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Applied nutritional investigation

Improving the understanding of key nutritional elements to support healthier and more informed food choices: The effect of front-of-pack label bundles

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ABSTRACT

Objectives: In the current open debate at the European level on what would be the best Front-of-Pack Label (FOPL) to support customers' healthier and more informed food choices, little effort has been dedicated to analyzing the potential effects of bundling existing FOPLs. This study aims to compare the effects of consumers' subjective understanding and liking of different types of FOPL bundles.
Methods: We performed an experimental design by manipulating the FOPLs' scheme, where different types of FOPL bundles were designed according to the "directiveness" of the FOPLs' scheme. A "mixed" bundle was composed of a non-directive label (i.e., NutrInform Battery) and a directive label (i.e., Keyhole), and a "double-directive" bundle was composed of two directive labels (i.e., Nutri-Score and Keyhole). This study was conducted among a sample of 327 Swedish individuals responsible for purchases recruited through international web panel providers.
Results: The results showed that a mixed bundle has been more effective than the double-directive bundle and the single-directive label (i.e., the existing FOPL in the investigated market) in allowing consumers to improve their subjective understanding (in terms of comprehensibility, help-to-shop, and complexity reduction) and liking towards the labels.
Conclusions: This study extends the current research on bundling in general and on FOPL bundles in particular by providing evidence regarding consumers' subjective understanding and liking of the labels. Additionally, the research provided findings that might be relevant for policymakers by suggesting to investigate bundle of FOPLs to help the consumers' understanding in their process toward healthier and more informed food choices.

Introduction

The boost in consumption of specific nutrients and the spread of a sedentary lifestyle has generated a sharp increase in the number of people affected by obesity [1]. To reverse this trend, governments, authorities, and socially responsible businesses and organizations have identified initiatives to stimulate the reduction of consumption of specific products [2].

In recent years, several countries have developed different types of "front-of-pack labels" (FOPLs) [3], schemes that are more noticeable than the Nutrition Facts Panel [4], with the purpose of explicating the nutritional information of food products [5] and helping customers to choose more informed and healthier diets [6–8].

Although several studies have been conducted during recent years, no FOPL has emerged as "dominant" above others in all the steps of consumers' decision-making. With that in mind, scholars have investigated the potential harmonization of FOPLs [9], and the European Union (EU) opened the "Inception Impact

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Table 1
European taxonomy on front-of-pack labels (FOPLs)

FOPLs—definitions and classification			
FOP labeling refers to nutrition labeling systems that 1) are presented on the front of food packages (in the principal field of vision) and can be applied across the packaged retail food supply and 2) comprise an underpinning nutrient profile model that considers the overall nutrition	Nutrient-specific labels	Non-directive	• Numerical labels (e.g., NutrInform Battery): Non-interpretative (non-evaluative) label, 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
		Semi-directive	• Color-coded labels (e.g., multiple traffic lights and warning labels): The label provides numerical information on the content of four nutrients (fat, saturates, sugars, salt) and on energy value, as well as on how much this represents as a percentage of the daily reference intake; colors are used to classify those nutrients as "low" (green), "medium" (amber), or "high" (red)
	Summary labels	Directive	• Endorsement logos (e.g., Keyhole logo): The label provides 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 • Graded indicators (e.g., Nutri-Score): The label provides 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

Source: Commission to the European Parliament and the Council (2020).
https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0207&from=GA.

Assessment" to identify a unified solution that could be applied to all member states. Furthermore, the "Presidency Conclusions on front-of-pack nutrition labeling, nutrient profiles and origin labeling" [10] document allows member states to use their respective FOPL while bundling their proposal alongside the upcoming harmonized EU FOPL scheme.

In this context, although a significant amount of extant literature focused on comparing effects of one single type of FOPL at a time on different steps of the consumer decision-making process, limited attention has been devoted to exploring and comparing bundles of FOPLs as an alternative solution. Our contribution is to research which combinations of FOPL bundles could better facilitate consumers' understanding while guiding them toward more informed food choices.

In this study, we hypothesized that an appropriate bundle of FOPLs with complementary information would increase subjective understanding and liking, two fundamental aspects of consumers' decision-making process with regard to healthier food choices.

In the remainder of the introduction, the first section introduces the different FOPL proposals and reviews existing research on bundling, and we then identify a reference theoretical framework to analyze consumers' decision-making and develop our research hypotheses. Then we describe the research methodology and report the main results of the study, comparing the effects of different bundles of FOPLs. Finally, we discuss the main implications, highlighting the limitations of our work and proposing cues for future research.

Taxonomy and FOPL selection

The most recent EU taxonomy [11] classifies FOPLs based on their level of "directiveness" (Table 1), defined as to "what extent the label provides a direct indication of whether the product is nutritionally good for the consumer or not" [12] and clustered as "non-directive" (presenting only factual nutrient information), "semidirective" (information combined with easy-to-interpret visuals), and "directive" (FOPLs that summarize the "healthiness" of a product without displaying any nutritional information) [5].

Previous studies have shown different results depending on the type of label and measurement used [7,8]. Van der Bend and Lissner [5] found that semidirective and directive labels are better at increasing consumer understanding of nutritional information, whereas more directive FOPLs are more effective in helping consumers make healthy choices [13]. Hodgkins et al. [12] highlight that when the directiveness of the FOPL's health message decreases, there is an increase of information for the consumer to process while initiating the need to investigate an FOPL that combines directive and non-directive components.

Literature background

We referred to the literature on product and message bundling to infer and hypothesize about FOPL bundles, because the combination of two elements generates a different evaluation process [14–16]. Over time, research on the bundle evaluation process has evolved. At first, it was thought that the overall utility of a bundle was equal to the sum of the bundled items' individual utilities [14,15]. Gaeth et al. [16] outlined the overall evaluation of the bundle to be an average of the separate evaluations of the two products. According to Guiltinan [17], the utility consumers extract is higher under the presence of a complementary product. Further studies (e.g., Sheng et al. [18]) classified bundles as either complementary (i.e., individual components function as a system or complementarily) or non-complementary (i.e., the components are not functionally related). Khandeparkar [19] reported a significant enhancement effect on the perceived quality of a new brand or product under the condition of a complementary bundle. Martins et al. [20] provided evidence that the output of a complementary bundle is higher than that of a non-complementary bundle. Karatas et al. [21] highlighted that it is more beneficial for the seller if multiple components of a bundle are complementary [22,23], confirming that complementary items have super-additive utilities. Consumers then process this information: it has been shown that exposure to bundles of complementary elements produces a higher utility or purchase intention [17,19,21,24,25].

In the food context, few studies considered the effect of the simultaneous presence of different types of FOPL on consumer choices. Hieke et al. [26] explored the presence of bundled claims on information overload. Barreiro-Hurlé et al. [27] provided evidence that consumers appreciate the copresence of nutritional and health information on food products, clarifying that additional

information can mean less utility when bundled claims coincide (i.e., redundant information).

These authors also showed that the simultaneous presence of bundled claims (health and nutrition) has a positive effect only when a nutritional claim is added in the presence of a detailed facts panel [28]. Furthermore, the combined presence of the Nutri-Score and the Nutrition Facts Panel produced a lower effect in assessing the product's healthfulness than did the presence of the Nutri-Score label alone [29].

Concerning the interpretation of the information in a bundle, an increase in redundancy decreases the marginal value of gathering and processing information (e.g., Einhorn and Hogarth [30], Einhorn et al. [31], and Hagerty et al. [32]). Non-complementary bundles for which consumers perceive limited relationships or do not receive complementary information may underestimate the value of gathering and processing product information [33]. Especially in the context of food, multiple health and nutrition labels representing redundant or similar information could significantly decrease product preference [28]. Therefore, proper combinations of different labels are characterized by complementary information [34].

Conceptual framework and research hypotheses

To analyze the effects of bundling FOPLs on consumer decision-making, we adopted the framework developed by Grunert and Wills [35], one of the most utilized models for studies concerning FOPL influence on consumers' understanding of nutrition information and subsequent food choices [7,36–39]. The framework considers five phases (exposure, perception, understanding, liking, and use) among consumers exposed to FOPLs and distinguishes between objective and subjective understanding (see Appendix). In this study, we consider the three subdimensions of consumers' subjective understanding [40,41]: comprehensibility (i.e., the ability to facilitate interpretation), help to shop (i.e., the ability to make food choices easier), and complexity reduction (i.e., the ability to simplify learning).

Consumer decision-making is influenced by individuals' cognitive abilities [42]; in fact, their processing capabilities can become cognitively overloaded if they attempt to process too much information in a limited time, and this can result in confusion, cognitive strain, and other dysfunctional consequences, including poorer decision making [43]. In the case of an FOPL bundle, on the other hand, the additional information provided to consumers could lead them toward different evaluating processes and different outcomes; Harris and Blair [44], for example, found that bundles may be perceived as a unique alternative that reduces cognitive complexity, saves time, and enhances desirability. Sweller [45] reported that simultaneously presenting identical information in different formats is ineffective because more cognitive resources are demanded to process the redundant messages. Encoding the same information in multiple formats is cognitively demanding because extra working-memory resources are required. Therefore, removing redundant representations reduces an unnecessary load on working memory and enhances learning, which is the basis of the subjective understanding described by Grunert and Wills [35]. Building on the previous evidence, one could argue that a bundle of two directive labels generates redundancy. In contrast, a bundle of a directive label and a non-directive label could generate complementarity. Therefore, we expect that a mixed bundle of FOPLs, characterized by complementary and non-redundant information, that brings together a synthetic appreciation of the product's overall nutritional and detailed nutritional information on specific nutrients would improve consumers' subjective understanding when compared with a double-directive FOPLs bundle characterized by non-complementary and redundant information.

We thus introduce the concepts of a "double-directive bundle," consisting of two labels belonging to the directive category (i.e., Keyhole and Nutri-Score), and of the "mixed bundle," consisting of two labels belonging to different categories, one directive (i.e., Keyhole) and one non-directive (i.e., NutrInform Battery), then basing bundles on a single-directive FOPL (i.e., Keyhole). We hypothesized that:

H1a. The mixed bundle of FOPLs would generate greater comprehensibility than the double-directive bundle of FOPLs.
H1b. The mixed bundle of FOPLs would generate more help to shop than the double-directive bundle of FOPLs.
H1c. The mixed bundle of FOPLs would reduce complexity more than the double-directive bundle of FOPLs.

Regarding the effect of bundling on consumer liking, compared with bundles of non-complementary products, bundles of complementary products positively affect consumers' liking [46,47], indicating that complementarity has a positive effect on consumers' preferences.

Previous studies on consumer perception of various FOPLs (e.g., Grunert and Wills [35]) showed that on one hand, people like simplified labels (e.g., directive labels) because they lead to a quicker decision, although consumers want to know how the information below the label was derived. On the other hand, Emrich et al. [48] tested the effects of four different FOPLs (two directive systems, the Health Check logo and Smart Pick, and two non-directive systems, Multiple Traffic Light and Nutrition Facts-based) on consumers' liking and reported that the two non-directive FOPL systems received higher scores on liking than the two directive FOPLs systems.

Therefore, we hypothesized that the combination of a directive and a non-directive label (i.e., a mixed bundle) could improve consumers' liking of the label by incorporating both a label that allows a quick decision and a label that provides detailed nutritional information, because it provides complementary information:

H2. The mixed bundle of FOPLs would generate more consumer liking of the label than the double-directive bundle of FOPLs.

Within the comparison between bundles and single products, Harlam et al. [24] and Venkatesh and Kamakura [49] highlighted that complementary bundles have a superior evaluation compared with single products. On the other hand, Martins et al. [20] provided evidence that a non-complementary bundle (i.e., characterized by redundant or non-related products) received a lower evaluation regarding quality, attractiveness, and purchase intention than did a single product.

Building on this evidence, it could thus be assumed that an FOPL mixed bundle consisting of complementary and not redundant information and offering a complete view of the nutritional information could improve consumers' subjective understanding and liking when compared with a single FOPL. On the contrary, where the information is redundant and not complementary (i.e., in the case of the double-directive bundle), the processing of this information may require a more significant effort on the part of the consumer; thus, we hypothesized that the double-directive bundle could decrease subjective understanding and liking of the label when compared with a single FOPL:

H3a. The mixed bundle of FOPLs would generate greater label comprehensibility compared with the single-directive FOPL.
H3b. The double-directive bundle of FOPLs would generate lower

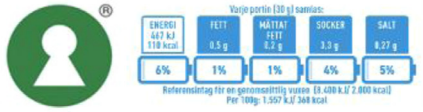
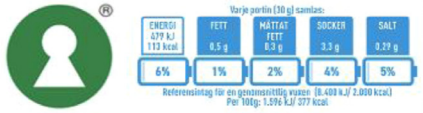
PDTs	Label's nutritional level	FOPL system		
		Single-directive	*Double-directive bundle*	*Mixed bundle*
Cereals	Level 1			
	Level 2			

Fig. 1. Front-of-package label conditions.

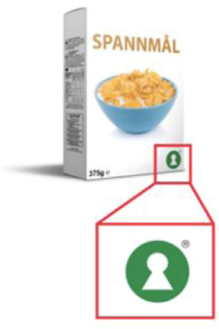
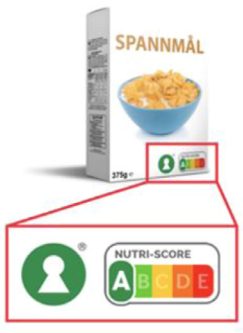
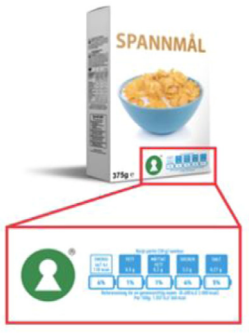
PDTs	Label's nutritional level	FOPL system		
		Single-directive	*Double-directive bundle*	*Mixed bundle*
Cereals	Level 1			
	Level 2			

Fig. 2. Mock-up product and conditions.

label comprehensibility compared with the single-directive FOPL.

H3c. The mixed bundle of FOPLs would improve a label's help to shop compared with the single-directive FOPL.

H3d. The double-directive bundle of FOPLs would decrease a label's help to shop compared with the single-directive FOPL.

H3e. The mixed bundle of FOPLs would lead to greater reduction of the label's complexity compared with the single-directive FOPL.

H3f. The double-directive bundle of FOPLs would lead to less reduction of the label's complexity compared with the single-directive FOPL.

H4a. The mixed bundle of FOPLs would increase consumer liking of the label compared with the single-directive FOPL.

H4b. The double-directive bundle of FOPLs would decrease consumer liking of the label compared with the single-directive FOPL.

Methods and materials

Stimuli

To manipulate the FOPL system, we considered three levels: a single-directive FOPL, a double-directive bundle of FOPLs, and a mixed bundle of FOPLs (Fig. 1). We decided to conduct our research in Sweden because it was one of the first countries to adopt an FOPL (1989), with a high level of awareness [50] and familiarity [51]. Sweden

Table 2
Scale reliability (Cronbach α)

Scale item	Reliability
Comprehensibility	
I feel well informed by the food label or bundle of front-of-pack labels	0.838
This label or bundle of front-of-pack labels is believable and trustworthy	
This label or bundle of front-of-pack labels is easy to interpret	
Help to shop	
This label or bundle of front-of-pack labels helps me to understand the product comparison	0.847
This label or bundle of front-of-pack labels helps me to understand different nutritional values	
This label or bundle of front-of-pack labels makes it easier to choose food	
Complexity reduction	
The food label or bundle of front-of-pack labels is rather extensive	0.683
Using this food label or bundle of front-of-pack labels to choose food is better than just relying on my own knowledge about what is in them	
Liking	
How do you evaluate the label or bundle of front-of-pack labels?	0.903
Bad/good	
Unfavorable/favorable	
Negative/positive	

Table 3
Sociodemographic details of the sample

Variable	Proportion of sample, %
Age, y	
18–24	13
25–34	58
35–49	22
50–64	6
≥65	1
Sex	
Men	59
Women	40
Prefer not to declare	1
Education	
Lower than diploma	46
Diploma	8
Bachelor degree	27
Master degree	15
Ph.D.	4
Employment status	
Full-time job	50
Part-time job	10
Unemployed	5
Student	20
Retired	3
Housewife	1
Self-employed	7
Unable to work	4
Income, SEK	
<200.000	39
200.000–400.000	35
410.000–600.000	18
610.000–800.000	5
810.000–1.000.000	1
>1.000.000	2

has also carried out national campaigns to increase awareness and knowledge and to encourage use during the purchase process [52]. Results of the campaign showed a 20% increase in the purchase of Keyhole Logo–labeled products among 2 out of 3 retailers [52]. Furthermore, this directive label has a substantial effect on perceived attraction and healthiness [50]; we therefore used it to represent the single-directive FOPL condition. To create the double-directive bundle of FOPLs, we selected the directive Nutri-Score, given that it is mostly present in Europe and is one of the most tested FOPLs in recent literature [37,39,53–55]. To create the mixed bundle of FOPLs, we selected the non-directive NutrInform Battery because, to our knowledge, it has been scarcely tested in other EU countries, except by Mazzù et al. [7,8,41].

We used mock products to avoid biases anchored to brands, colors, and additional information, also following prior research studies [36]. We selected breakfast cereals because, according to prior studies, they are a relevant segment of Swedish consumption and have one of the highest-volume growth rates [56].

Because the focus of this research was on the consumers' subjective understanding of FOPLs and their liking of the labels, we expected our hypotheses to be supported regardless of the nutritional level of the label. Therefore, to generalize the effects, we decided to consider two different levels of labels' nutritional values. Both the bundles of the Nutri-Score and of the NutrInform Battery refer to the same nutritional content; this is true for letter A of the Nutri-Score and level 1 of the NutrInform Battery information and for letter C of the Nutri-Score and level 2 of the NutrInform Battery information (Fig. 1).

Cereals were represented as a closed box with a white background, resembling a real product package. The labels were in the same position, on the bottom right of the box, and then presented in an enlarged version to make the information readable (Fig. 2). We decided not to provide prices because they might mislead the participants' responses.

Constructs and measures

We measured the subdimensions of subjective understanding (comprehensibility, help to shop, and complexity reduction) and liking of the labels through measures derived from extant literature [7,40,41,57], then translated and adapted them from English to Swedish. The reliability of the items has been measured through Cronbach's α, showing the reliability of all tested multi-item Likert scales (Table 2).

Research design

The study presents a 3 × 2 between-subjects design: (FOPLs system: double-directive FOPLs bundle versus mixed bundle of FOPLs versus single-directive FOPL) × (label's nutritional level: level 1 versus level 2). A sample of 327 Swedish respondents (Table 3) was recruited through international web panel providers (i.e., Prolific Academic). Participants were asked to complete an online questionnaire. First, they were assigned randomly to one of the six conditions; then they answered questions to measure subjective understanding and liking of the labels. Finally, they provided sociodemographic data. Details of sample size by sociodemographic information are provided in the Supplementary Appendix. The sample selection was developed following the experimental-research rule of the thumb of at least 50 respondents per cell; furthermore, according to Cohen et al. [58] and Gall et al. [59], the larger the sample, the better for the researcher.

Response data were analyzed through IBM SPSS Statistics, version 28 (SPSS Inc., Chicago, IL, USA). After evaluating reliability to assess the consistency of the scales, we calculated the means for the effects on consumers' subjective understanding and liking of the labels. Two-way analyses of variance (ANOVAs) were conducted to investigate the main effect of the FOPL system on the dependent variables, and consequently, the planned comparisons were performed to test our hypotheses. The results are provided in the Supplementary Appendix.

Results

Subjective understanding

To analyze the effects on consumers' subjective understanding, we measured the effect on the three subdimensions: comprehensibility, help to shop, and complexity reduction.

FOPL comprehensibility

A two–way ANOVA showed a significant main effect of FOPL systems on labels' comprehensibility (F_{2321} = 14.604; $P < 0.001$). The effect of the label's nutritional level (F_{1321} = 0.150; P = 0.699)

*https://ec.europa.eu/competition-policy/system/files/2021–06/HBERs_inception_impact_assessment.pdf

†Presidency conclusions on front-of-pack nutrition labeling, nutrient profiles, and origin labelling https://data.consilium.europa.eu/doc/document/ST-14048–2020-INIT/en/pdf

‡The "label's nutritional level" variable was included to generalize the results both in level 1 and level 2; no interaction was expected between the front-of-package label system and the label's nutritional level. The results confirm this, because in all two-way analyses of variance, the interaction effects were not statistically significant (all $P > 0.05$)

and the interaction effect of FOPL systems and label's nutritional level (F_{1321} = 1.180; P = 0.309) were both nonsignificant. Planned comparisons showed that comprehensibility was significantly higher for the mixed bundle of FOPLs than for the double-directive bundle of FOPLs (Comprehensibility$_{mixed_BundleFOPL}$ = 5.021; SD, 1.445; Comprehensibility$_{double\text{-}directive_BundleFOPL}$ = 3.936; SD, 1.535; $P < 0.001$), supporting H1a. Moreover, comprehensibility was significantly higher for the mixed bundle of FOPLs than for the single-directive FOPL (Comprehensibility$_{mixed_BundleFOPL}$ = 5.021; SD, 1.445; Comprehensibility$_{Single\text{-}directiveFOPL}$ = 4.361; SD, 1.516; P = 0.004), supporting H3a; however, there was no significant difference in terms of comprehensibility between the double-directive bundle of FOPLs and the single-directive FOPL (Comprehensibility$_{double\text{-}directive_BundleFOPL}$ = 3.936; SD, 1.535; Comprehensibility$_{Single\text{-}directiveFOPL}$ = 4.361; SD, 1.516; P = 0.115), not supporting H3b.

FOPL help to shop

A second two−way ANOVA showed a significant main effect of the FOPL system on help to shop (F_{2321} = 22.583; $P < 0.001$). The effect of the label's nutritional level (F_{1321} = 0.898; P = 0.344) and the interaction effect of FOPL systems and the label's nutritional level (F_{1321} = 2.407; P = 0.092) were both nonsignificant. Planned comparisons showed that the label's help-to-shop outcome was significantly higher for the mixed bundle of FOPLs than for the double-directive bundle of FOPLs (Help to shop$_{mixed_BundleFOPL}$ = 4.545; SD, 1.401; Help to shop$_{double\text{-}directive_BundleFOPL}$ = 3.345; SD, 1.607; $P < 0.001$), supporting H1b. Moreover, the label's help-to-shop outcome was significantly higher for the mixed bundle of FOPLs than for the single-directive FOPL (Help to shop$_{mixed_BundleFOPL}$ = 4.545; SD, 1.401; Help to shop$_{Single\text{-}directiveFOPL}$ = 3.357; SD, 1.558; $P < 0.001$), supporting H3c, whereas there was no significant difference in terms of label's help-to-shop outcome between the double-directive bundle of FOPLs and the single-directive FOPL (Help to shop$_{double\text{-}directive_BundleFOPL}$ = 3.345; SD, 1.607; Help to shop$_{Single\text{-}directiveFOPL}$ = 3.357; SD, 1.558; P = 1.000), not supporting H3d.

FOPL complexity reduction

A third two−way ANOVA showed a significant main effect of the FOPL system on labels' complexity reduction (F_{2321} = 29.462; $P < 0.001$). The effect of the label's nutritional level (F_{1321} = 1.673; P = 0.197) was not significant, whereas the results showed a significant two−way interaction between FOPL systems and the label's nutritional level (F_{1321} = 4.655; P = 0.010). Planned comparisons showed that in the label's nutritional level 1 scenario, the label's complexity reduction was significantly higher in the mixed bundle of FOPLs than in the double-directive bundle of FOPLs (Complexity reduction$_{mixed_BundleFOPL}$ = 4.25; SD, 1.308; Complexity reduction$_{double\text{-}directive_BundleFOPL}$ = 3.28; SD, 1.586; P = 0.001), supporting H1c. Moreover, complexity reduction was significantly higher for the mixed bundle of FOPLs than for the single-directive FOPL (Complexity reduction$_{mixed_BundleFOPL}$ = 4.25; SD, 1.308; Complexity reduction$_{Single\text{-}directiveFOPL}$ = 2.94; SD, 1.235; $P < 0.001$), supporting H3e, whereas there was no significant difference in terms of the label's complexity reduction between the double-directive bundle of FOPLs and the single-directive FOPL (Complexity reduction$_{double\text{-}directive_BundleFOPL}$ = 3.28; SD, 1.586; Complexity reduction$_{Single\text{-}directiveFOPL}$ = 2.94; SD, 1.235; P = 0.620), not supporting H3f. Finally, in the label's nutritional level 2 scenario, a planned comparison showed that the label's complexity reduction was significantly higher in the mixed bundle of FOPLs than in the double-directive bundle of FOPLs (Complexity reduction$_{mixed_BundleFOPL}$ = 4.52; SD, 1.198; Complexity reduction$_{double\text{-}directive_BundleFOPL}$ = 2.88; SD, 1.228; $P < 0.001$), supporting H1c. Moreover, complexity reduction was significantly higher for the mixed bundle of FOPLs than for the single-directive FOPL (Complexity reduction$_{mixed_BundleFOPL}$ = 4.52; SD, 1.198; Complexity reduction$_{Single\text{-}directiveFOPL}$ = 3.65; SD, 1.469; P = 0.002), supporting H3e. Furthermore, there was a significant difference in terms of the labels' complexity reduction given the fact that the double-directive bundle of FOPLs had a lower mean than the single-directive FOPL condition (Complexity reduction$_{double\text{-}directive_BundleFOPL}$ = 2.88; SD, 1.228; Complexity reduction$_{Single\text{-}directiveFOPL}$ = 3.65; SD, 1.469; P = 0.008), supporting H3f.

Liking

The last two−way ANOVA showed a significant main effect of the FOPL system on consumers' liking of the labels (F_{2321} = 4.912; P = 0.008). The effect of the label's nutritional level (F_{1321} = .151; P = 0.698) and the interaction effect of FOPL systems and the label's nutritional level (F_{1321} = 1.580; P = 0.208) were both nonsignificant. Planned comparisons showed that consumers' liking of the labels was significantly higher for the mixed bundle of FOPLs than for the double-directive bundle of FOPLs (Liking$_{mixed_BundleFOPL}$ = 4.730; SD, 1.532; Liking$_{double\text{-}directive_BundleFOPL}$ = 4.161; SD, 1.561; P = 0.012), supporting H2. Moreover, concerning the comparison between the bundle of FOPLs versus a single FOPL, findings showed that consumers' liking of the labels was significantly higher for the single-directive FOPL than for double-directive bundle of FOPLs (Liking$_{Single\text{-}directiveFOPL}$ = 4.655; SD, 1.275; Liking$_{double\text{-}directive_BundleFOPL}$ = 4.161; SD, 1.561; P = 0.040), supporting H4b. However, there was no significant difference in terms of consumers' liking of the labels between the mixed bundle of FOPLs and the single-directive FOPL (Liking$_{mixed_BundleFOPL}$ = 4.730; SD, 1.532; Liking$_{Single\text{-}directiveFOPL}$ = 4.655; SD, 1.275; P = 1.000), not supporting H4a.

Discussion

This study aimed to investigate the effects of different types of FOPL bundles (distinct in terms of directiveness of the FOPL scheme) on consumers' subjective understanding and liking of the labels. The study was conducted in Sweden, one of the first countries to adopt FOPLs to support consumers in their decision-making, first by comparing the effects of a mixed bundle of FOPLs (i.e., two types of labels belonging to different categories, one directive [Keyhole] and one non-directive [NutrInform Battery]) versus a double-directive bundle of FOPLs (i.e., two labels belonging to the directive category [Keyhole and Nutri-Score]) and secondly by comparing each bundle with the established FOPL in the local market (i.e., Keyhole). This research contributes to previous studies on bundling of FOPLs; furthermore, reported results contribute to the discussion about which FOPL bundle is the most effective in helping policymakers identify the basis to standardize the reference EU scheme.

The results showed a higher effect of the mixed bundle (versus the double-directive bundle) on consumers' subjective understanding in terms of comprehensibility (H1a was supported), help to shop (H1b was supported), complexity reduction (H1c was supported in both scenarios—label nutritional level 1 and label nutritional level 2), and liking of the label (H2 was supported). Consistent with the literature, the complementary bundle performed significantly better than the non-complementary bundle on dependent variables, reporting a higher utility for the consumers [20,21].

This might imply that in the case of our FOPLs combination, the presence of two labels belonging to the same category (i.e., two directive labels, Keyhole and Nutri-Score) weakens the effects on consumers' subjective understanding and liking of the labels, whereas the opposite happens in the case of two complementary

labels (i.e., a mix between directive and non-directive labels, NutrInform Battery and Keyhole). Although previous research has shown that directive and semidirective labels increase the understanding of nutritional information more than non-directive labels [5,13], our research has shown that the simultaneous presence of a directive label (i.e., Keyhole) and a non-directive label (i.e., NutrInform Battery) could improve subjective understanding. Finally, because a decrease in FOPL directiveness can lead to a greater amount of information for the consumer to process [12], the mixed bundle, by incorporating both a directive label (which allows for a quick decision) and a non-directive label (which provides detailed nutritional information), could represent a possible optimal solution for consumers, because it combines easily understandable information with more in-depth details.

The results of the second part of the analysis highlighted that the mixed bundle of FOPLs (versus the single-directive FOPL) improves label comprehensibility (supporting H3a). Although the average value of the single-directive condition was greater than the double-directive condition (consistent with the hypothesized direction), there was no significant difference in terms of labels' comprehensibility between the double-directive bundle of FOPLs and the single-directive FOPL (H3b was not supported). The mixed bundle of FOPLs (versus the single-directive FOPL) also improved the labels' help to shop (H3c was supported), whereas no statistical difference was found in the case of the double-directive bundle versus the single-directive FOPL (H3d was not supported). In terms of complexity reduction, the mixed bundle of FOPLs (versus the single-directive FOPL) did increase label complexity reduction in both scenarios (supporting H3e). The comparison of the double-directive bundle with the single-directive label had different outcomes according to the reference scenario. In the scenario with label nutritional level 1, we registered no significant differences between the two FOPL conditions (H3f was not supported); on the other hand, in the scenario with label nutritional level 2, we reported a significant higher mean of the single-directive label when compared with the double-directive bundle (supporting H3f). Finally, our results showed that the double-directive bundle (versus the single-directive FOPL) did not improve the liking of the label (H4b was supported); although the average value of the mixed condition was greater than the single-directive condition (consistent with the hypothesized direction), no statistical difference was found concerning the consumers' liking of the labels (H4a was not supported).

Consistent with the bundling literature (e.g., Harlam et al. [24] and Venkatesh and Kamakura [49]), the mixed FOPL bundle (i.e., complementary) performed better than the single label in terms of consumers' subjective understanding. Furthermore, regarding the comparison between the double-directive bundle (i.e., non-complementary) and the single label, in contrast to the results highlighted by Martins et al. [20], we registered no significant differences in consumers' subjective understanding. The reason for this difference between results highlighted in our research and past evidence could be owed to the fact that little has been explored in the comparison between bundles and single labels, especially on the effect that the different type of bundle has on the consumer. Future research could enrich this stream with additional studies, to verify the presence of statistical differences. On the other hand, statistically significant differences in liking were found, showing a higher performance of the single label compared with the double-directive bundle, consistent with the results of previous literature [20].

As mentioned before, to generalize the results, we decided to introduce the label's nutritional level as a variable in our model, arguing that the effects would not change depending on these scenarios (i.e., no interaction was expected between the FOPL system and the label's nutritional level). In all cases except complexity reduction, the interaction effects were not statistically significant (all $P > 0.05$), indicating that the main effects of the FOPL system occurred regardless of the different labels' nutritional levels (i.e., level 1 and level 2) in most of the cases.

This study was not without limitations, which may provide avenues for future research. The study was conducted in one country (Sweden). Replicating it in other countries is necessary to ensure the generalizability of the findings and to detect possible cultural differences. We also focused on one food category (cereals); future research may test the robustness of the effects for different food categories. Additional covariates and new behavioral elements could be analyzed.

Moreover, future research could implement further analysis regarding the performance of FOPL bundles using different FOPL combinations when creating the bundle. Our research could be considered as a starting point of a stream of research regarding FOPL bundles. Specifically, further research could try to 1) replicate our study to strengthen and generalize our results; 2) test different types of FOPL combinations, because our results are not generalizable given the fact that they are related only to our bundling combinations; and 3) identify the best bundling solution for leading consumers toward healthier and more informed food choices.

Another limitation of our research is that the Keyhole could only be applied to food products that meet certain requirements and features. In this case, the package only displayed the NutrInform Battery (or, in the case of the double-directive bundle, the Nutri-Score).

To check what would have been the situation in the absence of the Keyhole, we have conducted an additional experiment (80 participants, using a between-subjects design with two alternative conditions of NutrInform Battery and Nutri-Score and the same Dependent Variables of our study on bundles). Results showed that the NutrInform Battery significantly outperformed the Nutri-Score on subjective understanding (see the Supplementary Table in the Appendix). Thus, in the absence of the Keyhole, consumers might still count on a better situation in terms of subjective understanding and liking, confirming the "invariance" of the results to the benefit of end customers. Thus, in our scenario, when the Keyhole is not displayed in the package owing to its special requirements, customers will find only the NutrInform Battery, which also has been proven to perform better than the Nutri-Score on subjective understanding and liking in other countries [7,8]. The results, summarized in the Supplementary Appendix, might open new research avenues to understand the cumulative effect and the interplay of the combination of different FOPLs, for the benefit of improved customer decision-making with regard to healthier food choices.

Conclusion

Our study tested the effects of the presence of the FOPLs bundle, highlighting that a mixed bundle composed of NutrInform Battery and Keyhole labels was more effective than the double-directive bundle composed of a Nutri-Score and Keyhole label in allowing consumers to improve their subjective understanding and liking of the labels. In addition, the comparison of the performance obtained by a single-directive FOPL with the double-directive and mixed bundles, respectively, showed that consistent with previous research, FOPLs providing complementary information can significantly increase the performance of the information provided, whereas the single FOPL is preferred in cases where the information of the bundle might be perceived as redundant or overlapping.

This study contributes to two streams of research. The first concerns the literature on bundles, given the fact that this study showed the complementary bundle was preferable, from a cognitive and performance perspective, to the non-complementary one. Second, although most research involving FOPLs does register a comparison

between different FOPLs, this study reported, for the first time to our knowledge, the effect of the interaction of multiple FOPLs.

This research also enriches the literature by highlighting one of the effects of bundled FOPLs on consumers' subjective understanding and liking, showing the differences in the case of mixed bundles versus double-directive bundles. As mentioned earlier, our results need further investigation in order to generalize the effects of FOPL bundles and identify the right bundle of FOPLs for customers.

Furthermore, our findings show the importance of better understanding consumers' perceptions of label bundles, with the aim to identify the most effective combination to support their food-purchase decision-making. Therefore, the insights of the study might help decision-makers to further explore the effects of FOPL bundles in order to more effectively support consumers in making healthier and more informed food choices while leveraging complementary information available in different labels.

In our study, the use of a bundle of FOPLs showed results that might be also relevant for policymakers. Instead of a single label, the EU could consider adopting a bundle of FOPLs, consisting of a specific combination of a directive label and a non-directive label, shown to increase positive effects on consumers and to guide the purchasing process.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.nut.2022.111849.

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