USA, South America and Europe) while other regions are less represented.

In terms of methodological approach, as reported in previous reviews (e.g., Ma and Zhuang 2021), many experiments use choice and visual search tasks, with eye-tracking measures like FD (Fixation Duration), TTFF (Time to First Fixation) and dwell time being the most common ways to measure attention. Finally, remote eye-tracking is the most used methodology, with mobile eye-tracking being less frequently applied.

Outcomes of articles concerning top-down factors

Table 3 summarises the main characteristics of the studies concerning top-down factors. The results are discussed according to thinking style, emotions, prior knowledge, label understanding, attitude, and motivation for consumers' visual attention and choices.

Thinking style

Thinking style refers to how people organize their beliefs (Guilford 1980). Overall, the studies report that the scheme consumers use to process information predicts the visual processing of food labels (Ares et al. 2014; Mawad et al. 2015). Ares et al. (2014) explored the influence of thinking style on visual attention to nutrition information and traffic light systems. The authors showed that rational consumers searched and analyzed nutrition information more extensively and in-depth than intuitive thinkers. Results from ANOVA showed that eye-tracking analysis concerning traffic light labels revealed no significant differences in eye movement patterns between individuals with different thinking styles. Specifically, statistical testing showed no significant difference in the fixation counts across groups (F score = 1.5). Another thinking style examined by Mawad et al. (2015) was the influence of field dependence/independence on visual attention, representing two different ways of using information. In particular, the difference is given by the information type they would focus on. Field-dependent individuals were more prone to be influenced by external cues and relied on simple information (e.g. traffic light labels). Meanwhile, field-independent individuals relied more on complex information (e.g., nutritional information). However, similarly to Ares et al. (2014), they reported no difference when a traffic light system label was present.

Emotions

Motoki et al. (2019) explored the role of incidental emotions (i.e., anxiety, anger or neutral) on visual attention. The finding showed that consumers paid more visual attention to hedonic food in the case of incidental anxiety. At the same time, no effects due to anger were found on the visual attention to food labels.

Previous knowledge and label understanding

Different studies reported that previous knowledge and education influenced consumers' visual attention to food labels (Miller and Cassady 2012; Pennings et al. 2014; Samant and Seo 2016; Sørensen et al. 2012). In an explorative study, Sørensen et al. (2012) analyzed how visual search strategies differed in the case of consumers who relied on general food knowledge and consumers who were dependent on signpost label knowledge. They showed that high general food knowledge involves the capacity to process more information in a shorter time. On the contrary, consumers with a better knowledge of signpost label recognition concentrated on little details and had an unclear search strategy. Using a picture-based booklet could be a way to provide nutrition information and increase consumers' knowledge. Indeed, Pennings et al. (2014), in a study with various products, reported that reading a picture-based educational nutritional booklet enhanced consumers' visual attention to nutrition labels. However, the role of knowledge could be mediated by other factors, such as health motivation. Miller and Cassady (2012) manipulated the level of some nutrients in the NFP on three product categories (meat, soup, and bread). The results demonstrated that knowledge of nutrients influences the use of food labels for consumers with goal motivations. More specifically, motivated consumers with higher knowledge made more comparisons among nutrients. The importance of knowledge was also confirmed in the case of sustainability labels. Samant and Seo (2016) explored the role of label understanding in visual attention to different chicken packages with sustainability-related labels. Two groups of participants were considered: participants who received food label education and a control group without prior comprehension. The authors showed that label understanding increased visual attention to sustainability labels and the probability of purchasing products.

Attitude

Consumer attitude refers to aspects such as emotions, behavioural intentions, and beliefs that a consumer has toward a product and could be defined as consumers' overall product assessment (Solomon 2006). The first study to consider the role of attitudes on consumers' visual attention and choices has been conducted on a sustainability label for coffee product packages. Van Loo et al. (2015) demonstrated that consumers more concerned with sustainability looked at elements of that specific information longer. Moreover, greater visual attention to food labels led to a higher likelihood of buying the product. Similarly, Songa et al. (2019) analyzed the role of previous attitudes to logos of recyclability on visual attention. The findings showed that individuals with a positive attitude towards recyclability could find the logo faster and process it for longer.

However, when it comes to consumer purchasing behaviour, other studies (Gidlöf et al. 2021; Oselinsky et al. 2021; Takahashi et al. 2018) pointed out that the role of attitude is still under investigation since attitudes alone are not sufficient to influence purchasing behaviour. Takahashi et al. (2018) conducted a laboratory experiment reporting that environmental attitudes did not encourage individuals to buy certified coffee. The illustration's attractiveness conditioned the likelihood of buying certified forest coffee, and consumers who spent more time looking at the illustration of forest on certified forest coffee also bought more products. Similarly, Oselinsky et al. (2021) showed that

consumers' attitudes towards GMO labels did not influence their choices. Indeed, even if participants stated they were against food containing genetically modified organisms (GMOs) and attended the GMO labels, they chose products with GMO labels. Gidlöf et al. (2021) reported that consumers' attitudes towards the environment did not lead to more visual attention to ecolabels or a higher disposition to purchase products with ecolabels.

Grebitus and Van Loo (2022) investigated the role of concerns about production practices on visual attention patterns. Despite the low correlation coefficient, they reported that consumers who worried about the production practices had longer visual attention to GMO and pesticide-free labelling.

Motivation

Different studies suggested that motivation influenced how consumers looked at food labels (Bialkova et al. 2014, 2020; Fenko et al. 2018; Turner et al. 2014; van Herpen and Trijp 2011; Visschers et al. 2010). Studies focused on exploring the role of motivation reported that the health goal specificity influences how consumers analyze food labels.

Van Herpen and Trijp (2011) compared four nutritional labelling schemes (i.e., nutrition table, multiple traffic-light labels and logo) on various product categories (i.e., dried fruit, raisin, apple, banana), reporting that consumers with health goals tend to spend more time comparing different types of nutritional labelling rather than processing the single label in depth. Moreover, consumers with health goals looked longer at the nutritional information than individuals with preference goals that choose food products based on taste (Bialkova et al. 2014; Tanner et al. 2019; Turner et al. 2014; Visschers et al. 2010). However, Fenko et al. (2018) found that the effect of health interest in visual strategy could be mediated by the constraints: consumers who have a general health interest looked at the label for a longer time only without time constraints; on the contrary, consumers that had not health interest do not increase visual attention even when there were no time constraints.

Outcomes of articles concerning bottom-up factors

Table 4 summarises the main characteristics of the studies concerning bottom-up factors. The results are discussed, focussing on labels' features such as location, colour, format, visual saliency, and information density.

Labels' location

Label positioning plays a crucial role in influencing the visual attendance of food labels. Goldberg et al. (1999) showed that consumers faster detected elements of food labels located at the centre of the screen. Similarly, Graham and Jeffery (2011), in a study focused on nutrition facts labels, reported that consumers viewed more labels in the middle of the screen. Various articles analyzed the relationship between front-of-package (FOP) nutrition labels and visual attention to the labels (e.g., Antúnez et al. 2013; Ares et al. 2014; Bix et al. 2015; Graham and Jeffery 2011; Mansfield et al. 2020). Food labels positioned on the front-of-package were better at attracting consumers' attention and reducing the cognitive burden of processing information (Graham et al. 2015;

Mansfield et al. 2020). Consumers prefer FOP food labels since they can be seen without moving the package (Bartels et al. 2018; Graham et al. 2015; Varela et al. 2014).

Colour

Colour-coded labels (e.g., traffic light systems) were more effective in attracting consumers' visual attention to some specific nutrient information (Antúnez et al. 2013; Bialkova et al. 2014, 2020; Jones and Richardson 2007; Koenigstorfer et al. 2014; Oswald et al. 2022; Rramani et al. 2020; Siegrist et al. 2015). Indeed, colour-coded labels require less visual and cognitive attention than labels based on numeric value since consumers reduce the amount of calculation to understand the label (Gabor et al. 2020).

Bix et al. (2015) explored the efficiency of FOP labels in guiding consumers' attention in choosing among three categories (sweets, ready meals and fruit juices) in the case consumers are assigned to a task, such as selecting a food product with low fat. The findings showed that colour-coded labels increased attention to nutrition information for consumers who did not have a specific nutritional goal. However, even if colour-coded labels were better at attracting consumers' attention, other studies suggested they did not help understand the nutritional information since consumers misinterpret the colours. A way to increase visual attention and consumer understanding of the colour-coded labels was to add an interpretational aid such as a text descriptor (Antúnez et al. 2015). Similarly, Graham et al. (2015) reported that signage explaining the meaning of colour-coded FOP labels increased consumers' visual attention and understanding of nutritional labelling.

Visual saliency, size and shape of labels

Visual saliency depends on the low-level visual features of labels (i.e., colour, intensity, edge orientation and contrast) and can be determined through an algorithm, such as GBVS (Gidlöf et al. 2017; Harel et al. 2007). Two studies investigated the role of saliency using certification labels (Peschel et al. 2019; Proi et al. 2023). Peschel et al. (2019), in a study regarding three products (i.e., yoghurt, chocolate and tomatoes), manipulated the Danish organic logo size and saliency. The results demonstrated that saliency alone did not influence consumers' visual attention. Meanwhile, consumers' visual attention and choices were strongly influenced by the increased size of the ecolabels. However, combining saliency with a bigger surface of the Danish organic logo increased consumers' visual attention and influenced consumers' choices.

In the same way, Proi et al. (2023), in a study focused on the saliency and the size of four ecolabels, reported that saliency increased ecolabels visibility only when combined with the size and the type of ecolabels. Nevertheless, the higher saliency of ecolabels did not guide consumers' choices. On the contrary, the size of the ecolabels had a significant effect on consumers' choices. Neuhofer et al. (2020) also confirmed the importance of size in the labelling design. The authors reported that writing "Calories" in a larger size on the nutrition facts label enhanced consumers' visual attention.

Label format

Given the variety of label formats (e.g. nutritional warnings, ecolabels), a significant piece of literature is focused on understanding which format captured consumers'

attention better. Here, we focus on the following label formats: a) nutrition claims and certification logo, b) Nutri-score, c) nutritional warnings, and d) ecolabels.

(a) Nutrition claims and certification logo. Studies have confirmed the importance of text in food labelling focused on nutrition and health claims (Ballco et al. 2020; Bartels et al. 2018; Mansfield et al. 2020). Consumers relied on nutrition claims during food shopping since short text written on the front of the pack (e.g. "High in") was detected faster and more often than the nutrition Fact label (Ballco et al. 2019, 2020; Bartels et al. 2018; Mansfield et al. 2020). One study (Puerta et al. 2022) showed that consumers relied on the certification logo when they were present, missing to fixated the nutritional facts labels.

(b) Nutri-score. Nutri-score is a kind of FOP labelling used especially in European countries, based on five colours/letters ranging from green/A (the healthiest product) to red/E (the less healthy product). Dang and Nichols (2022) explored the role of the Facts Up Front (FUF) labels in a study comparing healthy and unhealthy foods. FUF labels are a kind of FOP label representing the amount of positive nutrients (i.e., calcium, Vitamin A, protein) contained in a specific food product. The results showed that a healthy nutrient (e.g., calcium) increases consumers' visual attention to the FUF label for unhealthy food.

(c) Nutritional warnings. Different studies have investigated the influence of nutritional warnings on consumers' preferences (Alonso-Dos-Santos et al. 2019; Centurión et al. 2019; Tórtora et al. 2019). The Nutritional warning is an FOP label with octagonal black signs that prevent consumers from buying unhealthy food. Centurión et al. (2019) and Machín et al. (2018) reported that consumers were visually attracted and influenced by the presence of warning labels in selecting a product. The nutritional warning was also easier to process than other forms of nutrition labelling schemes such as nutrition tables and Guideline Daily Amount (GDA) or the FUF (Alonso-Dos-Santos et al. 2019; Centurión et al. 2019; Tórtora et al. 2019).

(d) Ecolabels. Few studies compare consumers' visual attention among ecolabels and other certification formats (Proi et al. 2023; Van Loo et al. 2021). Van Loo et al. (2021) compared various nutrition and sustainability claims on a granola concept bar, reporting that sustainability information positively influenced visual attention. Similarly, Proi et al. (2023) reported that consumers' choices are not conditioned by certification labels in aquaculture products, even if they prefer products with ecolabels to those without ecolabels.

Density of information

Many elements on food packages reduce the visual attention to food labels. In a study with a nutrition label, Goldberg et al. (1999) found that information density increased the time needed for consumers to detect the label. On the same line, Oliveira et al. (2016), in a study regarding health claims on functional food, found that consumers did not process health claims in depth when other elements were present in the food package. Centurión et al. (2019) also confirmed this result, showing that visual attention to food packages was more superficial in information

overload. Visschers et al. (2010), in research focused on nutrition information on different cereal food products, reported that visual attention to nutrition information was higher in the food packages with simpler designs that did not report other information.

Discussion

Consumer responses to top-down factors

Top-down attention occurs when consumers visually select a stimulus in a supermarket based on personal goals and prior knowledge. The studies reviewed cover the following top-down factors influencing label perception: cognitive style, knowledge and understanding of food labels, attitude towards sustainability labels, and consumers' motivations.

Consumers' cognitive style also influences food label processing. Rational thinkers rely on systematic reasoning and analyze information methodically, while intuitive consumers rely more on external cues (Ares et al. 2014; Mawad et al. 2015). However, this effect appears to be label-dependent, as no significant difference in visual attention was observed between rational and intuitive thinkers when examining the traffic light labels (Ares et al. 2014; Mawad et al. 2015).

Findings consistently highlight the importance of nutrient knowledge and label comprehension in facilitating food labels' visual processing (Miller and Cassady 2012; Pennings et al. 2014; Samant and Seo 2016; Sørensen et al. 2012). Health-conscious consumers generally exhibit greater visual engagement with food labels, making more comparisons and fixating on them for more extended periods (Bialkova et al. 2014; Turner et al. 2014; van Herpen and Trijp 2011; Visschers et al. 2010; Zou and Liu 2019). However, some studies indicate that health-motivated consumers do not necessarily process all health-related labels in depth but focus selectively on specific nutritional information (Fenko et al. 2018; Kim et al. 2020). These discrepancies may stem from study design differences, as many studies assign specific evaluation tasks, while real-world shopping involves multiple competing goals (Chalamon and Nabec 2015; Meyerding 2018). Also, representativeness heuristics may influence health-conscious consumers, leading them to rely on familiar label formats (e.g., traffic light labels) rather than systematically analyzing all nutritional details (Fagerstrøm et al. 2021). Additionally, simplified and colour-coded labels naturally attract attention, making them more effective in influencing consumer behaviour (Muller and Prevost 2016).

Attitudes toward sustainability also affect visual attention but have a weaker impact on purchasing behaviour. Studies indicate that individuals with positive attitudes towards sustainability spend more time viewing sustainability labels and identifying them more quickly (Songa et al. 2019; Van Loo et al. 2015). However, an attitude-behaviour gap exists, as increased visual attention does not always translate into purchase decisions (Boulstridge and Carrigan 2000; Gidlöf et al. 2021; Oselinsky et al. 2021). Only one study (Van Loo et al. 2015) reported a direct link between sustainability concerns and increased selection of certified products. Still, it did not establish an apparent causal effect of attitude on purchase behaviour.

Consumers' responses to bottom-up factors

Studies exploring the role of bottom-up factors, which occurs when external stimulus properties guide consumers' visual focus, confirmed that people rely on simple visual cues, such as label format, colour, saliency, size, location, and information density, during food package inspection. Simplified label formats, such as FOP labels (e.g., traffic light label, health star system) significantly enhance visual attention compared to back-of-package nutrition panels (Antúnez et al. 2015; Bialkova et al. 2014, 2020; Gabor et al. 2020; Koenigstorfer et al. 2014; Oswald et al. 2022; Rramani et al. 2020; Siegrist et al. 2015). Moreover, colour-coded food labels (e.g., Nutri-score) enhance information processing efficiency by drawing attention more effectively than monochromatic labels (Antúnez et al. 2013; Ares et al. 2014; Bix et al. 2015; Graham and Jeffery 2011; Mansfield et al. 2020).

Higher information density on labels increases cognitive load, making it more challenging for consumers to process information (Goldberg et al. 1999; Oliveira et al. 2016; Visschers et al. 2010).

Lastly, label location on the food package matters since consumers focus on the centre and top of the label (Goldberg et al. 1999; Graham and Jeffery 2011). Given this shortcut effect, consumers rely on simplified labels like the traffic light system instead of more comprehensive nutrition fact panels.

Visual saliency does not significantly influence attention unless combined with other factors such as label type and size (Peschel et al. 2019; Proi et al. 2023). However, larger labels attract more attention and may overshadow smaller label elements (Orquin et al. 2018). Additionally, consumers primarily focus their gaze on centrally positioned and top-placed elements in food packages (Goldberg et al. 1999; Graham and Jeffery 2011).

The role of heuristics in visual attention and consumers' choice

Although few studies explicitly address heuristics (e.g., Turner et al. 2014; Dang and Nichols 2022), findings suggest that consumers frequently rely on heuristics to simplify food choices. Heuristics streamline food choices by guiding attention toward salient cues, reducing cognitive effort, and influencing bottom-up attention allocation and top-down decision-making strategies.

Bottom-up attention mechanisms, such as colour contrast and positioning, direct consumer focus toward prominent nutritional labels and warning signs, while top-down cognitive factors, including prior knowledge, motivation, and attitudes, shape how information is processed and used in decision-making. Consumers use colour-coded labels (e.g., traffic light systems, Nutri-Score, and "High in" warnings) as mental shortcuts to assess healthfulness and reduce cognitive load (Antúnez et al. 2013; Alonso-Dos-Santos et al. 2019; Tanner et al. 2019; Gabor et al. 2020). FOP symbols also act as decision shortcuts, capturing more attention than detailed nutrition panels (Bix et al. 2015; Bartels et al. 2018; Dang and Nichols 2022).

Consumers also default to well-known brands as proxies for quality, with more prominent logos and central positioning enhancing trust and purchase likelihood (Bialkova et al. 2020; Oliveira et al. 2016; Peschel et al. 2019; Proi et al. 2023). Attitudes toward health or sustainability goals influence heuristic processing, as consumers prioritize labels that align with their existing beliefs (Songa et al. 2019; Oselinsky et al. 2021).

Salient visual cues, like warning labels and bold claims, attract attention, while more detailed nutritional information is often ignored (Centurion et al. 2019; Machín et al. 2019). This effect varies by product category; while health-conscious consumers are more sensible to warning labels, those purchasing hedonic products often disregard them in favour of sensory appeal (Tòrtora et al. 2019). Among the other perceptual heuristics, eco-label size and salience influence sustainability judgments, shaping consumer preferences (Drexler et al. 2018; Proi et al. 2023).

Prior knowledge and label familiarity further enhance heuristic reliance, with experienced consumers relying on well-known certification logos and spatial memory for quick decision-making (Goldberg et al. 1999; Takahashi et al. 2018).

Future research should explore how individual differences, such as health literacy and shopping motivation, influence heuristic reliance, offering deeper insights into consumer behaviour.

Conclusions

This review examined early findings on consumers' attention to food labels using eye-tracking technologies, highlighting how top-down and bottom-up factors guide consumers' visual responses.

Top-down factors such as cognitive style, prior knowledge, and sustainability attitudes play an important role in shaping consumers' visual attention to food labels. Health-conscious individuals and those with greater label understanding tend to engage more with nutritional information. However, an attitude-behaviour gap can emerge when consumers pay attention to labels but do not reflect this in their final product choices.

As for the bottom-up factors like label format, colour, size, and placement, they significantly influence visual attention. Simplified, colour-coded front-of-pack labels attract more attention than detail panels, while high information density can hinder processing. Size and central positioning enhance visibility, whereas saliency alone has a limited effect. Furthermore, consumers often use simple shortcuts, like colour codes, logos, or familiar brands, to make quick food choices and reduce mental effort.

These insights have significant implications for food manufacturers, marketers, and policymakers seeking to optimize labelling strategies and influence consumer behaviour more effectively**.** For food manufacturers, the findings suggest prioritising label designs that match various cognitive styles. Given the diverse ways in which, according to literature, consumers process food labels, it could be essential to investigate a design packaging that accommodates analytical and intuitive decision-making styles. Consumers with a more systematic cognitive approach prefer structured, fact-based information, which could be facilitated by back-of-package labelling, detailed nutritional content, ingredient sourcing, and health claims. Digital solutions, like QR codes linking to additional product details, may further support informed decision-making. Conversely, individuals who rely on heuristic processing respond more favourably to simplified, visually salient cues, such as traffic light labels or the Nutri-Score system. Integrating detailed and intuitive labelling in a hybrid approach may enhance accessibility and comprehension across consumer segments.

Since consumers use heuristics to reduce their cognitive load during information processing, they prefer simple and colour-coded labels over complex nutrition facts. Further

research into alternative label designs could help food manufacturers prioritize intuitive formats, such as Nutri-Score and traffic light labels, to improve consumer understanding and engagement.

Furthermore, health-conscious consumers are reported to focus on key nutritional cues rather than processing all available information. To facilitate decision-making, essential nutrition claims (e.g., "high in fibre" or "low in sugar") should be strategically placed, and interactive packaging technologies (e.g., QR codes) should be utilized.

These insights show marketers how important it is to match labelling strategies to different consumer segments. Knowing how people read and understand labels can help create packaging that catches attention and helps guide their buying decisions. Eye-catching features (e.g., colour, layout) can enhance visibility and influence choices. Furthermore, effective labelling strengthens brand-consumer trust (Sayogo et al. 2016). From the policymaker's perspective, findings support policies that encourage clear and accessible labelling systems to meet the different needs of consumers. Furthermore, encouraging labels that facilitate healthier food choices (e.g., Nutri-score) aligns with broader public health goals (FAO 2024).

The main gaps in the literature refer to three aspects: the methodological approach for analyzing visual attention, the influence of food product categories, and the potential interaction between claims and certification. Concerning the first aspect, an increase in expanding neuromarketing research in actual conditions could be relevant to understanding consumers' motivations. Future studies should be conducted in retail, combining methods to capture consumers' visual attention with other neural marketing techniques (e.g., micro-facial expression recognition and electroencephalography).

Concerning the second aspect, most studies focused on dairy products, while other food categories (e.g., aquaculture products) remain underexplored. Since food labelling effectiveness may vary across food categories, further research should elucidate how product type influences consumer attention.

Finally, the scoping review results indicate that most of the literature focused on comparing consumers' preferences and visual attention towards different forms of nutritional labels. However, over the last few years, there has been an exponential increase in food products sustainability labels, which may have implications for labelling strategies in the food and beverage business. In this framework, the recent proposal for an EU Green Claims directive (European Commission 2023) highlights the importance of explicit, evidence-based environmental claims. Misleading claims or vague sustainability messaging could erode consumer trust, prompting businesses to rely more on verifiable certification processes. Future research should assess how these developments impact consumer engagement with food labels.

Future research should explore how cognitive load influences consumer focus on key nutritional details using eye-tracking and neurophysiological methods. AI-driven smart labels, which highlight nutritional details based on individual dietary needs, could offer promising solutions. The food industry stands to gain valuable insights by assessing the impact of QR codes, AR labels, and mobile apps on consumer engagement, comprehension, and purchasing behaviour. Addressing these gaps could help food companies and policymakers design more effective labels that align with consumer behaviour and promote healthier purchasing decisions.

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Competing interests
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