The role of trust and algorithms in consumers' front-of-pack labels acceptance: a cross-country investigation

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Abstract

Purpose – This study aims to reveal the implications that trust, as a key driver of consumer behaviour, might have on consumer acceptance of front-of-pack labels (FOPLs) and policy effectiveness. By conducting three studies on 1956 European consumers with different levels of exposure to FOPLs, this study offers additional theoretical and experimental support through a deep investigation of the central role of trust in consumers' decision-making towards healthier and more informed food choices.

Design/methodology/approach – Study 1 used structural equation modelling to assess whether trust is a relevant mediator of the relationship between attitude and behavioural intention (BI), thus upgrading the front-of-pack acceptance model (FOPAM); Study 2 tested the model by comparing two labels at the extremes of the current European scheme (NutrInform Battery [NiB], Nutri-Score [NS]); Study 3 assessed the effect in cases where the connection between trust and algorithms is made transparent and evaluated trust dimensions, focusing on the perception of an algorithm presence behind FOPLs information.

Findings – Study 1 strengthens the FOPAM model with the mediating role of trust in FOPLs, demonstrating a positive effect of attitude on trust and, in turn, on BI, and resulting in a higher model fit with all the significant relationships; Study 2 revealed that the relative performance of the different labels on the FOPAM can be explained by the trust dimension; Study 3, investigating the dynamics of trust in the FOPAM, revealed that the NS is less effective than the NiB on attitude, BI and trust.

Research limitations/implications – The sample was limited to Italian, French and English respondents, and two labels at the extreme of the spectrum were examined. Furthermore, the research has relevance to the issue of trust. Other moderators used in previous studies on technology acceptance model, such as actual use versus perceptual use, user experience level or type of users and type of use might be investigated.

Practical implications – The investigation of trust, with the upgrade of FOPAM, enhances understanding of consumers' decision-making processes when aided by food labels and makes a new contribution to the European Union "Inception Impact Assessment" in preparation for the finalization of the "From-Farm-to-Fork Strategy", providing new insights into the role of trust by assessing the relative performance of FOPLs in consumers' acceptance of food-related information. Furthermore, this study revealed that consumers' perception of FOPLs worsens when they realize that they are the result of an algorithmic calculation. Finally, the new FOPAM represents a reliable theoretical model for future research on FOPL.

Originality/value – This study increases the knowledge about the performance of different FOPLs on several dimensions of food decision-making, positions the upgraded FOPAM as a valid alternative to existing theoretical models to assess the relative performance of labels, also extending the literature in the context of algorithm-based FOPL, and could be used as a valid support to policymakers and industry experts in their decision towards a unified label at European level.

Keywords Trust, FOPAM, Algorithm, Nutri-score, NutrInform battery, Multiple traffic light, FOPL ease of use, Usefulness, TAM, Behaviour, Food, Labelling nutrition, Attitudes, Decision support systems, European Union, Processed foods

Paper type Research paper

Introduction

In recent years, overweight and obesity have risen dramatically across all age groups worldwide. To date, the number of people suffering from obesity has nearly tripled since 1975, with over 340 million children and adolescents and over 1.9 billion adults reported as overweight or obese in 2016 (Who.int, 2021). Furthermore, the projections are not encouraging, as nearly half of the world's population is likely to be obese by 2030 (Finkelstein *et al.*, 2012), with an increasingly larger proportion of younger people (Who.int, 2021). This situation is partially resulting from an increased intake of high-sugar, high-fat and high-salt, energy-dense foods. To support consumers in making more informed and healthier food choices and to control overweight and obesity, governments, authorities, socially responsible businesses and organizations are asked to identify effective intervention to improve the information provided for their dietary decisions, leveraging and combining different approaches to encourage consumer responsibilisation (Parth *et al.*, 2021).

To this end, as packaging has emerged as an important element of brand management, in which many elements must be taken into account, such as the language adopted (Khan, 2019; Khan and Lee, 2020) and the appearance of standard versus local indications (Khan *et al.*, 2015, 2017), an increasing number of countries are adopting front-of-pack labels (FOPLs). FOPLs are labels on the front of the packaging of pre-packaged foods (van der Bend and Lissner, 2019) that advise consumers on the composition of products, with the aim of promoting more informed and healthier habits. These labels have been suggested to draw consumers' attention more effectively than the ones traditionally placed on the back of products, especially due to the combination of their simplified format and prominent location on the front of the package (Elshiewy and Boztug, 2018; Becker *et al.*, 2015).

The absence of a standardized regulation has led over time to a wide variety of FOPLs, mainly grouped into two main categories: "nutrient-specific labels" and "summary labels" (European Commission, 2020a, 2020b) (Figure 1).

To understand which FOPL would best support customers to make healthier food choices, previous literature has largely adopted the conceptual framework developed by Grunert and Wills (2007), focusing on consumers' objective and subjective understanding, and leading to controvertible evidence (Hersey *et al.*, 2013; Aschemann-Witzel *et al.*, 2013; Ducrot *et al.*, 2015b; De la Cruz-Góngora *et al.*, 2017; Egnell *et al.*, 2018a, 2018b;
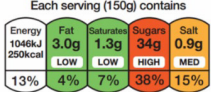
Taxonomies		Examples
Nutrient-Specific Labels: FOPLs that provide detailed information about certain nutrients (fat, saturates, sugars, salt, and energy value) with an objective description of the quantities contained in the food	• **Numerical Labels**: non-interpretative (non-evaluative) labels, providing numerical information on the content of four nutrients (fat, saturates, sugars, salt) and on the energy value, as well as on how much this represents as a percentage of the daily reference intake	• **NutrInform Battery** (here in after as "NiB")
	• **Colour-Coded Labels**: labels providing numerical information on the content of four nutrients (fat, saturates, sugars, salt) and on the energy value, as well as on how much this represents as a percentage of the daily reference intake. Colours are used to classify those nutrients as "low" (green), "medium" (amber) or "high" (red)	• **Multiple Traffic Light** (here in after as "MTL")
Summary Labels: FOPLs that provide a synthetic assessment of the product's overall nutritional healthfulness that is sometime the result of an algorithmic computation	• **Endorsement Logos**: labels providing a synthetic appreciation of a product's overall nutritional value through a positive (endorsement) logo that is applied only to foods that comply with nutritional criteria	• **Keyhole logo**
	• **Graded Indicators**: labels providing a synthetic appreciation of a product's overall nutritional value through a "graded indicator" that provides graded information on the nutritional quality of foods that is applied on all food products	• **Nutri-Score** (here in after as "NS")

Figure 1.
EU taxonomy and example of front-of-pack labels

Talati *et al.*, 2019; Packer *et al.*, 2021; Mazzù *et al.*, 2020; Mazzù *et al.*, 2021a) of an absolute superiority of a specific FOPL capable of affecting consumer behaviour towards healthier lifestyles. Thus, new investigations are needed to include additional factors and develop alternative and complementary conceptual frameworks that help consumers' decision-making towards utilization and acceptance of FOPLs that support informed decisions towards healthier diets.

One dimension that is documented to strongly influence consumer decision-making is trust, which was mentioned by Hobbs and Goddard (2015) as a variable that should be investigated to understand its ability to influence consumer response to food labels, in a context where several health/functional elements are to be intended as credence attributes in food purchase. According to cue utilization theory (Cox, 1967), the label – and the information it provides – is an extrinsic cue on the product that consumers look for, especially when the product quality is uncertain. Therefore, label information acts as a source of trust and quality of food products (Ayyub *et al.*, 2018, 2021; Lassoued and Hobbs, 2015; Loureiro and McCluskey, 2000). Consumers are more likely to buy or use a product or service they trust because trust reduces perceived risk among customers (Handi *et al.*, 2018; Harridge-March, 2006), which in turn increases their purchase intention (Bulut and Karabulut, 2018; Fang *et al.*, 2014; Limbu Yam *et al.*, 2012; Seo *et al.*, 2020). Conversely, trust, and consequently behavioural intention (BI), may be negatively affected when concerns about perceived risk increase due to uncertainty (Pavlou, 2003), which is what consumers

experience in circumstances where the amount of information generated by third parties is limited (Hong and Cha, 2013). For instance, in considering the increasing flow of information produced by algorithms to which consumers are subjected, several scholars (Granulo *et al.*, 2019; Logg *et al.*, 2019; Longoni *et al.*, 2019; Castelo *et al.*, 2019) focused on the implications of algorithm-based applications on trust. Following what has been suggested in the literature on trust, it is possible that, in the context of FOPLs, consumers may feel less trust in a label providing less information about the food content than in a richer and more detailed label. Furthermore, considering that some labels, such as the Nutri-Score (NS), are often constructed through algorithmic calculations, it might be of utmost importance to increase knowledge about the effects of algorithms on consumer behaviour regarding FOPLs. In addition, while several dimensions of trust have been explored, it remains unclear the underlying link that can support what public policies can be used to influence trust (Hobbs and Goddard, 2015).

In this context, in a sequence of three studies from the consumer's perspective, we recognize and reveal the relevance of trust in predicting label acceptance and, by improving the front-of-pack acceptance model (FOPAM) (Mazzù *et al.*, 2021c), provide an alternative point of view to previous models. On a sample of 1956 Europeans, we explore the role of trust as a mediator of the relationship between attitude and BI, thus upgrading the FOPAM (Study 1), compare label effectiveness between two labels at the extremes of the current European FOPL scheme, the NS and the NutrInform Battery (NiB), along the upgraded FOPAM framework (Study 2), and investigate the role of trust in the algorithm-based label as a mediator in the relationship between attitude and BI, while controlling the variable algorithm aversion (Study 3), and test the differences according to the two labels.

Theoretical background
Trust mediation in consumer acceptance of information
Previous research has led to conflicting results, with a lack of consistent evidence that a specific FOPL is more effective than others in supporting consumers towards more informed and healthier food choices along multiple variables; hence, the European Union's (EU) goal of identifying a single common label to be used by a set of diverse European consumers remains far from being realized (Mazzù *et al.*, 2021b). This also generates a high level of debate in some countries (Carruba *et al.*, 2021) and stimulates researchers to identify additional criteria and theoretical frameworks that can support a proper FOPL selection by policymakers.

Specifically, attention on consumers' comprehension has been broadened by a recent study that introduced the FOPAM (Figure 2) (Mazzù *et al.*, 2021c) with the aim of understanding whether consumers find labelling systems useful and easy to use when food shopping and whether they form their attitudes and intentions towards healthier products accordingly.
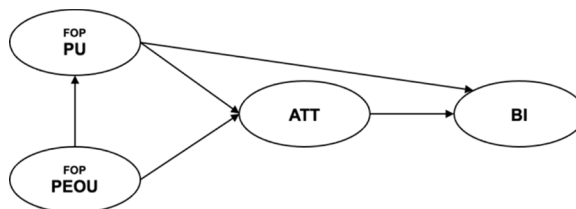

Figure 2.
Basic FOPAM

Drawing on the technology acceptance model (TAM) (Davis, 1989; Davis and Venkatesh, 2004), the FOPAM discusses the antecedents of BI, specifically, perceived usefulness (PU) and perceived ease of use (PEOU), to shed light on what increases the likelihood of accepting the information conveyed by FOPLs. These constructs (Table 1) implied by the TAM, could also be investigated outside information technology domains, such as in an FOPL-mediated context where the acceptance of information is required. They are also suitable for measuring the ability of a label to provide relevant (i.e. useful) and clear (i.e. ease of use) information to consumers to deepen the regard towards a label and the associated BI.

Accordingly, it has been demonstrated that PU and PEOU, when applied to an FOPL-mediated context, are significant predictors of attitude towards FOPLs, which in turn predicts BI towards using FOPL (Mazzù et al., 2021c). Specifically, FOPLs influence in-store purchases as they inform consumers about the nutrients of the product and are comparable to the decision support system that is frequently encountered and evaluated during food shopping (Caswell and Padberg, 1992; Hawley et al., 2013).

Although it has been shown that PU and PEOU are relevant antecedents for the acceptance of FOPLs (Mazzù et al., 2021c), it is also crucial to emphasize that consumers not only need to successfully interpret and understand information but also trust it sufficiently to influence the decision to buy (Rupprecht et al., 2020). Factors such as trust might increase the predictive power of TAM (Gefen, 2004), according to a meta-analysis of TAM conducted on 88 studies (King and He, 2006), and the same could be expected to happen with FOPAM.

In general, trust is an individual's attitude that has been defined by Hobbs and Goddard (2015) as "a heuristic that might be used in situations where lack of knowledge, experience or familiarity with firms, products or processes used to create products hampers decision making". Trust primarily concerns the willingness to accept something as true when vulnerability and uncertainty exist. Uncertainty is critical to trust because trust would be unnecessary if the trusting party has full control or total knowledge (Moorman et al., 1993; Morgan and Hunt, 1994; Coleman, 1994; Deutsch, 1958). As Blomqvist (1997, p. 272) reasons, trust can only exist when information is imperfect because "under perfect information, there is no trust but merely rational calculation". In our study, a context of perfect information is missing because the full information is not available to consumers with both NS and NiB. In the case of NS, and summary labels in general, not all the nutritional information is present but a summary assessment of the product's overall nutritional healthfulness, elaborated by an algorithm, is given; in the case of NiB, and nutrient-specific labels in general, consumers do not have a summary of all the nutritional elements that provides a clear integrated

Variable	TAM	FOPAM	
Perceived usefulness	"The degree to which an individual believes that using a particular system would improve his or her work performance" (Davis, 1989, 1993)	"The degree to which an individual believes that using a particular label would improve his/her healthier food choices"	
Perceived ease of use	"The degree to which an individual believes that using a particular system would be devoid of physical and mental effort" (Davis, 1989, 1993)	"The degree to which an individual believes that the physical and mental effort required to use a particular label is limited"	Table 1. TAM and FOPAM constructs on perceived ease of use, perceived usefulness and attitude
Attitude	"The degree of evaluative affect that an individual associates with the use of the target system in his or her work performance" (Davis, 1993)	"The degree of evaluative affect that an individual associates with the use of the target label in his/her food choices"	

indication to make a full comparison between, for example, different alternative dietary conditions. Thus, as FOPL information may still not be fully sufficient, trust appears to be critical in decision-making processes when FOPLs are assessed. This is true also when time constraints affect the consumer's opportunity to process information, make decisions and perform certain behaviours, because consumers are unlikely to process details systematically if they are under pressure (Suri and Monroe, 2003). However, in such cases, trust in others acts as a heuristic and allows consumers to make decision based on the trustworthiness of information source, as suggested by Lewicki and Brinsfield (2011).

Trust has been mostly researched as a mediator variable (Chang and Chen, 2008) and has been considered a major influential factor in the decision-making process (Alhidari and Almeshal, 2017) in several contexts. Indeed, lack of trust could impact adoption of new technologies, generate political resistance to policies and impede changes in behaviour that might otherwise be beneficial (Hobbs and Goddard, 2015). Conversely, with trust, consumers are more likely to engage in positive behaviours, such as purchase intention (Hong and Cha, 2013; Jiménez and San Martín, 2014; Cuong, 2020; Mahmud et al., 2020), repurchase intention (Trivedi and Yadav, 2020) and technology adoption (Van et al., 2020; Kassim et al., 2012; Siau and Shen, 2003). In addition, Dunning et al. (2012) show that trust is characterized by social and emotional aspects that cannot be underestimated and that it is necessary to address this aspect of trust in affecting various different decisions made at the level of the individual, also in relation to social behaviour (Kasperson et al., 1992).

In the context of food purchasing (Del Giudice et al., 2018; Glaeser et al., 2000; Hobbs and Goddard, 2015), trust has been identified as an important predictor of acceptance of functional foods, foods affected by nanotechnology (Siegrist et al., 2008, 2007) and unfamiliar versus more familiar organic food labels (Janssen and Hamm, 2014). Also, Lobb et al. (2007) demonstrate that decisions to purchase food products are influenced by "significant interactions between trust, risk perceptions and attitudes". Then, Lang (2013) found that trust among organisations is quite variable when examining the stakeholders who the public trusts with respect to genetically modified foods.

Following this stream, some researchers have proposed trust as a mediator of the relationship between attitude and BI. For example, Nguyen et al. (2019) demonstrated that attitude and website trust exert a direct and positive effect on the intention to purchase food online. Other authors have verified that trust is a mediating variable that is positively related to both consumer attitude formation and organic food purchase intention (de Magistris and Gracia, 2008; Wu and Chen, 2005; Yin et al., 2010), implying that trust, when combined with a positive attitude, can drive positive behaviours such as purchase intent. Even in the context of labels, trust has been identified as an antecedent of purchase intention. According to Harris et al. (2011), consumers with a higher degree of trust in the label rely on a higher level of BI, whereas those who find labels less trustworthy show less willingness to buy. Talati et al. (2016) indicated that trust, along with ease of interpretation, was the main factor that impacted the willingness to incorporate FOPLs into the evaluation process. It is clear that in the food context, trust has a pivotal role as an important factor in individual food purchasing decisions of credence goods (Carfora et al., 2019). Indeed, because there is information asymmetry about the characteristics of products (Cavallo et al., 2018; Garcia and Teixeira, 2017; Janssen and Hamm, 2014; Jensen et al., 2013; Nuttavuthisit and Thøgersen, 2017), an issue may arise when consumers think that certifications are not reliable (Carfora et al., 2019). As to which elements can overcome this lack of trust, providing more information to the consumer can be positive (Atkinson and Rosenthal, 2014; Daugbjerg et al., 2014).

However, although the studies previously mentioned suggest the active role of trust in the food context, to the best of our knowledge, the understanding of trust as a mediating variable of the relationship between attitude and BI in the context of FOPLs has been overlooked in the extant literature. These results indicate the possibility of demonstrating that, in the context of FOPL, the intention to use labels is positively influenced when consumers have greater confidence and trust in the labels. In fact, drawing on the definition of trust given by Moorman *et al.* (1993), both belief and BI must be present for trust to exist: trust is limited, if one only believes in the trustworthiness of the other, without being willing to rely on it, and vice versa. Hence, noting the role that the literature attributes to trust in information obtained from third parties, in both a technological and non-technological context, we propose the following:

H1. Trust mediates the relationship between attitude towards FOPL use and behavioural intention.

The comparative acceptance of nutrient-specific versus summary labels
As discussed earlier, given the rise of different FOPL proposals outlined in the EU, several researchers have investigated the differences in terms of FOPL comprehension and liking based on the conceptual framework developed by Grunert and Wills (2007), producing conflicting results between objective understanding (Packer *et al.*, 2021; Andreeva *et al.*, 2020; Egnell *et al.*, 2018a, 2018b, 2019; Ducrot *et al.*, 2015b, 2015a; Aschemann-Witzel *et al.*, 2013; Hersey *et al.*, 2013) and subjective understanding (Mazzù *et al.*, 2020, 2021a, 2021b, 2021c; De la Cruz-Góngora *et al.*, 2017; Hersey *et al.*, 2013). Table 2 provides a summary of previous studies.

The studies that compared the different FOPLs on objective understanding show, among other findings, a reduced degree of trust towards summary labels, mainly due to their simplicity and the smaller amount of information provided, when compared to nutrient-specific labels (Talati *et al.*, 2019). However, knowledge on this topic is limited as there are no past studies in the literature that have evaluated trust by comparing nutrition labels. Therefore, we attempt to fill this gap by comparing, through the upgraded FOPAM, the NS in the category of "summary labels" and the NiB in the category of "nutrient-specific labels". The former was developed by French researchers and adopted by France and other European countries, while the latter was developed and proposed by Italy (Carruba *et al.*, 2021; Ares *et al.*, 2018; Egnell *et al.*, 2018b; Finkelstein *et al.*, 2018; Talati *et al.*, 2019; Dréano-Trécant *et al.*, 2020). These labels were selected as they stand at opposite ends of the current scheme outlined by the European Commission (2020a, 2020b) and are prominent in the existing debate regarding the choice of an interpretive rather than informative supplementary nutrition labelling scheme (Carruba *et al.*, 2021).

Despite the wide adoption of NS by various countries and public institutions, results from Carruba *et al.* (2021) do not fully support the hypothesis that adopting this information system facilitates the conduction of a healthier lifestyle – maintaining a proper body mass index or reducing the probability of developing overweight or obesity – but they recognize the NiB system as more flexible and potentially more informative. In this context of public health, the concept of trust could play a fundamental role in progressing consumption of health-oriented food products and the form of information on FOP which garners ease of access for the consumer and the usefulness of same. Hence, we expect that the NiB is likely to be perceived as more useful and easier by consumers, as nutrient-specific labels convey more information and facilitate healthier choices for consumers (Talati *et al.*, 2019; Ducrot *et al.*, 2015a, 2015b; Aschemann-Witzel *et al.*, 2013; Hersey *et al.*, 2013), and to receive a

Variable	Evidence	Citation
Objective understanding	• Summary labels are more effective	• Ducrot *et al.* (2015a, 2015b); • Egnell *et al.* (2018a, 2018b)
	• Summary labels are easier to decode and more suitable for capturing attention thanks to the use of colour	• Ducrot *et al.* (2015a, 2015b); • Talati *et al.* (2019); • Hersey *et al.* (2013); • Aschemann-Witzel *et al.* (2013)
	• The NS (summary label) enhance participants' ability to identify the healthiness of foods and drinks more than the MTL (nutrient-specific label), which is considered the most informative FOPL	• Packer *et al.* (2021)
	• NS (summary label) achieves very positive results in terms of understanding and ability to allow respondents to rank food products in terms of nutritional quality	• Ares *et al.* (2018); • Egnell *et al.* (2018b); • Finkelstein *et al.* (2018); • Talati *et al.* (2019); • Dréano-Trécant *et al.* (2020)
Subjective understanding	• Nutrient-specific labels are preferred because the completeness and specificity of the information allow consumers to better define nutritional values	• Hersey *et al.* (2013)
	• The summary labels make it easier to estimate the healthiness of a product, meeting the needs of consumers who have limited processing time and who are required to make a quick decision process	• Hersey *et al.*, 2013; • De la Cruz-Góngora *et al.* (2017)
	• Consumers in multiple EU countries show preference for a richer and more informative label like the NiB (nutrient-specific label), compared to the NS (summary label)	• Mazzù *et al.* (2020, 2021a)

higher attitude and trust rating, given the completeness and specificity of the information provided. In addition, we hypothesize that the NS is more ease to be understood, as summary labels have been shown to facilitate the estimation of a product's healthiness (Hersey *et al.*, 2013), adapting to the needs of consumers who have limited processing time and are required to make quick decisions. Therefore, using the upgraded FOPAM model introduced in Study 1, we propose the following:

H2.   Perceived usefulness of NiB is higher than that of the NS.

H2a.   Perceived ease of use of NS is higher than that of the NiB.

H2b.   Attitude towards the usage of NiB is higher than that of the NS.

H2c.   Trust towards NiB is higher than that of the NS.

H2d.   Behavioural intention towards NiB is higher than that of the NS.

Trust towards algorithm-based labels

The main difference between nutrient-specific labels and summary labels is the assessment of the contribution of a portion of food to nutrient intake. In the case of the former, numerical information is provided on the content of four nutrients (fat, saturated fat, sugar, salt) and the energy value, as well as what this represents as a percentage of the reference daily intake (EU, 2020, p. 3); in the case of the latter, however, an evaluative judgment is provided via a "graded indicator" on how the numerical values should be interpreted (EU, 2020, p. 3). According to the French Santé Publique (2021), the score for a food is determined according to a threefold process: the assignment of favourable or unfavourable points to a nutrient; a subtraction of the total number of favourable points from the unfavourable points; and the definition of the given final score according to a predefined range. On the one hand, NS shows a graded indicator that uses both colours and letters to provide a synthetic assessment of the overall nutritional healthiness of the product. On the other hand, it exploits automated computing to form a second layer of judgment about food. Providing a graded indicator is attributed to a score, based on a predefined range, to a ratio based on the suggestions of experts and institutions. Conversely, in numerical nutrient-specific labels, the information is focused on the nutrient ratio based on thresholds defined by experts and institutions. Information on how the NS algorithm is calculated are present in several forms, including digital platforms easily accessible by consumers.

Taking into account the differences described in the formulation of the information provided by the two labels, it is relevant to note that the effectiveness of summary labels might be undermined by the aversion of individuals to algorithms (Dietvorst *et al.*, 2015; Longoni *et al.*, 2019; Dawes, 1979; Einhorn, 1986; Highhouse, 2008; Grove and Meehl, 1996). In general terms, individuals are reluctant to allow a numerical formula to make decisions for them, even though algorithms often exceed human judgment in terms of accuracy (Dawes *et al.*, 1989). They resist adopting recommendations generated by non-humans, and they do not trust the algorithm's ability to make accurate inferences about their preferences (Dietvorst *et al.*, 2015; Longoni *et al.*, 2019). Indeed, although some studies propose an alternative model of algorithm appreciation (Logg *et al.*, 2019), arguing for the greater accuracy and precision of algorithmic judgments compared to human evaluations (Dawes *et al.*, 1989), most studies show that consumers respond less favourably to algorithms, particularly when they are used to making more intuitive decisions (Guszcza *et al.*, 2017; McAfee *et al.*, 2012) than when they need to support the analytical aspects of decision-making (Jarrahi, 2018). Some of the reasons cited for causing aversion to algorithms are listed in Table 3.

Individuals have less trust in an algorithm than in an experienced human being (Castelo *et al.*, 2019), especially when the use of algorithms for each task seems to blur the boundary between humans and machines (the so-called "human distinctiveness threat"). Indeed, individuals rely more on a human advisor for more subjective decisions (Logg *et al.*, 2019), such as for medical care (Haslam, 2006; Loughnan and Haslam, 2007). One of the main reasons why domain subjectivity seems to undermine the increased reliance on algorithmic advice for objective estimates and predictions is closely related to the concept of uniqueness neglect, which identifies human concern about the inability of algorithms to explain a person's unique characteristics, as can humans (Longoni *et al.*, 2019).

The above evidence suggests that this concern could manifest itself also with food labels produced by algorithms, thus generating a lower level of trust when compared to human-based labels such as nutrient-specific labels. Consumer trust towards labels is enhanced, according to Rupprecht *et al.* (2020), when information is provided by independent and neutral experts using scientific methods to test and analyse foods, rather than by other

Motives	Citation
Desire for perfect predictions	• Dawes (1979);
	• Einhorn (1986);
	• Highhouse (2008)
Inability of algorithms to learn	• Dawes (1979)
Ability of human predictors to improve through experience	• Highhouse (2008)
Notion that algorithms are dehumanizing	• Dawes (1979);
	• Grove and Meehl (1996)
Concerns about the ethics of relying on algorithms to make important decisions	• Dawes (1979)
Fact that algorithms cannot adequately consider individual goals	• Grove and Meehl (1996)
Inability of algorithms to incorporate qualitative data	• Grove and Meehl (1996)

sources of food information. With regard to the operation of NS, marginal changes in some ingredients added in the production process have often caused a significant change in the output provided by the algorithm's calculation (Katsouri *et al.*, 2021), giving an example of its lower accuracy compared to labels produced using expert judgment. In addition, Narciso and Fonte (2021) highlighted that NS could tend to discriminate products that, if eating in moderation, have been considered quite beneficial in a diet; simplification of nutritional content might then not help to properly inform consumers on what they should eat but rather it could create further confusion.

Therefore, on the basis of the above, we assume that:

H3. Attitude towards the usage of NiB is higher than that for NS, including in contexts where FOPL computational methods are transparent.

H3a. Trust towards FOPL mediates the relationship between attitude towards using the FOPL and behavioural intention including in contexts where FOPL computational methods are transparent.

H3b. Behavioural intention enhanced by NS is higher than that by the NiB including contexts where FOPL computational methods are transparent.

H3c. Trust towards NiB is higher than that for NS including in contexts where the FOPL computational methods are transparent.

This study contributes to the extant literature by analysing the effect of trust in consumers' decision-making towards healthier choices.

To this end, in a sequence of three sub-sequential and interlinked online experiments, on a cumulative number of 1,956 primary grocery shoppers, we tested our hypothesis by advancing the FOPAM (Mazzù *et al.*, 2021) assuming trust as a mediator of the relationship between attitude and BI; observing potential mean differences between the NS and NiB according to the advanced FOPAM which involves trust as a mediator; and then repeating the procedure of the two previous studies and strengthening the results in a context where the algorithm (and related computational methods) behind the labels was explicitly disclosed.

Indeed, in Studies 1 and 2, we evaluated the relationships among PU, PEOU, attitude, trust and BI using a structural equation model (SEM) and then assessed the mean differences of the tested FOPL on each construct.

In Study 3, we deepened the results of Studies 1 and 2 by focusing only on the trust-mediated relationships between attitude and BI in the context of both disclosure of the computational methods behind FOPL and explanation of how the nutritional information is determined. Complementarily, we controlled for the algorithm aversion of individuals to prevent bias in the response.

Overview of studies

The development of three sequential studies allowed us to test our hypothesis according to extant literature gaps, the presence of FOPL in the country and the extent to which a FOPL has been tested. In Study 1, we assess whether trust is a relevant antecedent of BI, with the involvement of respondents from countries already adopting nutrient-specific labels and a summary labels (UK and France). In Study 2, we compare a nutrient-specific label and a summary label, and test relevant differences according to the FOPAM, with the involvement of respondents from a country not adopting FOPL yet (Italy). Finally, in Study 3, we tested the liking for algorithm-based labels, again with the involvement of Italian respondents while preventing potential bias derived from previous exposure to the labels.

Study 1
Research and method.
Participants and design. To ensure the recruitment of real consumers, for all three studies, we collected data derived from primary grocery shoppers on Prolific, a recently established international web panel provider that combines high recruitment standards and proper response rate, reliability and high replicability of studies (Palan and Schitter, 2018). Primary grocery shoppers were included regardless of the traditional gender roles within the household, as highlighted by several authors (Bhatti and Srivastava, 2003; Richbell and Kite, 2007). According to the recent paradigm shift in purchases, the number of both male/female and non-binary shoppers is on the rise, irrespective of the traditional perspective (Otnes and McGrath, 2001; Richbell and Kite, 2007). Furthermore, the filter ensures higher confidence that the interactions are associated with purchase-related tasks (Shim *et al.*, 1999). In Study 1, the sample consisted of 802 primary grocery shoppers from the UK and 703 from France. All participants accessed the study before an introductory screening of their knowledge of FOPLs. Those who never used FOPLS, both in real conditions and in the survey, were removed from the study, resulting in 800 valid cases for the UK and 670 for France.

Procedure. We evaluated the FOPAM model by analysing trust in the label as a mediator. The two groups of respondents were exposed to labels already present in their own market, namely, the NS in France and MTL in the UK. We conducted our research focusing on the MTL and NS as these two labels reflect different poles of the recent classification outlined by the European Commission (2020a, 2020b). Indeed, the NS is a summary label classified within the graded indicators, whereas MTL is a nutrient-specific label (European Commission, 2020a, 2020b). The MTL system was introduced into the UK in 2004, while the NS was introduced in France in 2017. This allowed us to test our hypothesis in a sample already exposed to FOPL who were aware of the underlying functioning.

All participants were asked to assess the measures referring to PU, PEOU, attitude and BI according to the labels of their own country. The FOPLs were described according to the

definition provided by the French Health Ministry (2021) and the UK Health Minister (2019) for the MTL.

To ensure subject familiarity with the FOPL being rated, we asked whether participants had ever used the label. Those who had lower than daily/weekly usage of the FOPL in their purchases were exposed to an additional task concerning the creation of a personal basket while using the information reported on FOPL. Specifically, respondents were asked to complete an online experimental task that consisted of selecting up to four products with the FOPLs attached, on the basis of five product categories that would be served to them and their family for brunch. Operationally, respondents were dragging and dropping into a basket, with a maximum number of products allowed, their food selection. We select five product categories and in each of these we include two alternatives of the same product (conventional vs light) based on the dietary composition, for a total of 10 food products. We aim at presenting products with different composition and, as a consequence, a different representation in terms of FOPLs to allow consumers to better understand how each type works. The categories and products included (in brackets, the first mentioned is the conventional product and the second mentioned is the light product) are the following: sauces (tomato with ricotta vs tomato with basil), yogurt (fruit yogurt vs zero-fat fruit yogurt), crackers (classic vs corn), biscuits (classic vs sugarless) and processed meat (salami vs cooked ham). Those who accomplished the simulated food selection either not using FOPLs at all or using it less frequently were excluded from the study. Instead, more regular users of FOPLs were exposed to the assessment of the items and were asked to rate the extent to which they agreed with each statement using a seven-point Likert scale (from "strongly disagree" to "strongly agree").

Statistical analysis. The response set was used to assess the reliability and validity of the constructs and the overall fit of the structural model. We performed a decomposition test using the bootstrap method, which allows inference of indirect effects. We performed the analysis on 5,000 samples with a bias-corrected bootstrap with a confidence interval of 95%. Overall, we followed two steps to define a set of valid and reliable scales. At the beginning of the study, we tested the scale's reliability and validity, and then assessed the differences in means among the constructs. Specifically, in the first phase of Study 1, we measured the overall reliability using Cronbach's alpha (Cronbach, 1951). The coefficient alpha is used to test the internal consistency of a scale that describes the extent to which all the items in a scale measure the same concept or construct; hence, it is connected to the inter-relatedness of the items within the test. Consequently, a confirmatory factor analysis (CFA) was performed to further assess the discriminant and convergent validity of both constructs while controlling for their effects. CFA is used to test a hypothesis, inquiring whether an expected pattern corresponds to a predetermined simple structure (Johnston, 2014). Convergent validity refers to the extent to which the same trait is measured by different items, whereas discriminant validity is defined as the extent to which traits are distinct (Carmines and Zeller, 1979). We further tested the common method bias for the data. This helped to confirm whether the items were able to measure the considered variable and discriminate with others. Also, we tested the discriminant validity of constructs by using the heterotrait-monotrait (HTMT) ratio of correlations (Henseler et al., 2015).

Finally, we tested the fit indexes of a SEM based on the research model (Mazzù et al., 2021c; Davis, 1993) assuming relationships among PU, PEOU, attitude and BI as latent variables. Then we evaluated the fit of the structural model. SEM allows the analysis of multivariate data and results to be appropriate for theory testing. This embeds observed variables and latent constructs, allowing us to test the associated validity and hypothesized relationships among them (Bagozzi, 1980).

Results
The CFA confirmed that the FOPAM fit for both countries was acceptable. The English sample displayed the following results: $\chi^2 = 285.021$; $p = 0.000$; goodness-of-fit index (GFI) = 0.951; comparative fit index (CFI) = 0.979; normed fit index (NFI) = 0.973; standardized root mean square residual (SRMR) = 0.027; root mean square error of approximation (RMSEA) = 0.064 (Hu and Bentler, 1999); all indices suggested an acceptable fit to the data (Hu and Bentler, 1999); the French sample also resulted in a high model fit ($\chi^2 = 166.162$; $p = 0.000$; GFI = 0.966; CFI = 0.988; NFI = 0.979; SRMR = 0.0229; RMSEA = 0.047; Hu and Bentler, 1999). The Harman's test for common method bias suggested an overall variance below the cut-off of 505 for both UK ($\sigma = 48.87$) and France ($\sigma = 41.27$). For both samples, all items highlight a high level of reliability and validity with all factor loadings exceeding the suggested cut-off of 0.70 (Fornell and Larcker, 1981). The convergent validity suggests that all loadings measure the construct properly ($\lambda > 0.70$ and squared multiple correlations [SMC] > 0.50) while remaining distinctive among them as average variance extracted is higher than SMC (Tables 4 and 5).

The HTMT reported values below the 0.90 cut-off for both samples (see Table 5) suggesting that the discriminant validity has been established and that constructs are able to discriminate the constructs under measurement (Henseler *et al.*, 2015).

Regarding the structural model, specified on the basis of the proposed research model (Nguyen *et al.*, 2019), the model fit was acceptable: $\chi^2 = 299.186$, $p = 0.000$; GFI = 0.949; CFI = 0.978; NFI = 0.972; SRMR = 0.031; RMSEA = 0.064 (Fornell and Larcker, 1981), indicating a high fit with the sample variance-covariance matrix. In addition, we found that all relationships were significant. In accordance with Nguyen *et al.* (2019), PEOU significantly predicted PU ($\beta = 0.583$; $p < 0.001$) and attitude towards using FOPL ($\beta = 0.266$; $p < 0.001$). Similarly, PU significantly affected attitude towards using FOPL ($\beta = 0.724$; $p < 0.001$) which in turn affects BI ($\beta = 0.300$; $p < 0.001$). Subsequently, we found a positive effect of attitude on trust ($\beta = 0.774$; $p < 0.001$) and trust in BI ($\beta = 0.138$; $p < 0.01$). Furthermore, we assessed whether trust was a significant mediator of attitude towards BI ($\beta = 0.106$; $p < 0.025$). This resulted in a direct effect greater than the indirect effect in the UK sample. Similarly, results from the French sample suggest a high fit of the model with the sample data: $\chi^2 = 182.934$; $p = 0.000$; GFI = 0.962; CFI = 0.986; NFI = 0.977; SRMR = 0.0274; RMSEA = 0.049. In addition, as in the previous model, all relationships were found to be significant. PU was positively affected by PEOU ($\beta = 0.521$; $p < 0.001$). Attitude was significantly predicted by PEOU ($\beta = 0.306$; $p < 0.001$) and PU ($\beta = 0.658$; $p < 0.001$) and, in turn, attitude positively predicted BI ($\beta = 0.349$; $p < 0.001$). The effect of attitude on trust was found to be significant ($\beta = 0.684$; $p < 0.001$) which in turn positively affected BI ($\beta = 0.349$; $p < 0.01$). The mediation effects of attitude on the relationship between PU and BI were positive ($\beta = 0.347$; upper limit (UL) = 0.360; lower limit (LL) = 0.193; $p < 0.001$). In this case, attitude partially mediates the effect of PU on BI, considering the greater size of the direct effect when compared with the indirect effect. In comparison, considering the size of the direct effect of attitude on BI, trust partially mediates the effect of attitude towards BI ($\beta = 0.075$; UL = 0.117; LL = 0.010; $p < 0.025$).

Discussion
The results of Study 1 provide support for our basic premise that trust mediates the relationship between attitude and BI, allowing us to highlight its relevant contribution in food consumer decision-making supported by FOPLs. Because relationships among variables are confirmed, and trust is observed to be a mediator in the relationship between attitude and BI, *H1* is supported. Analysis of the above results verified that trust is a determinant of BI,

Construct(s)	Item(s)	UK (n = 800)								France (n=673)							
		M	SD	CFA loading	SMC	t-value	p	α	AVE	M	SD	CFA loading	SMC	t value	p	α	AVE
Perceived usefulness (PU)	Food front-of-pack label give (will give) me access to useful food purchase information	5.540	1.140	0.771	0.555	18.479	***	0.924	0.771	4.994	1.329	0.807	0.599	24.992	***	0.924	0.756
	Food front-of-pack label are (will be) very beneficial to me	5.330	1.307	0.921	0.773	14.020	***			4.782	1.369	0.893	0.714	29.382	***		
	Using food front-of-pack label improves my food purchase	5.090	1.390	0.922	0.791	13.891	***			4.896	1.395	0.911	0.768	30.408	***		
	Using food front-of-pack label gives me greater control over my food purchase	5.260	1.374	0.862	0.704	16.949	***			4.848	1.430	0.863	0.691	27.792	***		
Perceived ease of use (PEOU)	My interaction with the food front-of-pack label is easy for me to understand	5.970	0.980	0.911	0.769	13.477	***	0.936	0.832	5.878	1.084	0.796	0.563	24.477	***	0.888	0.734
	Overall, I find the food front-of-pack label easy to use	6.020	0.987	0.947	0.797	9.253	***			5.997	1.056	0.918	0.704	29.776	***		
	It is easy to learn how to use food front-of-pack label for food purchase	6.050	0.955	0.876	0.711	15.850	***			5.990	1.058	0.850	0.628	26.441	***		
Attitude towards using (ATT)	I am positive about the front-of-pack label for food purchase	5.620	1.183	0.914	0.726	14.421	***	0.933	0.828	5.596	1.320	0.906	0.737	30.134	***	0.929	0.816
	The use of the front-of-pack label for food purchase is a good idea	5.930	1.039	0.898	0.762	15.486	***			5.731	1.217	0.918	0.773	30.795	***		
	It makes sense to use the front-of-pack label for food purchase	5.820	1.090	0.917	0.770	14.204	***			5.545	1.292	0.884	0.701	28.916	***		
Behavioural intention (BI)	I will use the front-of-pack label for food purchase in the future	5.580	1.315	0.942	0.480	5.850	***	0.810	0.681	5.209	1.453	0.942	0.480	0.532	***	0.842	0.746
	I will recommend using front-of-pack label for food purchase to my friends	4.790	1.597	0.736	0.480	17.952	***			4.579	1.584	0.736	0.480	0.532	***		
Trust towards the label (TTL)	This front-of-pack label inspires confidence	5.240	1.159	0.875	0.344	22.223	***	0.739	0.586	5.231	1.135	0.863	0.399	23.086	***	0.774	0.640
	Food products with front-of-pack labels are reliable and trustworthy	5.300	1.114	0.864	0.344	22.907	***			4.855	1.167	0.732	0.399	19.372	***		

Notes: ***$p < 0.001$; **$p < 0.01$; *$p < 0.05$

Table 4.
Model assessment –
convergent validity

particularly reinforced by attitude, thus enabling the introduction of the trust-mediated FOPAM model, as displayed in Figure 3, based on the results derived from two countries already exposed to different FOPLs and two samples of primary grocery shoppers.

Study 2
Research and method.
Participants and design. In Study 2, both labels were tested on 202 Italian respondents, because Italy is a country where any FOPL system has been previously adopted.

Procedure. In Study 2, we assessed the mean differences according to the constructs tested and validated in Study 1. Indeed, to the best of our knowledge, this is the first study to measure the mean differences of FOPLs' PU, PEOU, attitude and BI. As in the previous study, the items were evaluated by respondents after being exposed to the NiB and NS with cues from descriptions derived by the French Health Ministry (2021) and the Italian

	PEOU	PU	ATT	BI	Trust
UK (n = 800)					
PEOU					
PU	0.527				
ATT	0.615	0.752			
BI	0.444	0.689	0.689		
Trust	0.450	0.454	0.524	0.438	
France (n = 673)					
PEOU					
PU	0.603				
ATT	0.639	0.803			
BI	0.547	0.760	0.809		
Trust	0.532	0.655	0.726	0.730	

Table 5.
Model assessment –
heterotrait-monotrait
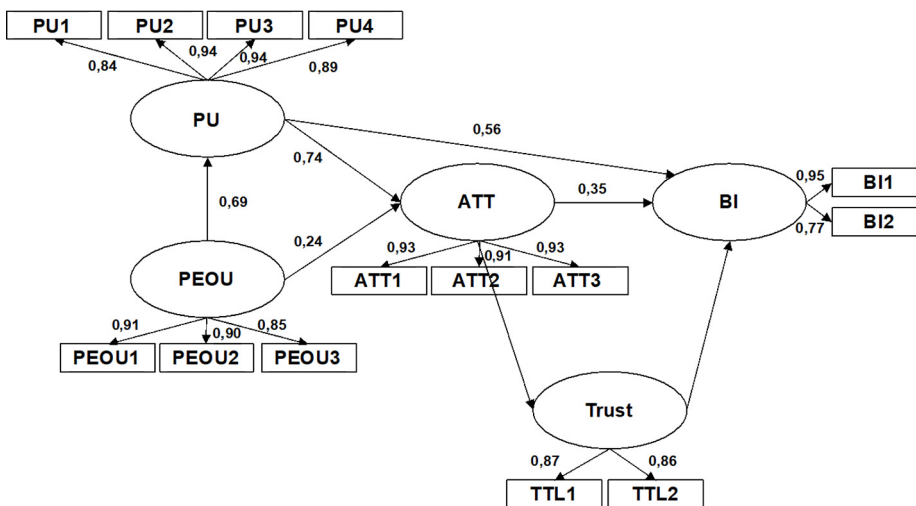ratio of correlations
for discriminant
validity

Figure 3.
Trust-mediated
FOPAM model

Economic Development Ministry (2021). Participants were then asked to rate the extent to which they agreed with each statement using a seven-point Likert scale (from "strongly disagree" to "strongly agree").

Statistical analysis. In Study 2, we assessed the reliability of items and then ran an independent *t*-test to explore potential mean differences according to the items evaluated.

Results
We validated our results using an independent two-sample *t*-test for each dependent variable, namely, PU, PEOU, attitude towards using the FOPL, BI and trust towards the label. The following results were organized according to the variables analysed. In addition, all the measures collected in the study were above the suggested cut-off of 0.7 of Cronbach's alpha (Cronbach and Gleser, 1959). PU was 0.952, PEOU 0.899, attitude scale 0.969, BI 0.936 and trust 0.949.

Assuming PU as the dependent variable, the results showed a positive mean difference (MD = −0.859; $p < 0.05$) between the NiB (M_{NiB} = 5.69; SD = 1.20) and NS (M_{NS} = 4.83; SD = 1.70). This indicates that respondents perceive the NiB as more beneficial and useful for providing information about the food and improving their control over the purchase. Regarding PEOU, the results highlight a significant mean difference (MD = −0.39; $p < 0.05$) between the NiB (M_{NiB} = 5.65; SD = 1.17) and NS (M_{NS} = 5.28; SD = 1.41). The nutrient-specific label is perceived as easier to understand and use than the NS. Similar results were also confirmed for attitude towards the label. However, a significant mean difference (MD=−0.87; $p < 0.05$) between the NiB (M_{NiB}=5.84; SD = 1.32) and NS (M_{NS} = 4.96; SD = 1.85) was assessed. Thus, respondents are more likely to develop positive attitudes towards the NiB rather than the NS. In addition, significant results have been highlighted, assuming trust towards the label as a dependent variable. Indeed, the NiB (M_{NiB} = 5.56; SD = 1.43) significantly differs from NS (M_{NS} = 4.69; SD = 1.69) (MD = −0.87; $p < 0.05$). Hence, respondents found the Italian label to be more reliable and trustworthy than the summary label. Regarding BI, respondents are more inclined to use and recommend the NiB than the NS. In fact, the results highlight a significant mean difference between the two labels. The NiB reported a mean of M_{NiB} = 5.65; SD = 1.41 whereas the NS of M_{NS} = 4.90; SD = 1.89, resulting in a mean difference of MD = −0.74 ($p < 0.05$). All results are shown in Figure 4.

Discussion
The results of Study 2 demonstrate that the relative performance of different labels on FOPAM can be explained by the dimension of trust. Study 2 highlighted the better effectiveness of the NiB compared to the NS with regard to PU, PEOU, attitude, trust and BI, supporting *H2*, *H2b*, *H2c* and *H2d*, respectively, while leading us to reject *H2a*. The above results indicate that respondents perceive that the NiB is better than NS, thus contributing to knowledge on the debate about the superiority of FOPLs. Specifically, the NiB is perceived as more beneficial and useful for providing information about food, improving consumers' control over the purchase and easier to understand and use than the NS. Moreover, consumers are more likely to develop positive attitudes towards the NiB, which is considered more reliable and trustworthy than the summary label, and are more inclined to use and recommend the NiB than the NS.
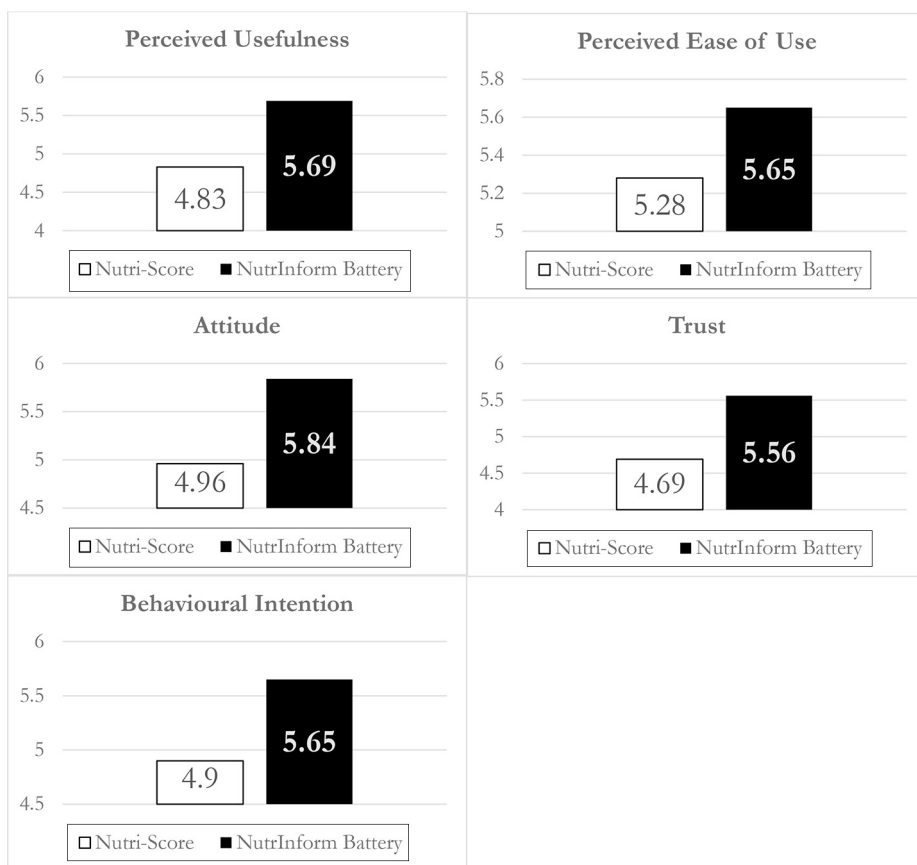
Study 3
Research and method.
Participants and design. Study 3 involved once again respondents from Italy, as they are not aware of the computational elements behind the different FOPLs, since no FOPL system has yet been adopted in the market. Participants amounted to 199 for this round.

Procedure. Since the definition of the algorithm is now under investigation and is mathematically and philosophically challenging (Moschovakis, 2001), prior to the study we performed a manipulation check on 60 Italian primary grocery shoppers. Respondents were asked to judge how the nutritional information presented on two different FOPLs and their consequent output applied to the packaging (i.e. NS and NiB), were formed. Specifically, using a seven-point Likert scale, consumers evaluated whether they perceived the nutritional information provided by FOPLs deriving from an algorithm, a nutritional expert, a consumers' associations, firms or an institution. This step allowed us to define whether consumers naturally recognize the different degrees of algorithm presence in each FOPL design.

Subsequently, we tested the mediation effect of trust between attitude and BI, cueing the description of both labels with computational details derived from the official methodologies

developed by the Italian Economic Development Ministry (2021) for NiB, and the French Health Ministry (2021) for NS. We collected a total of 197 Italian primary grocery through an online survey which provided the computational information behind the FOPL. The analysis was organized in two steps: first we developed a mediation analysis between attitude, trust, and behaviour; and then the response set was used to test the mean differences among the experimental conditions. The items involved in the study were the same as those used to collect responses in Studies 1 and 2 (see Table 3a). However, the stimuli adopted varied according to the aforementioned design. Hence, the respondents answered the same questions in Studies 1 and 2 after being randomly exposed to the description of the computational methods behind the FOPL. Eleven outliers were excluded from the study.

Statistical analysis. In Study 3, assuming BI as DV, attitude as IV and trust as a mediator while controlling for algorithm aversion, we ran a mediation analysis using Model 4 in PROCESS (Hayes, 2017).

Results

Manipulation check. We first checked how many respondents indicated that one of the two labels appeared more algorithm-based rather than outlined by nutrition experts, consumers' associations, institutions or firms. The results revealed that respondents perceived the French NS as more algorithm-based ($M_{NS} = 4.39$; SD = 1.606) than the NiB ($M_{NiB} = 4.04$; SD = 1.710; $t(1.57 = 815$; $p < 0.05$). Importantly, these results demonstrate that NS directly leads to an increase in the perception of algorithm-based graded indicators, whereas the NiB, composed of a sequence of percentages, reflects an expert computation behind the values.

These results allowed us to assess whether consumers perceive different underlying computational sources connected to the labels. Also, the results suggest that consumers properly discriminate among the different computational method of the information reported on the labels and recognize the different nature of the FOPL (i.e. algorithmic-, expert- or institutional-based FOPL). Hence, we further assessed the relevance of these differences in the main study checking the effects of the disclosure of the computational methods. To control these effects, we also measured the algorithm aversion and used it as a control variable.

Mediation analysis. Then, to test *H3*, we used Model 4 of PROCESS, controlling for algorithm aversion which was evaluated using the PANAS scale (Watson *et al.*, 1988). We first regressed trust towards the algorithmic label on the attitude towards using FOPL, and then regressed BI on trust and attitude towards its use. The results showed that an increase in attitude towards using the FOPL led to a higher trust of the label [$b = 0.73$; $t(189) = 16.37$; $p < 0.001$]; the trust, in turn, positively affected consumers' BI [$b = 0.36$; $t(189) = 6.26$; $p < 0.001$]. However, because the algorithm aversion does not vary significantly across the sample, we found it to be insignificant [$b = 0.25$; $t(189) = 0.92$; $p = 0.35$]. When considering attitude towards using FOPL in the regression model with BI as the dependent variable, the variable shows a positive significant effect on BI [$b = 0.53$; $t(189) = 9.691$; $p < 0.001$]. More importantly, the indirect effect of trust variable on BI was positive and significant ($b = 0.2607$; 95% CI: 0.1659–0.3675), thus confirming that trust partially mediates the effect of attitude towards using the label on BI (*H3a*).

FOPL superiority on constructs. Next, to assess whether the FOPLs cued with computational details significantly varied the perception of the two FOPLs, we ran a sequence of independent two-sample *t*-tests. With regard to the comparison between NS and NiB cued with computational information, the nutrient-specific label showed higher means in terms of attitude [$M_{NS} = 5.30$; SD = 1.56 vs $M_{NiB} = 6.03$; SD = 0.84; $t(1.189) = -3.778$;

$p < 0.001$] and trust [$M_{NS} = 4.94$; SD = 1.47 vs $M_{NiB} = 5.58$; SD = 0.90; $t(1.189) = −3.410$; $p < 0.001$]. Similarly, BI varied significantly between the two labels [$M_{NS} = 5.30$; SD = 1.47 vs $M_{NiB} = 5.89$; SD = 0.94; $t(1.189) = −3.134$; $p < 0.001$]. Hence, the NiB showed significant and positive mean differences in terms of trust, attitude and BI when the two labels were cued with details referring to the computational information. Thus, *H3*, *H3b* and *H3c* are supported.

Discussion
The results of Study 3 provide additional evidence for the proposition that trust plays a mediating role between attitude and BI by further assessing its effect in cases where the connection between trust and algorithms is made transparent. One of the main insights of this study is that consumers are able to recognize the fact that an FOPL is derived from complex computational models and differentiates against others which are not. Indeed, thanks to a deepening of the construct of trust, it is possible to understand the extent to which even an indirect presence of algorithmic elements can result in changes in consumer decision-making. In fact, trust in FOPL cued with algorithms could be a key element in acknowledging whether the acceptance of specific labels, based on computational methods, can be compromised by algorithm aversion. In addition, Study 3 revealed a significantly different perception of the two labels among respondents in terms of the perception of algorithm presence. Furthermore, on the one hand, NS directly leads to an increase in the perception of the algorithm behind the graded indicators; while on the other, the NiB, composed of a sequence of percentages, reflects an expert computation behind the values.

The results also showed that an increase in attitude towards using the FOPL led respondents to feel greater trust in the label, positively affecting their BI. Thus, it was confirmed that trust partially mediates the relationship between attitude and BI, supporting *H3*. In addition, examining the results for the individual variables shows evidence that the NS was less effective than the NiB on attitude, BI, and trust, supporting *H3*, *H3b* and *H3c*, respectively. Moreover, the results indicated that respondents do not vary their attitude towards the label, trust and BI if the FOPLs are combined with computational details. Indeed, consumers recognize the nature of labels, regardless of the information provided. However, comparing the NS and NiB under the condition of computational information disclosure and not, the latter relies on a higher degree of trust and attitude in both scenarios. Hence, the NiB showed significant and positive mean differences in terms of trust, attitude and BI when the two labels were cued with details referring to computational information.

Discussion
Theoretical and managerial implications
While the importance of FOPLs has been acknowledged in prior research (Hersey *et al.*, 2013; Aschemann-Witzel *et al.*, 2013; Ducrot *et al.*, 2015b; De la Cruz-Góngora *et al.*, 2017; Egnell *et al.*, 2018a, 2018b; Talati *et al.*, 2019; Packer *et al.*, 2021; Mazzù *et al.*, 2020; Mazzù *et al.*, 2021a), a consensus has not been achieved on which label would be the best to support customers towards more informed and healthier food choices. Drawing on the fundamental variables of consumer objective and subjective understanding in the framework proposed by Grunert and Wills (2007), researchers found different evidences (Hersey *et al.*, 2013; Aschemann-Witzel *et al.*, 2013; Ducrot *et al.*, 2015b; 2017; Egnell *et al.*, 2018a, 2018b; Talati *et al.*, 2019; Mazzù *et al.*, 2020; Mazzù *et al.*, 2021a) resulting, depending on the situation, in a higher effectiveness of summary labels (e.g. NS) or of nutrient-specific labels (e.g. NiB).

The need to move from the focus of research from understanding towards a new framework has been advanced by the new FOPAM model (Mazzù *et al.*, 2021b) which,

however, overlooked the importance of trust, as a fundamental variable in food decision-making, and as a relevant antecedents of the acceptance (Handi *et al.*, 2018; Harridge-March, 2006). Indeed, in Study 1 we clarified the centrality of trust towards FOPL as a determinant of BI towards labels and a mediator of the relationship with attitude, shedding a light on the fact that BI connections were most mediated by trust. This, in turn, motivates consumers to adopt the FOPL. These findings suggest the importance for institutions and regulators of being aware of those labels which are more likely to inspire trust among consumers.

According to bounded rationality, consumers tend to take suboptimal decisions due to cognitive limitations, imperfect information and time constraints. When buying food products, they are exposed to a lack of information given by the credence nature of some food products and the related difficulty to assess their attributes even after consuming them. In this vein, FoPL might support the change of the perception of nutrients from credence to search food attributes and are adopted as an extrinsic cue which appear to be useful in situations when credence characteristics predominate the decision-making process (Fotopoulos and Krystallis, 2003). However, in this credence-to-search transformation process, there are at least two implicit mediators intervening in the decoding process that need to be trusted: the computational method behind the transformation process and information (i.e. the algorithm), and the information source (i.e. the label). Furthermore, summary labels do not present a detailed explanation of the attributes whereas nutrient-specific ones do not summarize the nutrients in a sole indicator that could be easily benchmarked. In this vein, the paper shed light on the fundamental role of trust as a mediator by confirming how this variable can change the output of the behavioural intention and, subsequently, confirms how consumers attach variable levels of trust towards different computational methods and labels. Furthermore, it can even act as a heuristic to take decisions. To the extent of our knowledge, it is the first contribution highlighting the role of trust in FOPL-mediated context and comparing its outcomes in relation to nutrient-specific and summary labels.

In contrast, it may be argued, that both components, the computational methods and information source, can contribute to the generation of an imperfect information. In fact, consumers may ignore the rationale of the calculations behind the FOPL and how the label is built. This leads to a relevant implication for policymakers and food brands that should intervene to educate consumers towards the usage of this labels that will become mandatory in all European countries in the upcoming years. By promoting these labels and their rationale, they will increase their related expertise and, in turn, drastically decrease the credence component of foods and allow them to take a more informed decision.

The upgraded FOPAM, validated cross-country in Study 1, could then be used as a valid alternative to existing models based on understanding to assess the superiority of different FOPLs. The structural elements of the model – ease of use and usefulness – combined with trust as a key mediator, take into account and balance the strengths of the different categories (e.g. summary vs nutrient-specific) of FOPLs, towards the formation of BI.

The FOPAM offers a comprehensive reading of the antecedents of the FOPL acceptance. In fact, if compared to other models discussed in the literature (Grunert and Wills, 2007), it integrates a set of variables that can potentially favour the outcomes of both summary labels and nutrient-specific labels. According to previous studies, the NS should be easier to use while the NiB more informative and useful. However, this evidence have been tested only focusing on specific parts of theoretical models. If we observe the model of Grunert and Wills (2007), it integrates objective and subjective understanding in the same model, but the majority of evidence arise only by focusing either on the subjective or objective part, leading to opposite results.

In contrast with previous studies, this paper theoretically contributes to the literature by offering a comprehensive and balanced model able to take into account the diversity of all FoPL and explain their effectiveness while avoiding to be construct-specific.

Also, considering the implied differences in the European territories in terms of cultures and the aforementioned absence of homogenous results in the literature, the EU could opt for a non-univocal choice allowing countries to implement the preferred options. The most recent goal of EU policymakers, is to find an harmonized and universal labelling system to adapt in all European countries. However, there are two current risks that EU should contrast. The first risk is to outline a labelling scheme which is not fully supported by converging evidence. The second one refers to the risk to implement a labelling scheme grounded on the evidence created on recurrent models and overlook the fragmentation of other valid positions in the literature that together contribute to depict an environment in which the different and still valid results reflect the diversity of alternatives that are equally effective. The right choice of FoPL would benefit the food industry but, there are still additional usage gaps that must be fulfilled to define the best option. This study represents an initial contribution to this field.

Study 2 than showed that the NiB would obtain superior responses to NS across all dimensions of FOPAM. Consumers tend to perceive NiB as more trustworthy and are able to guide consumer choice in an informed way. In addition, in facilitating consumers' understanding of information, the NiB experiences limited impact from sociocultural differences compared to the NS (Mazzù *et al.*, 2021a), rebalancing the claim that age, socio-economic status and education influence consumer choice, regardless of the amount and type of information contained in FOPLs (Narciso and Fonte, 2021; Grunert and Aachmann, 2016). In conditions of imperfect information, consumers might prefer labels able to summarize the information. However, this study further contributes to literature highlighting that in context of imperfect information, consumers tend to prefer nutrient-specific labels as more informative, detailed and able to clarify the credence components of the product. It suggests that policymakers should find the right balance between informative labels and summary ones. Further research might also explore whether bundling of FoPL could generate healthier and more informed food choices; a potential solution in line with the "Presidency Conclusions on front-of-pack nutrition labelling, nutrient profiles and origin labelling" document which allows member states to use their respective FOPL while bundling their proposal alongside the upcoming harmonized EU FOPL scheme (European Commission, 2020b).

While prior research has identified the variation of the understanding of the labels, the liking or the units consumed by users, our findings further advance extant theory by observing the differences in the variables involved in the FOPAM and showcasing the higher level of trust attached to the NiB. In general, consumers purchase intention increases with trust because they perceive less risk and uncertainty (Handi *et al.*, 2018; Harridge-March, 2006) and thus are more likely to buy or use a product or service (Bulut and Karabulut, 2018; Fang *et al.*, 2014; Limbu Yam *et al.*, 2012; Seo *et al.*, 2020); conversely, consumers experience uncertainty when fewer information is available (Hong and Cha, 2013). Therefore, in an FOPL context, consumers are least likely to trust a poorly detailed label on food content compared to a richer, more informative label.

In addition, considering that some labels, such as NS, are claimed to be the result of algorithmic calculations, this study shows statistically significant differences in the effects of algorithms on consumer behaviour and investigates whether the mediating role of trust in the label is also effective in these contexts. In this context, Study 3 further extends the literature on food decision-making by clarifying the acceptance in settings where the FOPLs

underlying computational model are made transparent to consumers. As shown in Study 3, adding details relating to the computational method that each type of label adopts did not change the results for the NiB, which always remained higher than for the NS, which instead recorded a greater negative perception. FOPL cued with algorithms appears to be less trustworthy and consumers' evaluation is compromised by algorithm aversion (Dietvorst *et al.*, 2015; Longoni *et al.*, 2019; Dawes, 1979; Einhorn, 1986; Highhouse, 2008; Grove and Meehl, 1996). Study 3 further aspires to provide additional support to policymakers in understanding the complex process of label acceptance and consequently develop guidelines that could promote better dietary habits among consumers. It also contributes to the advice-taking literature through an empirical examination of the resistances deriving from the adoption of non-human recommendations (Dietvorst *et al.*, 2015; Longoni *et al.*, 2019) highlighting that consumers respond less favourably to algorithms when they need to support the analytical aspects of decision-making (Jarrahi, 2018). An efficient education strategy activated by policymakers and food brands could shed light on the computational methods of the labels, highlight their benefits in orientating consumers towards healthier choices and automatise the informative process.

The FOPAM represents a research model that is complementary to other approaches adopted in the literature, such as that developed by Grunert and Wills (2007), expanding the set of available theoretical support for labelling and food consumers' decision-making. The evidence from this study is relevant to institutions, who could thus be encouraged to base their labelling policies on the fact that consumers may be less inclined to accept labels they consider less trustworthy. Also, these findings can lead consumers on the path to food well-being that is a collaborative venture between consumers and food providers (Bogomolova *et al.*, 2021). In this vein, marketers and regulators can also interact with customers to co-create products that meet their needs (Ashman *et al.*, 2021), or stimulating insights on consumers' interpretation of the food label (Machin *et al.*, 2021). In a context where health "is used by marketers to idealize, embellish, and highlight the positive aspects of the food industry over the more controversial ones" and to connect with other concerns such as sustainability and nutrition (Silchenko and Askegaard, 2021), FOPL could support proper informed choice about the real composition of the product and move consumers towards healthier food choices.

Finally, the upgraded FOPAM offers an alternative theoretical model to move forward in the European debate for assessing the relative effectiveness of different FOPLs and for preventing the possible introduction of less reliable and effective labels, from the point of view of customer acceptance, and could help overcome the concern highlighted by previous models by acting as a potential support to institutions that are considering which common FOPL to adopt.

Present limitations and opportunity for future research

Our study has some limitations. The sample consisted of Italian, French and English respondents and two FOPLs. Future research should therefore try to target individuals from different countries to ascertain whether the results are broadly generalizable, and measure the potential moderating effect of FOPL knowledge among different customer groups. Furthermore, although our research has made trust relevant, the model could be further integrated by considering other variables, such as actual use and perceptual use, user experience level or type of users, and type of use, which were used as moderators in the past applications of the TAM (King and He, 2006; Venkatesh, 2000).

It would also be of value to expand the current study by including in the perspective, also in the light of the from-farm-to-fork strategy, the inter-play and the effects of combining food and eco-sustainable labels on consumers' food decision-making.

In addition, our study posits that consumers do or do not trust information about FOPL. However, the presence of trust could be a consequence of their perception that the FOPL information is telling the truth. In fact, consumers should not trust the brand or product if they believe the FOPL information is false or not entirely honest. As a result, future research could also study respondents' perceptions of whether what they read on the label is true or not to understand if this has implications for trust.

Finally, we mentioned the opportunity for marketers to engage with customers to collaboratively create products that meet their needs, stimulating insights into consumer interpretation of the food label (Machin *et al.*, 2021). This process can be extended, becoming appealing for future research, to include a design thinking approach that can enable the development of "generative engagement" (Garud *et al.*, 2008) to usher in change towards sustainable practices (Parth *et al.*, 2021).

Conclusion

In conclusion, this research contributes to the European debate with the aim of providing an alternative viewpoint to that offered by Grunert and Wills (2007) to confront food decision-making processes, that of the consumer. In our study, we demonstrated that a strengthened theoretical contribution in FOPAM is of significant practical contribution as support to decision-makers, avoiding the problem of non-converging evidences, shown by previous models, in assessing the effectiveness of different FOPLs. The upgraded FOPAM could help overcoming this, as a potential support to Institutions that are currently evaluating which common FOPL should be adopted. Through three studies, we have revealed the implications of trust, as a key factor of consumer behaviour, on consumer acceptance of FOPLs, providing theoretical and practical support to policymakers through an upgraded version of the recent FOPAM used to explore the mediating role of trust. In fact, trust has not only proved to be a determining factor in the BI of consumers towards food labels but has also made it possible to build a model capable of measuring the different performances of two divergent labels – the NiB and the NS – leading to clear and incontrovertible results on the superiority of the NiB across all dimensions of the FOPAM (ease of use, utility, attitude, trust and BI).

The results of these studies provide new findings on the effectiveness of the FOPAM and on the role of trust in influencing consumer response to FOPL. The issues addressed are all of direct public policy relevance, as the adoption of nutrient-specific labels could be beneficial to consumers. The NiB system allows the consumer to make informed choices on whether to eat that specific product based on its personal decision, knowing that it should not go over the suggested daily intake to maintain a healthy diet (Narciso and Fonte, 2021). Non-directive labels require more cognitive effort from the consumer, but in the long run, this could favour an increase in nutrition knowledge and more balanced dietary patterns (Muzzioli, *et al.*, 2022). If trust plays a role in influencing consumer acceptance of these labels, then policymakers are encouraged to promote nutrition education among consumers through the diffusion of specific food labels, and clarify more the algorithmic essence of some of them.

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