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STUDIES IN HUMANS

A cross-country experimental study on consumers' subjective understanding and liking on front-of-pack nutrition labels

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ABSTRACT

Different Front-of-Pack (FOP) nutritional labels have been implemented in order to increase consumers' awareness of food nutritional quality and encourage healthier choices. However, few studies have analysed the effects of FOPLs on consumers' subjective understanding and liking across different socio-cultural contexts. This study tests the effect that the new enriched informative label NutrInform Battery and the summary label Nutri-Score have on subjective comprehension and liking across 2776 respondents of seven European countries (France, Germany, Greece, Italy, Portugal, Romania and Spain). Main effects regarding socio-demographic differences are also explored according to extant literature and highlighting significant effects of education and income. This study therefore extends the current research on subjective understanding and liking with a cross-country analysis. Findings suggest that NutrInform Battery can help consumers in understanding information in a relevant way, obtaining the highest performance across countries and showing limited impact of socio-cultural differences.

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Front-of-pack nutritional label; Nutri-Score; NutrInform Battery; subjective understanding; liking; cross-country

Introduction

In recent years, the increase in consumption of high-sugar, high-fat, high-salt and energy-dense food, combined with changes in lifestyle and a decreased physical activity, contributed to a sharp surge in the number of people affected by obesity (WHO 2020). According to some estimates, by 2025, obesity will increase in 44 countries and, as many as 33 of the 53 European states will be characterised by 1 in 5 people which will be over-weight (Pineda et al. 2018). Furthermore, the projections are not encouraging: some forecasts suggest that 51% of the world population will be obese by 2030 (Finkelstein et al. 2012). Given the magnitude of the problem, and without a clear intervention in order to revert the trends, serious negative consequences might affect part of the population, with subsequent risks on noncommunicable diseases (WHO 2020).

Therefore, also in light of the relationship between individuals' nutritional conditions and success in chronic disease prevention, helping consumers to make healthier food choices has become a priority for governments, authorities, socially responsible businesses and organisations, in their attempt to identify ways to control overweight and obesity.

The solution would require not only a potential change in formulation by producers of some specific pre-packaged products, but also, and more important, the development of a system that can help consumers taking food-eating decisions, eventually positively changing them, in an informed way. On their side, companies, institutions and society at large have increasingly committed to actions aimed at reformulating the nutritional information presented on food packages (van der Bend and Lissner 2019). While back-of-pack information already showed their effectiveness in generating healthier eating intentions on people who read those information (Barreiro-Hurle et al. 2010), a more "visible approach" would be required to widen the impact of labels. In particular, the introduction and diffusion in some countries of "Front-of-Pack Labels" (also, in the acronyms, "FOP labels" or "FOPLs"), i.e. labels that carry nutritional information on the front of the packaging of food products (van der Bend and Lissner 2019) that are not Nutrition Facts Panel (NFP), represents an important opportunity to increase consumer awareness, to link eating habits to the state of health, and to stimulate the

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reduction of the demand and consumption of products with high levels of sugars, sodium and saturated fats. FOPL in recent years have then become more and more part of the discussion among institutions, governments, firms and private citizens. The number of initiatives promoted by nutritionists, food scientists and the media has significantly increased. These initiatives all tend to create associations, direct and indirect, between the presence (or absence) of certain nutrients and health and well-being, with sometime the aim of "nudging", i.e. "gently" affecting consumer behaviours (Thaler and Sunstein 2008) towards a more balanced and healthier personal diet, to which many improvements are connected for individual consumers and for the community. However, the absence of a unique worldwide regulation has generated, overtime, a great variety of FOP labels, often combined with equally heterogeneous regulatory policies, with a lack of unambiguous and incontrovertible evidences of an absolute superiority of a specific FOPL, affecting behaviours and the health of consumers. Scientific backing on previous cross-country studies, shows non-identical performances of different FOPL on variables along multiple steps of consumers' behaviour. The problem is then far from being solved, while the recent EU "Farm-to-Fork" Strategy highlights the need of harmonisation among FOPL within 2022 (European Commission 2020).

This paper aims at contributing to the current discussion by exploring subjective understanding and liking in seven European Countries, characterised by a different state of FOPLs' public debate and market penetration. Specifically, the study investigates the perception that consumers have on NutrInform Battery, a new *Nutrient Specific* enriched informative FOPL, and compare it with Nutri-Score, one of the most diffused *Summary Label* at EU level, designed to support consumers make healthier choices.

The paper is organised in three sections. First, we briefly recap some FOPL alternatives present in the market, illustrate the selected FOPL classification utilised and its link with the main theoretical framework. We then show statistical analyses and the main results with specific attention to potential cross-interactions between FOPL and countries. Finally, we discuss the main implications, highlighting the limitations of our work and hypothesising new research avenues.

Conceptual framework and extant literature

In Europe, FOPLs were first introduced in the late 1980s in Sweden through the adoption of the Keyhole Logo (Kanter et al. 2018). In 2006, the European food and drink industry presented the Guideline Daily Amount (GDA), later known as Reference Intakes (RI). In 2011, the European Union introduced a Regulation (EU Regulation 1169/2011 2011) allowing Member States, together with Iceland, Norway, Liechtenstein and Switzerland, to develop, on a voluntary basis, FOPLs guidelines and stimulating a debate about the effectiveness of the different systems in use (van der Bend and Lissner 2019). In the absence of a FOP nutritional scheme that would be understandable and acceptable for all EU consumers, Member States and food business operators developed their own schemes, adapted to their consumers, and compliant with certain criteria. Examples are the Multiple Traffic Light (MTL) introduced in the UK in 2013 by the Department of Health (European Parliaments and the Council 2020), the Nutri-Score (NS), adopted in France as of 2017, in Belgium as of 2019, in Germany as of 2020, and announced to be adopted in Luxembourg in 2021, and the NutrInform (NI) Battery System, a proposal from the Italian government in 2020. Outside Europe, other relevant systems are the Health Rating System (HSR), present on a voluntary basis in New Zealand as of 2014 (Hamlin and McNeill 2016) and the Warning Labels (WL) present in the Chilean market as of 2016 (Reyes et al. 2019). In 2018, at global level, a FOP scheme is present in more than 40 countries (Anvisa 2018).

Extant literature provided different definitions, taxonomies, and classifications of FOPLs (Kanter et al. 2018; van der Bend and Lissner 2019). In this paper, we adopt the current EU view on typologies and formats of FOPL, based on schemes implemented, or proposed, or announced at Member States and UK level (European Parliaments and the Council 2020). The approach distinguishes FOPL in two main categories: (1) "Nutrient Specific FOP" and (2) "Summary Labels". The first category is then clustered into two main sub-categories: (1a) "Numerical FOP", typically "non-directive", reductive/non-interpretative labels (Talati et al. 2017a; Newman et al. 2018; Ikonen et al. 2020) as the Reference Intake (RI), or the newly submitted enriched informative NutrInform Battery (NI), and (1b) "Colour coded", as the semi-directive, evaluative/interpretative Multiple-Traffic Light (MTL). The second category, which includes directive and evaluative (interpretative) labels, is also clustered into the two main sub-categories of (2a) "Positive (endorsement) logos", as the Keyhole, the health logos and the Healthy Choices, and the (2b) "Graded indicators", as the Nutri-Score. The idea behind "summary labels" is to guide consumers towards the purchase of foods

with a low content of specific ingredients (fats, sugar and sodium) and/or the presence of ingredients that are assumed to have a positive effect on health (e.g. vegetables, proteins, fibre, fruit), regardless of the frequency and dosage of the specific food intake and consumer's health status. In this perspective, evaluative/interpretative labels, such as Nutri-Score, tend to improve the amount of information provided by the Nutrition Fact Panel, making available a summary of the information shown by the back-of-pack labels (Talati et al. 2017b; Chantal et al. 2017). On the above, *evaluative labels* include all FOPLs which, through algorithms and treatment of quantitative information on the presence of nutrients, propose a qualitative evaluation of the product, expressing it in a synthetic form through images or symbols that are easy to interpret (e.g. through colors); by contrast *reductive labels* insert information regarding calories and nutrients on the front of the packs, without proposing predefined *interpretative* evaluations of the effects of the product contents on nutrition and health, but limiting to provide relevant information in a clear way that will then be decoded and interpreted by the consumer.

Conceptual framework

We structure our design following the framework developed by Grunert and Wills (2007), one of the most utilised in past FOPL studies on consumers' understanding of nutrition information and subsequent food choices (Méjean et al. 2013, 2014; Ducrot et al. 2015a; Julia et al. 2015a, 2015b; Chantal et al. 2017; Egnell et al. 2018a, 2018b, 2019; Talati et al. 2019). The framework is articulated in the following phases: exposure, perception, understanding and liking, and use. Given the objectives of our study, we concentrate on *consumer understanding and liking* as consumers' responses to FOPL exposure and their ability to inform consumers on the nutritional values of foods. The framework introduces two types of understanding: subjective and objective.

Objective understanding requires the correct response to an information stimuli, compatible with the meaning that the sender intended to communicate, or, in other words, that a customer would attach a "more healthy" vs. "less healthy" meaning to a product characterised by a specific FOPL. On average, "summary labels" registered the highest performance regarding "objective understanding" (Hersey et al. 2013; Ducrot et al. 2015b; Egnell et al. 2018a, 2018b) since they are characterised by a synthesis of the main information and, in most of the cases, by the presence of colour, that is considered fundamental in capturing consumers' attention (Aschemann-Witzel et al. 2013; Hersey et al. 2013; Ducrot et al. 2015a, 2015b; Egnell et al. 2018b; Talati et al. 2019). However, due to the fact that these labels provide less information if compared with "nutrient-specific" ones, they are less trusted by consumers and less likely to be wanted as compulsory (Talati et al. 2019).

Subjective understanding, meanings that consumers derive from the perceived label information and the extent to which consumers believe they have understood the communication in a relevant way. It could serve as a basis to form consumers' opinions and thus an informed decision. *Nutrient specific* labels fit more with the concept of giving consumers "data-driven" information, empowering them to utilise information for their best use, according to varying consumption situations and occasions at single customer level. In this respect, evaluative/interpretative labels register the highest degree of liking, trustworthiness and information fitness, while the most comprehensible are the Warning Labels (Talati et al. 2019). The main shortcomings deriving from the usage of such systems regard the time consumption and the overall comprehensibility of the label itself (Hersey et al. 2013; Talati et al. 2017a).

Cross-country FOPL effectiveness

A relevant stream of recent academic research focussed on comparing FOPLs effectiveness across countries to understand whether any FOPL presents a consistent superiority irrespective of socio-cultural differences and different degree of market presence. The topic is also a relevant element for the growing debate among governmental bodies at EU level (Radosavljevic and Foote 2020), a discussion which requires the backing of research evidences to inform potentially divergent positions. We anticipate that, to our knowledge, there is no uniform evidence of absolute "superiority" of one label over the others along all variables, as pre-condition to achieve the institutional desired goal of overweight and obesity reduction and supporting without any reasonable doubt changes in consumers' dietary habits.

According to the perspective of this paper, we concentrated on researches related to consumers' understanding. In 2009, GDA/RI was tested in six countries showing differences in understanding and use (Grunert et al. 2010a). van Kleef and Dagevos (2015) studied attentional capture, processing time, purchase

intention and perceived healthfulness, and the effect of colour in terms of salience of the stimuli. In 2018, 11 FOPLs were tested in Canada, the US, the UK and Australia, to understand symbols' effectiveness in communicating "high" level of critical nutrients in time-limited situation (Goodman et al. 2018). More recent studies focussed on perception to include mandatory FOPL on products (Talati et al. 2019) and on the discrimination of food products (Dréano-Trécant et al. 2020).

With a specific focus on *objective understanding*, a study on 12 countries (Egnell et al. 2018b) showed how, irrespective of the socio-cultural contexts, the Nutri-Score performed better than Health Star Rating (HSR), Multiple-Traffic-Light (MTL), Reference Intake (RI) and Warning Labels (WL) in terms of ranking product categories on their nutritional quality and *helping customers to discriminate among foods*. A similar study has recently been replicated in Italy (Fialon et al. 2020). A subsequent study on the same countries, but on different variables – trust, liking, easy understanding and capability of providing needed information – showed how, differently from previous cases, Multiple-Traffic-Light consistently over-performed other FOPLs, with Nutri-Score showing a lower performance in terms of comprehensibility, trustworthiness and completeness (Talati et al. 2019). Ares et al. (2018c) demonstrated that on one side "Warning Labels" had a significant effect on consumers' purchase intention for a larger share of products than Nutri-Score, on the other side, the Nutri-Score and the Health Star Rating increased the percentage of participants who regarded the products as healthful compared to nutritional Warnings Labels.

A widely uncovered area in terms of cross-country comparison is still related to *subjective understanding*, and the understanding of which FOPLs can better empower customers to take an informed decision. Extant analysis focus in fact on single countries (De la Cruz-Gongora et al. 2017; Vargas-Meza et al. 2019). For example, a study on Italian consumers on a set of high consumption categories of pre-packaged foods in different "at-home" usage-occasions, showed the effectiveness of NutrInform Battery and the positive performance in being perceived by consumers as an informative FOPL in terms of understanding of the product composition (Mazzù et al. 2020).

A shift of focus in the tested variables might produce different results. To our knowledge, thus, previous researches are lacking in providing consistent evidences that socio-cultural aspects might impact the superiority of FOPL in specific dimensions of consumer understanding. This study then contributes to the current research and institutional debate and to future research avenues in the perspective of *subjective understanding*, comparing FOPLs belonging to different nutritional labelling schemes, in multiple and diverse EU countries.

Research objectives

In the light of the above, we will then explore the impact, in terms of subjective understanding and liking, of two representative FOPLs, the "Nutrient Specific", non-directive enriched informative NutrInform Battery and the directive "Summary label" Nutri-Score in multiple countries. We will analyse (i) if Countries' performance differs in terms of FOPL subjective comprehension and likeability, i.e. if one of the two labels presents a consistently better performance than the other, and if the magnitude of the difference is comparable across countries, (ii) the specific main effects *by-country*, and (iii) if results are influenced by individuals' socio-demographics.

Tested countries vary in terms of official adoption of FOPL in own market, "position" of Country's Governmental Bodies, percentage of penetration of overweight and obesity in the population, "volume" of the public debate and discussion on FOPL and socio-cultural background.

Methods and materials

Stimuli

We conducted our research focussing on two labels representative of different ends in the spectrum of current FOPL categories: the brand-new NutrInform Battery in the area of "Nutrient Specific FOP" and the established Nutri-Score in the area of "Summary Labels". We selected NutrInform Battery FOPL also because, to our knowledge, this *non-directive* label has not yet been tested in any other study in EU countries, except for the study of Mazzù et al. (2020) which specifically focussed on Italian respondents. We then selected the *directive* Nutri-Score also for its aim at helping consumers choosing the healthiest alternative and encourage producers to reformulate their food products (Julia and Hercberg 2017). Among the various summary labels presented in the market, the Nutri-Score is one of the most frequently tested FOPL in the recent literature (Ares et al. 2018b; Egnell et al. 2018b; Finkelstein et al. 2019; Talati et al. 2019; Dréano-Trécant et al. 2020), obtaining in most of the cases the highest performance in terms of objective

understanding and capability to allow respondents to rank food products in terms of their nutritional quality. Moreover, Nutri-Score is currently among the most adopted label in Europe, as it is presently applied in France, Belgium and Germany and intended to be adopted also in Netherlands, Spain and Luxembourg (European Parliaments and the Council 2020). Finally, despite the overall volume of "Front-of-Pack labelling" is quite low in social media, Nutri-Score showed up as among the most discussed keywords on this topic. An exploratory analysis on twitter highlights that Nutri-Score dominates the discussion on FOPL topic, as its volume of discussion is much higher vs. both other FOPL tested in past cross-country analysis e.g. Multiple-Traffic-Light, Warning Labels and Reference Intake) and vs. more generic keyword as FOP, FOPL, and Front-of-Pack.

Research design

A between-subject design was used for this study, with two different conditions as stimuli: condition (1) with NutrInform Battery FOPL and condition (2) with Nutri-Score FOPL. In each country, respondents were exposed to one randomised condition (product stickered with a FOPL) only. This resulted in a 2 (Nutri-Score vs. NutrInform Battery) × 7 (tested countries), with a total of 14 different scenarios.

The decision to include mock products relies on the purpose to avoid brand and additional information influence on participants' perceptions of the products, in accordance with similar research (Arrúa et al. 2017; Pettigrew et al. 2017; Ares et al. 2018a; Egnell et al. 2018b). The mock packages were realised to resemble real food products in 4 alternative categories – yogurt, sauces, biscuits, and saltines - already tested in a previous research (Mazzù et al. 2020). The two FOPL variants covered approximately the same surface area on the package of products belonging to the same product category. Respondents saw also an enlarged version of FOPL in order to clearly read the information provided and answer to questions.

The study was carried out in seven countries – France, Germany, Greece, Italy, Portugal, Romania, Spain. To note, to the extent of our knowledge, no other study has already tested the effect of NutrInform Battery in terms of understanding and liking on the aforementioned countries. The selection of countries was based on a number of criteria: official adoption of FOPL in own market, "position" of Country's Governmental Bodies, percentage of penetration of overweight and obesity in the population, "volume" of the public debate and discussion on FOPL, and socio-cultural background. For the first criteria, at the time of field, one country (France) already had a FOPL system (Nutri-Score), another (Germany) was about to introduce a FOPL system (Nutri-Score), while all other tested countries did not have a specific FOP presence. Governmental institutions also have different positions towards different FOPL approaches: France, Germany and Spain in favour (already adopting or announcing to adopt) of the directive Summary Label "Nutri-Score"; Greece, Italy and Romania in favour of enriched informative *Nutrient Specific* systems (Radosavljevic and Foote 2020); Portugal as overall neutral in the debate. In terms of the third criteria, obesity index (Eurostat 2014), countries perform differently with Italy at 10.5%, France at 14.7%, Germany at 16.4%, Spain at 16.2%, Portugal at 16.1%, Romania at 9.1% and Greece at 16.9%. On the fourth criteria, an exploratory Twitter-based query analysis, with 15,832 geo-referenced tweets on a five months period from January to June 2020, analysed the presence of Nutri-Score as discussion topic and highlighted its relevance in the debate in most of the tested countries. The fifth criteria is backed by evidences of different scores in the Dimension of National Culture (Hofstede Model 2011, 2020).

With the aim to contribute to the extant literature, this research then outlines evidences on the acceptance of the brand-new enriched informative *Nutrient Specific* system (NutrInform Battery) in terms of subjective understanding and liking in the seven aforementioned countries and compares results with one of the most tested and spread Summary Label (Nutri-Score).

Study population and data collection

A total of 2996 individuals from the 7 countries, namely France (FRA), Germany (GER), Greece (EL), Italy (ITA), Portugal (PT), Romania (RO) and Spain (ES), were recruited through Qualtrics XM platform, an international web panel provider, using demographic quotas based on age and gender, representative of country's population. Details of sample size by country and socio-demographics information are provided in Table 1. Participants were asked to complete an online survey and had been excluded if the quota bracket to which they belong, had been filled. Respondents with a time response lower than 3 minutes were removed from the dataset (n = 220; 7.34% of the sample). The 2776 net respondents

Table 1. Details of sample size by country and socio-demographic information.

	Italy		France		Germany		Spain		Portugal		Greece		Romania	
	N = 368		N = 341		N = 330		N = 440		N = 417		N = 440		N = 440	
Variables	Group 1 (NutrInform Battery) (%)	Group 2 (Nutri-Score) (%)	Group 1 (NutrInform Battery) (%)	Group 2 (Nutri-Score) (%)	Group 1 (NutrInform Battery) (%)	Group 2 (Nutri-Score) (%)	Group 1 (NutrInform Battery) (%)	Group 2 (Nutri-Score) (%)	Group 1 (NutrInform Battery) (%)	Group 2 (Nutri-Score) (%)	Group 1 (NutrInform Battery) (%)	Group 2 (Nutri-Score) (%)	Group 1 (NutrInform Battery) (%)	Group 2 (Nutri-Score) (%)
18–24	6.30	7.80	7.00	10.50	3.60	6.80	6.40	10.00	11.20	10.40	15.90	10.50	10.90	10.00
25–34	11.40	12.00	12.90	11.20	12.40	9.30	18.20	11.80	16.00	17.50	19.10	19.10	16.80	20.00
35–49	24.40	28.70	22.20	25.30	27.40	21.00	26.40	34.10	34.00	33.70	30.90	33.60	34.10	34.10
50–64	27.80	23.40	29.20	25.90	30.40	27.70	29.50	29.10	27.60	29.90	26.80	27.30	23.70	24.50
65+	30.10	28.10	28.70	27.10	26.20	35.20	19.50	15.00	11.20	8.50	7.30	9.50	14.50	11.40
Gender														
Men	48.30	46.40	49.70	47.10	41.70	53.10	56.80	52.30	48.10	51.20	51.70	52.30	48.60	58.60
Women	51.70	53.60	50.30	52.90	58.30	46.90	43.20	47.70	51.90	48.80	48.30	47.70	51.40	41.40
Education														
Lower than diploma	42.60	45.80	21.40	33.30	21.40	13.00	3.60	4.50	8.70	8.10	2.30	2.40	8.20	10.00
Diploma	44.30	39.60	50.00	39.90	56.50	61.10	42.80	40.00	47.10	43.10	26.80	26.40	30.90	36.40
Bachelor Degree	4.00	2.10	16.10	17.90	13.80	11.10	44.10	41.40	16.00	15.10	55.50	56.00	38.20	40.50
Master Degree	5.10	9.90	11.30	6.10	8.30	13.60	6.80	7.70	21.90	26.10	14.50	13.70	14.50	6.70
PhD	4.00	2.60	1.20	2.80	0.00	1.20	2.70	6.40	6.30	7.60	0.90	1.50	8.20	6.40
Occupation														
Full-time job	32.40	29.70	32.10	34.10	38.70	29.60	41.80	45.90	54.40	58.30	38.80	40.90	59.50	54.10
Part-time job	19.80	7.80	7.00	6.50	11.90	12.30	6.40	10.50	5.80	6.60	14.20	13.20	4.50	3.60
Unemployed	10.80	12.00	7.50	14.10	1.80	1.90	12.70	10.90	6.80	7.60	26.00	19.10	5.00	3.60
Student	3.40	4.20	7.60	3.50	3.00	6.20	4.50	6.80	5.80	4.80	0.00	13.60	2.70	5.50
Retired	28.40	24.40	34.70	31.20	29.10	37.00	19.50	15.00	15.00	10.90	7.70	3.60	17.80	17.30
Housewife	9.70	15.10	4.10	5.30	8.90	5.60	8.20	4.50	0.50	0.90	4.50	9.10	3.60	6.80
Self-employed	4.50	6.30	4.70	2.40	4.80	6.20	5.50	5.90	11.70	10.40	8.80	0.50	6.90	8.20
Unable to work	0.00	0.50	2.30	2.90	1.80	1.20	1.40	0.50	0.00	0.50	0.00	0.00	0.00	0.90
Income														
<20,000	47.70	40.10	39.20	45.90	26.80	34.00	50.00	40.50	56.30	58.80	77.30	74.10	77.30	84.10
20,000–40,000	35.30	44.80	39.80	37.60	37.50	31.50	40.00	40.90	30.10	31.30	21.40	22.30	14.10	10.40
41,000–60,000	11.30	8.30	11.10	11.20	18.40	16.60	7.70	14.50	11.10	7.60	0.80	2.70	4.50	3.10
61,000–80,000	2.30	4.20	4.10	2.90	11.90	11.70	1.40	2.30	1.00	1.40	0.00	0.40	1.80	1.40
81,000–100,000	2.30	1.00	1.70	1.20	3.00	3.70	0.90	0.90	0.50	0.90	0.50	0.50	1.80	0.50
>100,000	1.10	1.60	4.10	1.20	2.40	2.50	0.00	0.90	1.00	0.00	0.00	0.00	0.50	0.50

completed an online questionnaire which collected socio-demographic data before answering the questionnaire and expressing their opinion regarding FOPL on food products.

For each country, the survey was submitted in the local official language. Translation and adaptation was provided by professional mother-tongue translators. A soft launch of the survey was used to check consumers' acceptance and understanding of the questionnaire before full survey delivery. After having answered information concerning socio-demographic data, respondents in all countries had been randomly assigned to one of the different stimuli presented above, thus each respondent saw one of the four food product categories with one of the two alternative FOPL (NutrInform or Nutri-Score).

Subsequently, respondents were asked to read a brief description of FOPL meaning, and asked to answer questions aimed at measuring subjective understanding and liking of the label they saw.

Participants gave their informed consent for inclusion before they participated in the study.

Constructs and measures

The dimension of *subjective understanding* is constituted by the following sub-measures: (a) *comprehensibility design*, (b) *help-to-shop*, (c) *complexity*. We also add a specific set of measure for (d) *liking*. In line with the items tested in past researches (Mazzù et al. 2020), we will utilise a set of measures all present and derived from extant literature, and pre-validated in terms of their reliability also for this study. Specifically:

- *Comprehensibility/design* items, rated through (Moser et al. 2010): "I feel well informed by the food label", "This label is believable and trustworthy" and "This label is easy to interpret" (alpha= 0.879);
- *Help-to-shop* items, rated through (Moser et al. 2010): "This label helps me to understand the product composition", "This label helps me to understand different nutritional values", "This label makes it easier to choose food" (alpha= 0.895);
- *Complexity* items, rated through (Moser et al. 2010): "The food label is rather extensive", "Using this food label to choose foods is better than just relying on my own knowledge about what is in them" (alpha = 0.841).
- *Liking*, measured asking participants: "How do you evaluate the label?". Respondents expressed their opinion answering to the following scales: "bad/good", "unfavourable/favourable" and "negative/positive" (Allen and Janiszewski 1989) (alpha = 0.938).

Consumers were asked to rate their assessment on all dimensions through a seven-point Likert scale.

Statistical analysis

Data obtained from participants' results have been analysed using IBM SPSS Statistics (version 25, SPSS Inc., Chicago, IL, USA). After evaluating the reliability to assess the scale consistency, we calculated and graphed the means for the subdimension of subjective understanding (comprehensibility design, help-to-shop and complexity) and for liking in each country.

A 2 (FOPL condition) × 7 (Country) Analysis of covariance (ANCOVA) was conducted to test whether the means of each dependent variable (*comprehensibility*, *help-to-shop*, *complexity* and *liking*) are equal across levels of the categorical independent variables (FOPL and Country), while statistically controlling for the effects of three variables, such as age, level of income and education level. The interaction between FOPL and country, while controlling for age, level of education and income has been included as an independent variable. Contrasts among FOPLs and countries were performed with a Bonferroni correction for multiple comparisons applied to dimension to delving into mean differences of each FOPL across countries. The estimated marginal means for the different FOPLs and the FOPL by country interactions were graphed for all the dependent variables where a significant main effect of FOPL or interaction between FOPL and country was observed.

We included *control variables* in line with extant literature findings (Egnell et al. 2018b; Talati et al. 2019). Indeed, former studies highlighted miscellaneous performances due to differences in socio-demographic characteristics of respondents, related to: (a) *age*, (b) *education*, and (c) *income level*. Concerning *age*, studies that consider children and adults as respondents, highlighted a significant higher preference among children towards summary/evaluative FOPLs (Talati et al. 2016; Pettigrew et al. 2017), while more heterogenous results were found across adults and regarding elderly people, they are generally less inclined to collect new information from FOPL and to use it to improve their knowledge (Thiene et al. 2018). Moreover, different *education levels* might impact FOPL understanding, since the capacity of

Table 2. Results of the two-way Analysis of Covariance (ANCOVA).

	Comprehensibility						Help-to-shop						Complexity						Liking					
Predictor	SS	df	MS	F	p	η^2	SS	df	MS	F	p	η^2	SS	df	MS	F	p	η^2	SS	df	MS	F	p	η^2
Front-of-pack label (A)	276.32	1	276.32	124.315	***	0.043	541.256	1	541.256	217.596	***	0.073	516.93	1	516.93	190.52	***	0.065	32.014	1	32.014	14.853	***	0.005
Country (B)	75.721	6	12.62	5.678	***	0.012	150.799	6	25.133	6.311	***	0.022	139.277	6	23.213	8.56	***	0.018	91.325	6	15.221	7.062	***	0.015
Front-of-pack label × Country (A × B)	39.853	6	6.642	2.988	**	0.006	27.494	6	4.582	1.842		0.004	27.069	6	4.511	1.66		0.004	32.476	6	5.413	2.511	***	0.005
Age	7.201	1	7.201	3.24		0.001	33.203	1	33.203	13.348	***	0.005	57.278	1	57.278	21.11	***	0.008	5.835	1	5.835	2.707		0.001
Level of education	8.035	1	8.035	3.615	*	0.001	15.698	1	15.698	7.519	*	0.002	36.253	1	36.253	13.36	***	0.005	9.442	1	9.442	4.38	*	0.002
Income	26.965	1	26.965	12.132	**	0.004	20.306	1	20.306	10.104	**	0.003	22.879	1	22.879	8.43	***	0.003	22.290	1	22.29	10.341	***	0.004
Error	6110.33	2749					6837.96	2749					7458.614	2749					5925.29	2749				

Comprehensibility: $R^2 = 0.068$; Help-to-shop: $R^2 = 0.099$; Complexity: $R^2 = 0.099$; Liking: $R^2 = 0.030$.
SS: sum of squares; df: degrees of freedom; MS: mean square; F: F-test; η2: effect size; $^*p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.
Age, Level of education and Income are covariates.

decoding nutritional information is a function of the education and lower education level could negatively impact on FOPL understanding (Grunert et al. 2010b; Julia et al. 2015b). This is particularly evident in studies involving nutrient-based FOPL, as for example RI, since they are characterised by more complex information, which request a higher cognitive workload to be interpreted (Campos et al. 2011; Hawley et al. 2013; Hersey et al. 2013; Méjean et al. 2013; Gregori et al. 2014; Ducrot et al. 2015a; Egnell et al. 2018b). Similar results have been highlighted in case of low *income level* which is correlated with preference of consumers for more evaluative/directive labels (Vargas-Meza et al. 2019) and lower level of use of *nutrition information* (Grunert et al. 2010a, 2010b).

We ran a series of independent t-test in each country to analyse the magnitude of the difference between the two FOPL on the four examined dimensions.

Finally, with the aim of understanding whether the performance of each FOPL varies across countries, a 1×7 one-way Analysis of Variance (ANOVA) was then carried out separately for NutrInform Battery and Nutri-Score on each tested dependent variable.

Results

FOPL performance – descriptive statistics by country

In the following paragraph, we report the *mean* performance of NutrInform Battery and Nutri-Score in each tested country. In France, the NutrInform Battery reports a mean of 4.92 vs. 4.62 of Nutri-Score in terms of *comprehensibility*, which reflects how much respondents consider the label to be able to inform, to be believable and easy to understand; 4.27 vs. 4.82 for the *help-to-shop* variable, which measures the label's ability to help customers understand product composition and make related decisions; 4.67 vs 4.07 for *complexity*, which reflects the extent of the label's information. On the contrary, according to the French sample, the variable *liking* scores a mean that is higher for the Nutri-Score label, namely 5.05 vs. 4.89 of NutrInform Battery. This result occurs only in the aforementioned country, but it is not statistically significant. In Germany, the *comprehensibility* is higher for the Battery than the Nutri-Score, namely the former reports a mean of 5.2 vs. 4.66. For the *help-to-shop* the mean is 5.08 vs. 4.23, for *complexity* 4.8 vs. 4.2 and for *liking* 4.95 vs. 4.8. In Greece, the NutrInform scores a mean of 5.08 vs. 4.06 of the Nutri-Score in terms of comprehensibility. *Help-to-shop* (4.9 vs 3.8), *complexity* (4.5 vs. 3.5) and *liking*

(4.77 vs. 4.48) present a similar behavior. All report mean differences which are higher for the NutrInform Battery. In Italy, the NutrInform Battery reports a mean of 5.06 vs. 4.4 of the Nutri-Score for the *comprehensibility*; 5.09 vs. 4.09 for *help-to-shop*; 4.81 vs 3.78 for *complexity*; and 5.07 v. 4.47 for *liking*. In Portugal, *comprehensibility* is higher for NutrInform Battery than the Nutri-Score (5.02 vs. 4.24), and same for *help-to-shop (5.1 vs. 3.9); complexity* (4.6 vs. 3.5) and *liking* (5.04 vs. 3.45). In Romania, the NutrInform *comprehensibility* scores a mean of 5.35 vs. 4.84 of Nutri-Score, 5.4 vs. 4.8 for the *help-to-shop*, 5.07 vs. 4.2 for the *complexity* and 5.3 vs. 5.2 for *liking*. In Spain, the *comprehensibility* is 5.03 for the NutrInform vs. 4.58 for the Nutri-Score, the NutrInform *help-to-shop* is 5.06 vs. 4.2, *complexity* is 4.65 vs. 3.76 and *liking* 4.95 vs. 4.7.

FOPL–country interaction effect

We validated our results using a between-subjects two-way ANCOVA for each dependent variable (*comprehensibility*, *help-to-shop*, *complexity* and *liking*), while controlling for *age*, *education* and *income*. We present results starting from the three dimensions of *subjective understanding* and then we conclude with *liking* (Table 2).

As shown in the Table 2, considering *comprehensibility* as the dependent variable and FOPL system (0 = Nutri-Score; 1 = NutrInform Battery), country and their interaction, as independent variables while controlling for age, education and income, the control variables show significant associations with comprehensibility except for age ($F(1, 2749) = 3.240$, $p = 0.072$). The ANCOVA also showed that there is a significant main effect of NutrInform Battery on *comprehensibility* (MNutrInform = 5.11 vs. MNutri-Score = 4.47; $F(1, 2749) = 124.315$, $p = 0.000$). Regarding the main effect of the country on the *comprehensibility*, we found it to be statistically significant (MGreece = 4.65; MSpain= 4.80; MFrance = 4.70; MGermany= 4.82; MItaly = 4.66; MPortugal = 4.75; MRomania = 5.16; $F(6,2749)=5.678$, $p = 0.000$). Further, there was a statistically significant interaction between FOPL system and Country on *comprehensibility*, whilst controlling for age, income and education ($F(6, 2749) = 2.988$, $p = 0.007$). In order to better examine such a moderating influence, we controlled for planned contrast. It proved that according to the NutrInform Battery, across all the countries, respondents are more likely to consider the label to be able to inform, to be believable and easy to understand (MNutrInform = 5.11 vs. MNutri-Score = 4.47; $F(1, 2749) = 124.315$, $p = 0.000$).

Similarly, a two-way ANCOVA was carried out to test whether significant effects of FOPL system exist (NutrInform vs Nutri-Score), country and their interaction on *help-to-shop*, controlling for age, education level and income. The results suggest that there is a statically significant effect of FOPL system on *help-to-shop*, which measures the label's ability to help customers understand product composition and make related decisions (MNutrInform = 5.06 vs. MNutri-Score= 4.17; $F(1,2749)=217,596$, $p = 0.000$). Also, a significant effect of the country on the dependent variable has been outlined (MGreece = 4.46; MSpain= 4.63; MFrance = 4.46; MGermany= 4.53; MItaly = 4.5; MPortugal = 4.55; MRomania = 5.16; $F(6,2749)=6.311$, $p = 0.000$). A significant interaction effect between FOPL system and Country has not been found ($F(6, 2749) = 1.842$, $p = 0.087$)[1]. Delving into these outputs, we performed contrasts which showed that there is a statistically significant mean difference between NutrInform Battery and Nutri-Score in each country ($F(1,2749)=217.596$; $p = 0.000$).

As regards to *complexity*, the two-way ANCOVA showed a significant main effect of FOPL system ($F(1,2749)=190.523$; $p = 0.000$), Country ($F(6,2749)=8.555$; $p = 0.000$) and the covariates age ($F(1,2749)=21.111$; $p = 0.002$), education level ($F(1,2749)=13.362$; $p = 0.000$) and income ($F(1,2749)=8,432$; $p = 0.002$). As regards to the interaction between FOPLs and Country we found it not to be statistically significant ($F(6,2749)=1.663$, $p = 0.290$)[2]. The mean of NutrInform (MNutrInform = 4.72) is higher than the one of Nutri-Score (MNutri-Score = 3.85; $F(1, 2749) = 190.523$, $p = 0.000$). Thus, NutrInform Battery shows a better performance in terms of complexity irrespective of the country analysed.

Controlling for age, level of education and Income, a two-way ANCOVA also proved variance's heterogeneity on *liking*. First, the effects of the education level ($F(1, 2749) = 4.380$, $p = 0.036$) and income ($F(1, 2749) = 10.341$, $p = 0.001$) were statistically significant. Further, the analysis revealed that there is a significant main effect of FOPL system on the liking (MNutrInform = 4.99 vs. MNutri-Score= 4.76; $F(1, 2749) = 14.853$, $p = 0.000$). Furthermore, there was a significant main effect for the country on liking ((MGreece = 4.70; MSpain= 4.84; MFrance = 4.93; MGermany= 4.79; MItaly = 4.70; MPortugal = 4.89; MRomania = 5.26; $F(6,2749)=7.062$, $p = 0.000$). Also, we found a significant interaction between the FOPL

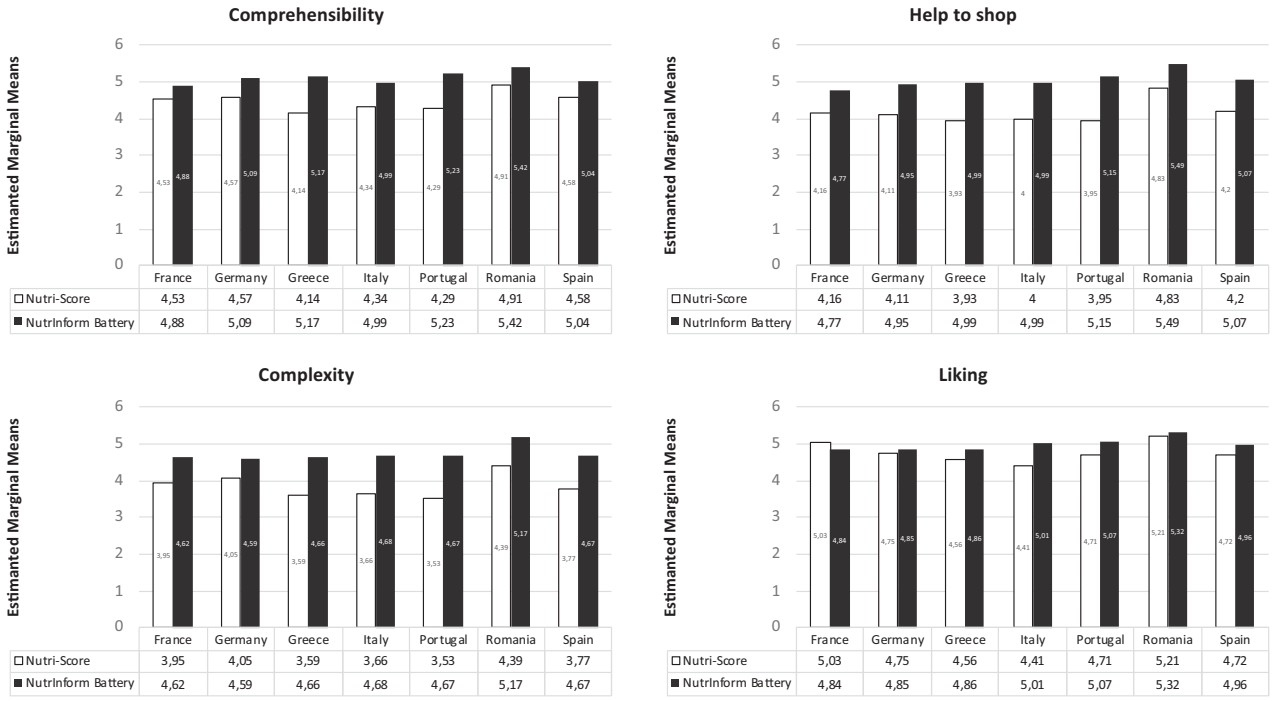

Figure 1. Mean scores by Country on comprehensibility, help to shop, complexity and liking items for Nutri-Score and NutrInform FOPLs adjusted for age, education, income status.

system (Nutri-Score vs. NutrInform) and the country on liking, whilst controlling for age, education and income ($F(6, 2749) = 2.511$, $p = 0.02$). Planned contrast showed that there is a statistically significant difference ($MD = -0.217$; $SD = 0.056$) between the NutrInform Battery's liking and Nutri-Score ($F(1, 2749) = 2.155$, $p = 0.000$).

A synthesis of the adjusted mean is presented in Figure 1.

By country analysis – NutrInform battery vs. Nutri-Score

According to the present study in all tested countries, NutrInform Battery performed significantly better than the Nutri-Score in terms of subjective understanding, showing some variability in terms of liking. We illustrate the results of the *independent t-test* to validate the magnitude of the differences between the two FOPLs. In France, the NutrInform Battery reports a directionally better performance than the Nutri-Score on *comprehensibility* ($t(339)=1.84$; $p = 0.066$), and a significantly better performance on *help-to-shop* ($t(339)=3.15$; $p < 0.01$) and *complexity* ($t(339)=3.37$; $p < 0.01$). On the contrary, the variable *liking* presents a not statistically significant higher mean for the Nutri-Score ($t(339)=1.03$; $p = 0.303$). In Germany, the *comprehensibility* is statistically higher for the NutrInform Battery vs. the Nutri-Score, ($t(328)=3.31$; $p < 0.01$). A similar situation can be observed for *help-to-shop* ($t(328)=4.80$; $p < 0.01$) and *complexity* ($t(328)=3.09$; $p < 0.01$), while mean difference in *liking* is not significant ($t(328)=0.70$; $p = 0.481$). In Greece, the NutrInform Battery reports significant mean differences vs. Nutri-Score on all four dependent variables. Specifically, *comprehensibility* ($t(438)=7.2$; $p < 0.01$), *help-to-shop* ($t(438)= 7.04$; $p < 0.01$), *complexity* ($t(438)= 6.84$; $p < 0.01$) and *liking* ($t(438)=2.18$; $p < 0.05$). In Italy, all tested dimensions vary significantly, with NutrInform Battery performing better than the Nutri-Score for *comprehensibility* ($t(366)=4.09$; $p < 0.01$), *help-to-shop* ($t(366)=5.78$; $p < 0.01$), *complexity* ($t(366)=5.78$; $p < 0.01$), and *liking* ($t(366)=3.50$; $p < 0.01$). In Portugal, *comprehensibility* is statistically higher in NutrInform Battery vs. Nutri-Score ($t(415)=7.03$; $p < 0.01$). A similar performance is also present in *help-to-shop* *($t(415)=8.50$; $p < 0.01$)*, *Complexity* ($t(415)=7.52$; $p < 0.01$) and *liking* ($t(415)=11.02$; $p < 0.01$). In Romania, the NutrInform shows a significantly higher mean than Nutri-score for *comprehensibility* ($t(438)=3.51$; $p < 0.01$), *help-to-shop* ($t(438)=4.46$; $p < 0.01$), *complexity* ($t(438)=4.73$; $p < 0.01$), but not for *liking* ($t(438)=0.80$; $p = 0.421$). In Spain, in all tested variables, NutrInform Battery performed better than Nutri-Score. Specifically, on *comprehensibility* ($t(438)=3.02$; $p < 0.01$), *help-to-shop* ($t(438)=5.57$; $p < 0.01$), *complexity* ($t(438)=5.46$;

$p < 0.01$) and *liking* (t(438)=1.58; $p = 0.115$). According to the present study in all countries NutrInform Battery performed significantly better than the Nutri-Score in terms of subjective understanding.

Subjective understanding and liking across country

With the aim of understanding whether the performance of each FOPL varies across countries, a 1×7 one-way Analysis of Variance (ANOVA) was then carried out separately for NutrInform Battery and Nutri-Score on each tested dependent variable.

Comprehensibility

In the case of NutrInform Battery, results (F(6, 1374) = 2.120, $p < 0.05$) showed that at least one country presents a statistically significant different mean vs. other countries. *Post-hoc* analysis highlighted that the only significant variance is present between Romania and France ($MD = 0.4290$, $p < 0.05$). A significant main effect of the country (F(1, 1388) = 5.784, $p < 0.001$) occurred also on the Nutri-Score. In this case, Romania positively differs from Greece ($MD = 0.7760$; $p < 0.001$) and Portugal ($MD = 0.5995$; $p < 0.001$) and, Greece from Spain ($MD = 0.5150$; $p < 0.05$), France ($MD = 0.5531$; $p < 0.05$), and Germany ($MD = 0.5987$; $p < 0.05$). All the rest are not significantly different.

Help-to-shop

Similar results are present also for this dependent variable. The country is a significant predictor of the *help-to-shop* in both FOPL (FNutrInformBattery (1,1374) = 3.659, $p < 0.001$; FNutri-Score(1, 1388) = 6.748, $p < 0.001$)). According to the contrasts, for NutrInform Battery *help-to-shop*, only Romania significantly differs from the other countries, with variability present on Romania-Greece (MD = 0.5348, $p < 0.05$) and Romania-France (MD = 0.5977, $p < 0.05$). For the Nutri-Score, the differences are significant between Romania-Greece (MD = 0.9121, $p < 0.05$), Romania-Spain (MD = 0.5591, $p < 0.05$), Romania-Italy (MD = 0.6619, $p < 0.05$) and Romania-Portugal (MD = 0.8681, $p < 0.05$).

Complexity

Results highlight that the country significantly predicts both NutrInform Battery (F(6, 1374) = 2.850, $p < 0.05$) and Nutri-Score complexity (F(1, 1388) = 7.506, $p < 0.001$). For NutrInform Battery, mean differences are significant only in Romania, as testified by the contrasts Romania-Greece (MD = 0.5477, $p < 0.05$) and Romania- Portugal (MD = 0.4611, $p < 0.05$). Nutri-Score wise, multiple differences in contrast exist mainly connected to Romania (Romania-Greece (MD = 0.8273, $p < 0.05$); Romania-Spain (MD = 0.5432, $p < 0.05$); Romania-Portugal (MD = 0.8519, $p < 0.05$)), Greece (Greece-France (MD = 0.5933, $p < 0.05$); Greece-Germany (MD = 0.7203, $p < 0.05$), and Portugal (Portugal-France (MD= −0.6180, $p < 0.05$); Portugal-Germany (MD= −0.7449, $p < 0.05$)).

Liking

NutrInform Battery and Nutri-Score significantly vary across countries (FNutri-Score(1, 1388) = 5.817, $p < 0.001$); FNutrInformBattery(1,1374) = 2.643, $p < 0.05$). According to the contrast, NutrInform Battery means differ in the pair Romania-Greece (MD = 0.4876, $p < 0.05$) and Nutri-Score in Romania-Greece (MD = 0.6665, $p < 0.05$), Romania-Italy (MD = 0.6757, $p < 0.05$), Romania-Portugal (MD = 0.4844, $p < 0.05$), and Greece-France (MD= −0.5724; $p < 0.05$).

Discussion

This study explored consumers' *subjective understanding* and *liking* of the enriched-informative FOPL NutrInform Battery and the summary FOPL Nutri-Score across seven European countries. Tested countries have been selected on a number of criteria: official adoption of FOPL in own market, "position" of Country's Governmental Bodies, percentage of penetration of overweight and obesity in the population, "volume" of the public debate and discussion on FOPL, and socio-cultural background.

Results highlight that a significant effect exists in the interaction between Country and FOPLs on *comprehensibility* and *liking*, while controlling for covariates. On *help-to-shop* and *complexity* results show only a main effect of FOPLs on the dependent variable, without any significant interaction with the countries. It suggests that the NutrInform Battery, in terms of *help-to-shop* and *complexity*, relies on a positive assessment of European consumers, irrespective of the cross-cultural differences.

Subsequently, although the NutrInform Battery reached higher means in each country for the investigated variables (unless in France in the case of *liking*, which is not significant), the label outperformed in Romania. The aforementioned country in comparison

to France (*comprehensibility* and *help-to-shop*), Greece (*help-to-shop*, *complexity*, *liking*) and Portugal (*complexity*) reached significant positive mean differences which reflect the higher consumers' evaluation according to the FOPL. We signal no other differences in terms of NutrInform Battery performance among countries, implying a constant effectiveness of the label in different socio-cultural backgrounds. The effectiveness of NutrInform Battery could then be considered stable across the European sample, except for Romania which relies on a greater attitude towards the two FOPLs. Indeed, the results are not heterogeneous, showing a common pattern in terms of *comprehensibility*, *help-to-shop*, *complexity* and *liking* across the countries despite the potential socio-cultural aspects which distinguish them.

Nutri-Score presents a similar situation for Romania, with higher mean performance in comparison to Greece (*comprehensibility*, *help-to-shop, complexity and liking*), Italy (*help-to-shop*, *liking*), Portugal (all dimensions), and Spain (*help-to-shop*, c*omplexity*). In addition, differences are also present in the performance of Greece in comparison to France (*comprehensibility*, *complexity* and *liking*), Germany (*comprehensibility*, *complexity*) and Spain (*comprehensibility*); and Portugal in comparison to France (*complexity*) and Germany (*complexity*), signalling a much higher variability across countries in terms of subjective understanding and liking.

A subsequent analysis by-country, signals the presence of a significant differential performance of the two FOPLs. In all countries, NutrInform Battery showed a consistent and greater effectiveness vs. Nutri-Score on *comprehensibility*, *help-to-shop* and *complexity*. Regarding *liking*, NutrInform Battery was significantly the most favourably appreciated label in Italy, Greece, Portugal. The difference of means was not significant in France, where Nutri-Score outperformed NutrInform Battery, and Germany, Romania and Spain where, on the contrary, NutrInform Battery was preferred to Nutri-Score. The highest results among French respondents for Nutri-Score could be related to the fact that the FOPL is highly penetrated and customers are used to see it in front of the package of the products in the supermarket during the product selection phase and at home during product consumption. Indeed, as mentioned in a previous study (van Herpen et al. 2012) familiarity with a FOPL can influence self-reported evaluations.

In terms of subjective *comprehension*, NutrInform Battery had then been positively evaluated as it provided the information in an extensive and easy way and it was considered helpful in understanding product composition and different nutritional values. These results confirmed what demonstrated in previous studies, where consumers perceived that more information is better (Dana et al. 2019; Talati et al. 2019) and they trusted more FOPLs that were not summary-based (Talati et al. 2019).

Moreover, it could be of interest to verify if the various institutional positions regarding the FOPL adoption that characterise each country, influence how these labels are perceived and appreciated by consumers. Indeed, differences in performance of FOPL across countries may be related to some extent also to the local context (Egnell et al. 2018b) and the influence of public discussion on nutrition and labelling issues. Further research should also be conducted adding other FOPLs currently present on the market, as for example MTL or Warning Labels, to explore in more detail, the different perceptions that can emerge in relation to the different aims of FOPLs.

Our last level of the analysis evidenced some differences in terms of effectiveness according to the socio-demographics. In line with the extant literature, our results highlight there is a main effect of education and income level on *subjective understanding* and *liking*, with *age* specifically on *complexity*.

These results added interesting insights regarding the literature of FOPL perception among respondents from different countries, focussing on two labels that, to the extent to our knowledge, have not been fully analysed in terms of subjective understanding across-countries.

However, some limitations of the study should be recognised. Experimental process did not allow participants to have access to back-of-pack information regarding the nutritional composition of the products used in the study and they do not have any tactile experiences as in real life settings, as supermarkets. However, back-of-pack information is rarely used during real shopping situations (Van Kleef et al. 2008; Grunert et al. 2010a; Chantal et al. 2017), where other relevant aspects can have effect on consumers' evaluations. Moreover, subjective understanding and liking are just two dimensions that influence consumers' reactions to FOPL. Future research should therefore focus also on other important dimensions that influence consumer behaviour, as evaluation and choice.

Since the results showed the effectiveness of NutrInform Battery in terms of *subjective understanding* and *liking*, future researches could deepen other relevant aspects such as the influence on the willingness-to-buy at retail level, on Perceived Healthiness

and on whether the NutrInform Battery could influence away-from-home behaviours promoting a healthier pattern or the overall effect in terms of objective understanding. Furthermore, the incidence of socio-cultural aspects which affect the individuals' information processing could be deepened according to the attitudes to the FOPLs. Also, verify whether a preliminary introduction and description of the NutrInform Battery modify the respondents' evaluation.

Conclusion

In conclusion, regarding *subjective comprehension* and *liking*, NutrInform Battery emerged as more effective than Nutri-Score in allowing consumers understand information in a relevant way. It appeared to be understood in a clear way across the various countries, showing limited impact of socio-cultural differences among countries and outweighing potential familiarity of consumers with Nutri-Score in selected countries where the FOPL label is already part of consumers' daily experience. Moreover, except for France where Nutri-Score presented a higher mean, yet not significant, than NutrInform Battery in terms of *liking*, NutrInform Battery emerged as the preferred label on *subjective understanding* within and across each country examined. Policy makers should be encouraged to implement comparative studies including *subjective understanding* to promote food education among consumers and NutrInform Battery to guarantee an informed selection and implementation of the most efficient and useful scheme, while deep diving their effectiveness in different socio-economical and health-related segments of the population.

Notes

1. To test whether exists a significant interaction on the items of the *help-to-shop* variable, we repeated the two-way Ancova controlling for age, education and income on each single measure. Results suggest there is a significant interaction effect only regarding the label "This label helps me to understand different nutritional values" ($F(6,2749)=3,112$; $p=0.005$). The interaction between FOPLs and country for the items "This label helps me to understand the product composition" ($F(6,2749)= 1,290$; $p=0.258$) and "This label makes it easier to choose food" ($F(6,2749)= 1,464$; $p=0.187$) is not significant.

2. To test whether exists a significant interaction on the items of Complexity, we ran a two-way Ancova on each single measure. Results suggest there is no interaction in all the subdimensions of the construct. The label "The food label is rather extensive" does not present a significant interaction effect ($F(6,2749)=1.201$; $p=0.302$) and, similarly, the label "Using this food label to choose foods is better than just relying on my own knowledge about what is in them" ($F(6,2749)=1.756$; $p=0.104$).

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Author contributions

The study was developed by MFM, SR, AB, AG also following a scientific protocol approved by the Italian Authorities; data was analysed by MFM, SR, AB, AG; data interpretation was undertaken by MFM, SR, AB, AG; writing - original draft preparation was carried out by MFM, SR, AB, AG. All authors have read and agreed to the published version of the manuscript.

Disclosure statement

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References

Allen CT, Janiszewski CA. 1989. Assessing the role of contingency awareness in attitudinal conditioning with implications for advertising research. J Market Res. 26(1): 30–43.

Ares G, Aschemann-Witzel J, Curutchet MR, Antunez L, Machin L, Vidal L, Martinez J, Gimenez A. 2018a. Nutritional warnings and product substitution or

abandonment: policy implications derived from a repeated purchase simulation. Food Qual Prefer. 65: 40–48.
Ares G, Aschemann-Witzel J, Curutchet MR, Antúnez L, Moratorio X, Bove I. 2018b. A citizen perspective on nutritional warnings as front-of-pack labels: insights for the design of accompanying policy measures. Public Health Nutr. 21(18):3450–3461.
Ares G, Varela F, Machin L, Antúnez L, Giménez A, Curutchet MR, Aschemann-Witzel J. 2018c. Comparative performance of three interpretative front-of-pack nutrition labelling schemes: insights for policy making. Food Qual Prefer. 68:215–225.
Arrúa A, Vidal L, Antúnez L, Machín L, Martínez J, Curutchet MR, Giménez A, Ares G. 2017. Influence of label design on children's perception of 2 snack foods. J Nutr Educ Behav. 49:211–217.e1.
Aschemann-Witzel J, Grunert KG, van Trijp HC, Bialkova S, Raats MM, Hodgkins C, Wasowicz-Kirylo G, Koenigstorfer J. 2013. Effects of nutrition label format and product assortment on the healthfulness of food choice. Appetite. 71:63–74.
Barreiro-Hurle J, Gracia A, De-Magistris T. 2010. Does nutrition information on food products lead to healthier food choices? FOOD Policy. 35:221–229.
Campos S, Doxey J, Hammond D. 2011. Nutrition labels on pre-packaged foods: a systematic review. Public Health Nutr. 14(8):1496–1506.
Chantal J, Hercberg S., World Health Organization 2017. Development of a new front-of-pack nutrition label in France: the five-colour Nutri-Score. Public Health Panorama. 03:712–725.
Dréano-Trécant L, Egnell M, Hercberg S, Galan P, Soudon J, Fialon M, Touvier M, Kesse-Guyot E, Julia C. 2020. Performance of the front-of-pack nutrition label nutri-score to discriminate the nutritional quality of foods products: a comparative study across 8 European countries. Nutrients. 12(5):1303.
Dana LM, Chapman K, Talati Z, Kelly B, Dixon H, Miller C, Pettigrew S. 2019. Consumers' views on the importance of specific front-of-pack nutrition information: a latent profile analysis. Nutrients. 11:1158.
Ducrot P, Méjean C, Julia C, Kesse-Guyot E, Touvier M, Fezeu L, Hercberg S, Péneau S. 2015a. Effectiveness of front-of-pack nutrition labels in French adults: results from the NutriNet-Sante cohort study. PLoS One. 10: e0140898.
Ducrot P, Méjean C, Julia C, Kesse-Guyot E, Touvier M, Fezeu LK, Hercberg S, Péneau S. 2015b. Objective understanding of front-of-package nutrition labels among nutritionally at-risk individuals. Nutrients. 7:7106–7125.
Egnell M, Ducrot P, Touvier M, Allès B, Hercberg S, Kesse-Guyot E, Julia C. 2018a. Objective understanding of Nutri-Score Front-Of-Package nutrition label according to individual characteristics of subjects: comparisons with other format labels. PLoS One. 13(8):e0202095
Egnell M, Talati Z, Hercberg S, Pettigrew S, Julia C. 2018b. Objective understanding of front-of-package nutrition labels: an international comparative experimental study across 12 countries. Nutrients. 10:1542.
Egnell M, Talati Z, Gombaud M, Galan P, Hercberg S, Pettigrew S, Julia C. 2019. Consumers' responses to front-of-pack nutrition labelling: results from a sample from The Netherlands. Nutrients. 11:1817.
EU Regulation. 2011. Regulation (EU) No 1169/2011 of the European Parliament and of the Council of 25 October 2011. OJ. L 304:18–63.
European Commission. 2020. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions a Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0381
European Parliaments and the Council. 2020. Report from the Commission to the European Parliament and the Council regarding the use of additional forms of expression and presentation of the nutrition declaration. https://ec.europa.eu/food/sites/food/files/safety/docs/labelling-nutrition_fop-report-2020-207_en.pdf
Eurostat 2014. Overweight and obesity - BMI statistics. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Overweight_and_obesity_-_BMI_statistics.
Fialon M, Egnell M, Talati Z, Galan P, Dréano-Trécant L, Touvier M, Pettigrew S, Hercberg S, Julia C. 2020. Effectiveness of different front-of-pack nutrition labels among Italian consumers: results from an online randomized controlled trial. Nutrients. 12:2307.
Finkelstein EA, Ang FJL, Doble B, Wong WHM, van Dam RM. 2019. A randomized controlled trial evaluating the relative effectiveness of the multiple traffic light and nutri-score front of package nutrition labels. Nutrients. 11(9):2236.
Finkelstein EA, Khavjou OA, Thompson H, Trogdon JG, Pan L, Sherry B, Dietz W. 2012. Obesity and severe obesity forecasts through 2030. Am J Prev Med. 42:563–570.
Goodman S, Vanderlee L, Acton R, Mahamad S, Hammond D. 2018. The impact of front-of-package label design on consumer understanding of nutrient amounts. Nutrients. 10:1624.
Gregori D, Ballali S, Vögele C, Gafare CE, Stefanini G, Widhalm K. 2014. Evaluating food front-of-pack labelling: a pan-European survey on consumers' attitudes toward food labelling. Int J Food Sci Nutr. 65:177–186.
Grunert KG, Fernández-Celemín L, Wills JM, Genannt Bonsmann SS, Nureeva L. 2010a. Use and understanding of nutrition information on food labels in six European countries. Z Gesundh Wiss. 18:261–277.
Grunert KG, Lähteenmäki L, Boztug Y, Martinsdóttir E, Ueland Ø, Åström A, Lampila P. 2009. Perception of health claims among Nordic consumers. J Consum Policy. 32:269–287.
Grunert KG, Wills JM, Fernández-Celemín L. 2010b. Nutrition knowledge, and use and understanding of nutrition information on food labels among consumers in the UK. Appetite. 55:177–189.
Grunert KG, Wills JM. 2007. A review of European research on consumer response to nutrition information on food labels. J Public Health. 15:385–399.

Hamlin R, McNeill L. 2016. Does the Australasian "Health Star Rating" front of pack nutritional label system work? Nutrients. 8:327.
Hawley KL, Roberto CA, Bragg MA, Liu PJ, Schwartz MB, Brownell KD. 2013. The science on front-of-package food labels. Public Health Nutr. 16(3):430–439.
Hersey JC, Wohlgenant KC, Arsenault JE, Kosa KM, Muth MK. 2013. Effects of front-of-package and shelf nutrition labeling systems on consumers. Nutr Rev. 71:1–14.
Hofstede G. 2011. Dimensionalizing cultures: the Hofstede model in context. Online Read Psychol Cult. 2.
Hofstede 2020. Country comparison. https://www.hofstede-insights.com/product/compare-countries/.
Ikonen I, Sotgiu F, Aydinli A, Verlegh PWJ. 2020. Consumer effects of front-of-package nutrition labeling: an interdisciplinary meta-analysis. J Acad Mark Sci. 48: 360–383.
Julia C, Ducrot P, Péneau S, Deschamps V, Méjean C, Fézeu L, Touvier M, HErcberg S, Kesse-Guyot E. 2015a. Discriminating nutritional quality of foods using the 5-Color nutrition label in the French food market: consistency with nutritional recommendations. Nutr J. 14:100.
Julia C, Hercberg S. 2017. Nutri-Score: Evidence of the effectiveness of the French front-of-pack nutrition label. Ernahrungs Umschau. 64:181–187.
Julia C, Kesse-Guyot E, Ducrot P, Péneau S, Touvier M, Méjean C, Hercberg S. 2015b. Performance of a five category front-of-pack labelling system - the 5-colour nutrition label – to differentiate nutritional quality of breakfast cereals in France. BMC Public Health. 15:179.
Kanter R, Vanderlee L, Vandevijvere S. 2018. Front-of-package nutrition labelling policy: global progress and future directions. Public Health Nutr. 21:1399–1408.
la Cruz-Gongora V, Torres P, Contreras-Manzano A, de la Mota A, Mundo-Rosas V, Villalpando S, Rodriguez-Oliveros G. 2017. Understanding and acceptability by Hispanic consumers of four front-of-pack food labels. Int J Behav Nutr Phys Act. 14:28.
Mazzù MF, Romani S, Gambicorti A. 2020. Effects on consumers' subjective understanding of a new front-of-pack nutritional label: a study on Italian consumers. Int J Food Sci Nutr.
Méjean C, Deglaire A, Kesse-Guyot E, Hercberg S, Schlich P, Castetbon K. 2014. Association between intake of nutrients and food groups and liking for fat (The Nutrinet-Santé Study). Appetite. 78:147–155.
Méjean C, Macouillard P, Péneau S, Hercberg S, Castetbon K. 2013. Perception of front-of-pack labels according to social characteristics, nutritional knowledge and food purchasing habits. Public Health Nutr. 16:392–402.
Moser A, Hoefkens C, Van Camp J, Verbeke W. 2010. Simplified nutrient labelling: consumers' perceptions in Germany and Belgium. J Verbr Lebensm. 5:169–180.
Newman CL, Burton S, Andrews JC, Netemeyer RG, Kees J. 2018. Marketers' use of alternative front-of-package nutrition symbols: an examination of effects on product evaluations. J Acad Mark Sci. 46:453–476.
Pettigrew S, Jongenelis M, Miller C, Chapman K. 2017. A path analysis model of factors influencing children's requests for unhealthy foods. Eating Behav. 24:95–101.
Pineda E, Sanchez-Romero LM, Brown M, Jaccard A, Jewell J, Galea G, Webber L, Breda J. 2018. Forecasting future trends in obesity across Europe: the value of improving surveillance. Obes Facts. 11:360–371.
Radosavljevic Z, Foote N. 2020. Member states coalition presents latest challenge to colour-coded nutrition label. [accessed 2020 Oct 26]. https://www.euractiv.com/section/agriculture-food/news/member-states-coalition-presents-latest-challenge-to-colour-coded-nutrition-label/
Reyes M, Luisa Garmendia M, Olivares S, Aqueveque C, Zacarias I, Corvalan C. 2019. Development of the Chilean front-of-package food warning label. BMC Public Health. 19:906.
Talati Z, Pettigrew S, Kelly B, Ball K, Dixon H, Shilton T. 2016. Consumers' responses to front-of-pack labels that vary by interpretive content. Appetite. 101:205–213.
Talati Z, Egnell M, Hercberg S, Julia C, Pettigrew S. 2019. Consumers' perceptions of five front-of-package nutrition labels: an experimental study across 12 countries. Nutrients. 11:1934.
Talati Z, Norman R, Pettigrew S, Neal B, Kelly B, Dixon H, Ball K, Miller C, Shilton T. 2017a. The impact of interpretive and reductive front-of-pack labels on food choice and willingness to pay. Int J Behav Nutr Phys Act. 14:171.
Talati Z, Pettigrew S, Neal B, Dixon H, Hughes C, Kelly B, Miller C. 2017b. Consumers' responses to health claims in the context of other on-pack nutrition information: a systematic review. Nutr Rev. 75(4):260–273.
Thaler RH, Sunstein CR. 2008. Nudge: improving decisions about health, wealth, and happiness. New York (NY): Penguin Books.
Thiene M, Scarpa R, Longo A, Hutchinson WG. 2018. Types of front of pack food labels: do obese consumers care? Evidence from Northern Ireland. Food Policy. 80: 84–102.
van der Bend DLM, Lissner L. 2019. Differences and similarities between front-of-pack nutrition labels in Europe: a comparison of functional and visual aspects. Nutrients. 11:626.
van Herpen E, Seiss E, van Trijp HC. 2012. The role of familiarity in front-of-pack label evaluation and use: a comparison between the United Kingdom and The Netherlands. Food Qual Prefer. 26(1):22–34.
van Kleef E, Dagevos H. 2015. The growing role of front-of-pack nutrition profile labeling: a consumer perspective on key issues and controversies. Crit Rev Food Sci Nutr. 55:291–303.
Van Kleef E, Van Trijp H, Paeps F, Fernandez-Celemin L. 2008. Consumer preferences for front-of-pack calories labelling. Public Health Nutr. 11:203–213.
Vargas-Meza J, Jauregui A, Pacheco-Miranda S, ContrerasManzano A, Barquera S. 2019. Front-of-pack nutritional labels: understanding by low- and middle-income Mexican consumers. PLoS One. 14:e0225268.
WHO. 2020. Obesity and overweight. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight