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Nutritional labeling, communication design, and relevance

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In this paper, I use relevance theory to explain the relative effectiveness of three different nutrition labeling systems in communicating information and influencing consumer food choices. Facts Up Front [also known as Reference intake (RI) or Guideline Daily Amounts (GDA)], traffic light systems, and warning labels present nutritional information in different front of pack (FOP) formats. Research into the effectiveness of these systems shows that warning labels improve consumers' ability to identify unhealthy products, compared with both Facts Up Front and traffic light systems. Warnings and traffic light systems perform equally well, however, when participants are asked to identify the most healthful product. I demonstrate how these findings can be explained in terms of the processing effort and inferential steps required from the consumer when accessing relevant contextual assumptions and deriving relevant implications in decision-making contexts. That is, I show how the success of the various labeling systems is linked to their relevance in the context of interpretation. This analysis illustrates the explanatory power of relevance theory in relation to visual communication and has implications for communication design and policy more generally.

KEYWORDS

pragmatics, relevance theory, communication design, labeling, relevance-theoretic analyses

1. Introduction

The effectiveness of the communications strategies of governments and advisory bodies can influence the health-related behavior of the public (Hornik, 2002; Wakefield et al., 2010). One area in which many governments legislate and/or provide guidance and recommendations is food and drink labeling. Policies around food packaging and the presentation of nutritional information vary by region and country. There are several formats for displaying nutritional information on food packaging, and there is a wealth of research into how these systems perform, both in terms of conveying information and changing consumer behavior. However, explanations as to why some systems yield better outcomes than others remain general. For example, Temple (2020; p. 5) discusses the apparent effectiveness of two of the systems and concludes that the "most likely reason for this is that these designs are fairly easy for shoppers to understand." In this article, I use a pragmatic framework to analyze the interpretative processes that consumers go through when interpreting a label. This then allows us to unpack what "easy for shoppers to understand" might mean in terms of the cognitive processes involved in reaching an interpretation of the nutritional information. As the various labeling systems present the same basic information in different ways, they can be used as a test case for the application of pragmatic principles in communication design.

Pragmatics is the study of communication in context. Relevance-theoretic pragmatics (Sperber and Wilson, 1995; Carston, 2002; Wilson and Sperber, 2012) offers a framework for understanding how intentional acts of communication are interpreted. As such, it is well-placed to provide insight into why some nutritional labeling systems are more effective in terms of conveying information and influencing behavior than others. By applying the principles of relevance to the interpretation of labels as communicative devices, we can compare the interpretative routes that users take when they process this information. Effective communication is not just about what information is included in a message, but also about how that information is presented. An understanding of the interpretative processes which underlie consumers' engagement with nutritional labeling should feed into both design practice and communications policy decisions in the future, and it paves the way for ideas from pragmatics to inform future work within communication design.

I start in the next section by outlining the key aspects of the relevance-theoretic approach to cognition and communication. The assumptions and principles presented here underpin the analyses and discussions that follow. In Section 3, I outline the main food labeling systems that are currently in use, and I then give an overview of the main findings of research into the effectiveness of these systems in Section 4. In Section 5, I bring these ideas together and present a relevance-theoretic analysis of the labeling systems, demonstrating how differences in interpretation can be tied to differences in the design of the systems. In Section 6, I discuss some implications of this analysis, with a focus on how communication design and policy might be informed by our understanding of pragmatics and utterance interpretation.

2. Relevance and communication design

Relevance theory (Sperber and Wilson, 1995; Carston, 2002; Wilson and Sperber, 2006, 2012) is a framework for understanding how communicative acts (including utterances) are interpreted. At its heart are two core principles, one relating to human cognition and the other to communication. According to the cognitive principle of relevance, human cognition is geared to the maximization of relevance. An input will be relevant to an individual if it leads to cognitive effects. Cognitive effects are changes in our cognitive environment, and we can think of these as changes to the assumptions that we hold. An input might be relevant because it causes us to strengthen an assumption that we already hold. It may be relevant because it contradicts an assumption that we hold and leads us to eliminate it. Finally, an input may be relevant because it combines with an assumption that we hold to yield a new assumption that was previously unavailable to us.

Relevance is a matter of degree, and some inputs will be more relevant than others. The more cognitive effects that an input leads to (all other things being equal), the more relevant that input will be. However, processing inputs and deriving cognitive effects takes mental effort, and the more effort involved, the less relevant that input will be (again, all other things being equal). The relevance of an input is also relative to the context in which it is processed, and it is specific to the individual who is processing it. Something that is highly relevant for one person, may have little relevance for another.

According to the communicative principle of relevance, ostensive acts of communication carry with them, as part of their meaning, a presumption of their own optimal relevance. That is, when information is communicated intentionally and overtly, the addressee can assume that the communicator intended the message to be optimally relevant. The definition of optimal relevance is given in (1).

(1) (a) The ostensive stimulus is relevant enough to be worth the audience's processing effort, and (b) it is the most relevant one compatible with the communicator's abilities and preferences (Wilson and Sperber, 2006; p. 612).

This characterization of optimal relevance and the communicative principle of relevance combine to give us the relevance-theoretic comprehension procedure, given in (2).

(2) Follow a path of least effort in computing cognitive effects: Test interpretive hypotheses (disambiguations, reference resolutions, implicatures, etc.) in order of accessibility. Stop when your expectations of relevance are satisfied (or abandoned) (Wilson and Sperber, 2006; p. 613).

This framework for understanding how utterances (and other ostensive acts of communication) are interpreted has significant consequences for communication design. To interpret a message, the audience must access contextual assumptions that can combine with the input in a way that yields cognitive effects. Communicators therefore need to make predictions about the assumptions that their intended audience will hold and how strongly they will hold them. It will, for example, be much harder to change behavior if that behavior is based on assumptions that are held with a high degree of confidence. Furthermore, communication is likely to be unsuccessful if the information included in a message cannot combine with an assumption that the intended audience already holds. The task of predicting the assumptions of an audience is further complicated if there are no definite addressees or if the message is intended for a mass audience. A communicator may not know exactly who the message will reach and what assumptions they might hold. Public service announcements may be intended to communicate with a large and diverse group of people, all of whom may bring different assumptions to their interpretation.

A further consequence of this model of utterance interpretation is that the relevance of a message depends not just on the information that it includes but also on the ease with which the audience can access and process this information. Processing effort, and hence relevance, is affected by the accessibility of the information itself (Can it be clearly read? Is it written in a language that the audience understands? Does it use vocabulary that the audience members are familiar with? How linguistically or logically complicated is the information? etc.). The processing effort demanded of the audience will also be affected by the accessibility of the contextual assumptions

with which the information interacts to yield cognitive effects. Assumptions that are accessed frequently or which have been accessed recently will be more accessible than those that are rarely part of an individual's interpretation processes. The more effort that is demanded from the audience, the less relevant the message will be, and, as allowed for in the relevance-theoretic comprehension procedure in (2), if put to too much effort, the audience member may abandon the search for relevance altogether.

The principles of relevance and the definitions that underpin them provide a framework for understanding how we process and interpret new information. Relevance is comparative, and we can understand differences in the relevance of inputs in terms of the processing effort that they demand and the cognitive effects to which they lead.

Various studies have considered the role of visual and multimodal communication from the perspective of relevance theory. Forceville (2014; p. 67) has argued that relevance theory 'allows for the systematic analysis of all forms of communication in all (combinations of) modes in all media' and demonstrates the potential of this approach in his analyses of logos, advertising, political cartoons, and comics (Forceville, 2020). In an analysis of the front covers of political magazines, Tseronis (2018) uses relevance theory to demonstrate that multimodal cues in images not only attract the attention of an audience but also play a role in the communication of an argument. Relevance theory has also been used to demonstrate how the visual design of text plays a role in the communication of meaning. Sasamoto et al. (2017; p. 427) show that the "multi-colored, and highly visible, intra-lingual captions" added to some Japanese television programmes are "deliberately used to influence viewers' interpretations." Both Sasamoto and O'Hagan (2020) and Scott and Jackson (2020) consider the role that the visual appearance of text plays in the interpretation of written utterances and conclude that stylistic decisions can be used to guide the audience to an intended interpretation. I build on this work here, using insights from relevance theory to explain the patterns that we find in the effectiveness of different food product labeling systems.

3. Nutritional labeling and consumer perception

3.1. An overview of labeling policies and systems

Restrictions and requirements for nutritional labeling on food and drink products vary according to the country in which the product will be sold. Some form of nutritional information is often required by law on all pre-packaged foods, and this most often appears on the back of packaging. Regulation around front of pack (FOP) labeling varies more widely and is often voluntary. For example, in the European Union, producers must provide a nutritional declaration in a specific format, but they may also repeat that information for certain nutrients (energy, fat, saturates, sugar and salt) on the front of the food packaging (European Union, 2/11/22). In Chile, warnings must be included as part of the FOP packaging when the product exceeds a recommended limit for certain key nutrients.

According to Hersey et al. (2013) front of pack labeling falls into two main categories: nutrient specific systems and summary systems. Nutrient specific systems provide information about various key nutrients in the product. Summary systems, on the other hand, "use an algorithm to provide an overall nutritional score" (Hersey et al., 2013; p. 2). This summary may take the form of an endorsement logo indicating that the product satisfies certain requirements, or it may be a rating system of some sort, such as the Guiding Star system which rates products as "good," "better," or "best" (Guiding Stars Licensing Company) by awarding them one, two, or three stars. Nutri-Score is a summary system used in several EU countries. Products are given a rating of A to E, based on nutritional value. In a systematic review of studies into food labeling systems, Hersey et al. (2013; p. 13) conclude that "consumers more easily identify healthier foods using nutrient-specific schemes compared with the summary systems."

Hodgkins et al. (2012) propose that labeling systems can be divided into three sub-categories based on how much direction they give the consumer. They may be directive, semi-directive, and non-directive. In the analysis that follows, I look at research that compares the effectiveness of labeling systems from across this three-way categorization and explain the results using relevance-theoretic assumptions about how we interpret ostensive stimuli. A brief introduction to the three categories and the schemes which fall into them is therefore useful at this stage.

3.2. Directive systems

Directive labels make direct claims about the healthfulness (or otherwise) of a product and the claims are usually endorsed by a third party such as a government, charity, or regulating body. Some directive labels provide summaries, indicating that a food has been classified as meeting a certain overall standard. Others may provide direct information about one or more nutrient. Nutrition-specific directive labels make general claims ("low in fat," "high in sugar") about a nutrient, but they lack specific details of the quantities involved. As Hodgkins et al. (2012; p. 813) note, consumers do not need these details with summary systems as "in terms of [the product's] health utility, the decision has already been made for them."

Warnings are a directive form of FOP labeling which indicate when the product contains high levels of a nutrient that should only be consumed in a limited quantity. Warning systems have been included in strategies to reduce obesity and over-consumption of processed foods in some regions of the world. The Pan American Health Organization recommends that warnings be included on labels for food containing high levels of calories or key nutrients (saturated fats, salt, sugar). These recommendations have been implemented as mandatory in Mexico, Chile, Peru, and Uruguay (Buchanan, 2020). Warning labels from Chile are shown in Figure 1.

In the Pan American Health Organization system, labels are only required on FOP packaging when the quantity of calories or nutrient is higher than recommended. In this system there are no

FIGURE 1
Warning labels from Chile. Image taken from Grummon (2019) under creative commons attribution 4.0 international license.

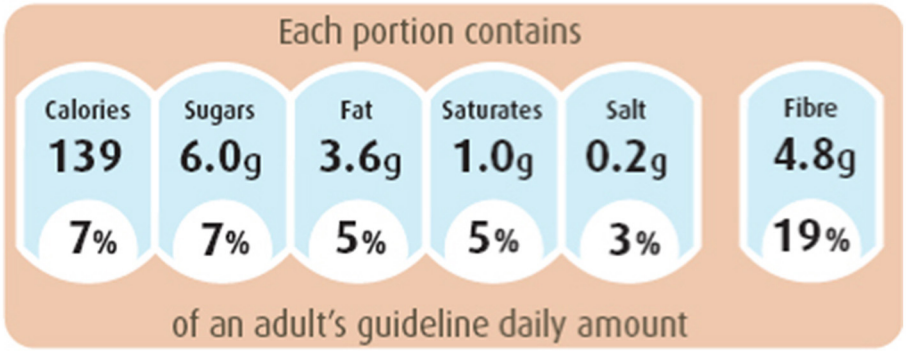

FIGURE 2
GDA label. Image from https://wiki.ead.pucv.cl/index.php/Usuario:Romina_Guerra CC BY-SA 3.0.

FIGURE 3
Traffic light labeling on food. Photograph Ian Clark/ijclark. CC BY-NC 2.0.

TABLE 1 Meaning of traffic light colors scheme colors, according to the British Nutrition Foundation (2022).

Color	Meaning (British Nutrition Foundation, 2022)
Green	If there is mostly green on the label, then this is telling you straight away it is low in that nutrient and a healthier choice![a]
Amber	This means the product is neither high nor low in the specific nutrient. You can eat foods with all or mostly amber on the label most of the time
Red	Red does not mean you cannot eat the product, but means the food is high in fat, saturated fat, salt, or sugar. We should be cutting down on foods with lots of red on the label, or if they are eaten, to have less often and in small amounts

[a] As pointed out by a reviewer, this explanation is slightly confusing as "mostly green" means more than one nutrient. Presumably the intention is to communicate that a green section indicates a low (and therefore healthy) level of that nutrient, and that if the label is mostly green, then the product is a healthy choice.

corresponding "low in …" labels or other indicators that a product might be a healthy option.

3.3. Non-directive: facts up front/reference intake/guideline daily amount

Non-directive systems include detailed information about the nutritional content of the product. However, no explicit value judgement is provided about whether the food is a healthy choice or not. As illustrated in Figure 2, the amount of each nutrient is given per portion (or per 100 g) and the label also shows the percentage that this represents of an adult's guideline daily amount. For this reason, these systems are sometimes referred to as GDA labeling or RI (reference intake).

In the United States of America, this system is referred to as "Facts Up Front" (Consumer Brands Association FMI, 2022). It displays the nutrient amount per serving both in grams/milligrams and as a percentage of a daily value (DV). These are categorized as non-directive, as they provide no indication of whether the product is a healthy choice or not.

3.4. Semi-directive: traffic light systems

Finally, semi-directive systems "contain information on nutrient content but also communicate decisions on healthfulness" (Hodgkins et al., 2012; p. 814). This is often achieved by Facts Up Front style labels with added color-coding, as seen in Figure 3. The most common systems use a traffic light red-green-amber distinction. As each nutrient is coded separately, these labels are sometimes referred to as Multiple Traffic Lights or MTL. In some semi-directive schemes, each nutrient is labeled as "high," "medium," or "low"" as well as, or instead of, the color-coding.

The traffic light labeling scheme is the government recommended format in the UK, and Table 1 shows the British Nutrition Foundation (2022) explanation of the coding.

As Hodgkins et al. (2012) discuss, for most food products, there will be a mixture of red, green and/or amber across the different nutrient categories. It is unusual for a product to be all red or all green. Therefore, the direction given to consumers is not as binary and clear as with the directive systems. The consumers must make a decision based on a particular nutrient or on the overall traffic light profile. For this reason, Hodgins et al. suggest that traffic light systems be classed as semi-directive and that therefore a three-way categorization labeling system is necessary. Having outlined these three categories of labels, I move on, in the next section, to give an overview of research into the effectiveness of the different systems.

4. Effectiveness of the labeling systems: empirical evidence

Various studies and experiments have sought to identify the most efficient way to communicate nutritional information to consumers and to thereby alter behavior in favor of more healthful food and drink choices. The discussions here draw on three systematic reviews of work in this area (Hawley et al., 2013; Hersey et al., 2013; Temple, 2020), and from these some clear patterns emerge. I then discuss several individual studies to provide more detail on the methods used and to illustrate the findings that underpin the patterns and conclusions.

The first key finding to note is that semi-directive systems appear to be more effective than the non-directive messaging. A systematic review by Hawley et al. (2013) of research into the effectiveness of food labeling found that "the MTL [multiple traffic light] label has the most consistent support" (p. 437) in terms of being beneficial to consumers. Hersey et al. (2013) similarly found that "consumers can more easily interpret nutrition information using FOP schemes that incorporate text and color to indicate "high," "medium," or "low" levels of nutrients compared with FOP labels that only display numeric information including %GDA and/or grams" (p. 12). Both reviews conclude therefore, that the semi-directive traffic light style systems are more effective than the non-directive Facts Up Front style systems. However, these reviews were carried out before the introduction of warning labels in countries such as Chile, and so they do not include directive systems in their comparisons. Temple (2020) conducted a literature search on studies published after 2011 to fill that gap and his review covers only studies that were not included in the two previous reviews (Hawley et al., 2013; Hersey et al., 2013). Although Temple notes a high level of inconsistency across the studies in his review, he concludes that the "designs for FOP labels that appear to be most successful are MTL, warning labels and Nutri-Score." Meanwhile, labels "based on GDA … were much less successful" (Temple, 2020, 5). Given these general patterns, we can look more closely at the findings of individual studies to explore the effectiveness of the labeling in more detail.

Arrúa et al. (2017) compared three labeling schemes, one from each of Hodgkins et al. categories: the GDA system (non-directive), the traffic light system (semi-directive) and the Chilean warning system (directive). Participants were asked to identify if the food products displayed on a computer screen were high in sodium. That is, they were asked to identify unhealthy products based on salt content. The participants gave correct answers in an average of 95 per cent of cases with no significant difference found between the labeling systems. There was, however, a significant difference between response times across the different labeling

systems. Response times for GDA labels were significantly longer than for the traffic light system and warning labels. Warning label response times were the fastest of all.

While warning labels appear to have the most impact when it comes to identifying unhealthy options, Adasme-Berríos et al. (2022) found that their impact was limited in other ways. Their study showed "no evidence for effects on nutritional knowledge" (p. 1547) when warning labels were used. So, while they may be the most effective in terms of individual decisions, warning labels did little to educate consumers about nutrition and health more generally.

In a follow up study, Arrúa et al. (2017) asked participants to rate the perceived healthfulness of products and the frequency with which they should consume them. The stimuli were all products that were typically consumed in the region (Uruguay), but the brands used were not commercially available there. The labels were modified so that one in each set was more healthful than the others based on one key nutrient. The task was therefore to identify the healthiest option. They found that warnings and traffic light labels performed equally well when participants were asked to identify the most healthful product.

Directive and semi-directive labels were also found to be effective by van Herpen and Trijp (2011). They compared a health tick logo directive label with both traffic lights and a Facts Up Front nutrition table, and this led them to the conclusion that "the logo seems to have an advantage, both in terms of the likelihood of attending to the label and the effect on choice. The MTL label also performs well, but the nutrition table does not enhance healthy choices beyond the level when no labels are present" (p. 158). A similar result was reported by Roberto et al. (2012) who compared consumer understanding of the non-directive Facts Up Front system with the semi-directive multiple traffic light scheme. They found that when it came to judging the levels of nutrients in a product, traffic lights were "substantially more helpful" (p. 140) than Facts Up Front.

As part of their study, Machín et al. (2017) compared GDA labels with two versions of the semi-directive traffic light system. One version used the typical red-amber-green multicolored coding while the other was monochromatic. The multicolored version used red for high levels of a nutrient and green for low. The monochromatic version used black for high and white for low. The study examined participants' perceptions of healthfulness for ultra-processed products, and it compared low-, middle- and high-income participants. The results paralleled the other studies in that the semi-directive systems outperformed the non-directive system. Both the traffic light systems led the participants to rate the ultra-processed products as lower in healthfulness than the GDA system for low-income participants (p. 336). However, Machín et al. found a difference between the two traffic light systems for some products. In certain instances, where the product contained some nutrients with low levels alongside others with high levels, the monochrome labels resulted in a lower perception of healthfulness. That is, the same products were perceived to be less healthy when the nutritional information was presented in black and white than when it was displayed in color. Machín et al. suggest that this might be because the green used in the colored system for low nutrient content carries with it associations of healthfulness, whereas in the monochrome system these nutrients were presented in a more neutral white.

A study carried out by Araya et al. (2019) looked at the effects of warning labels on different categories of food. They studied purchasing behavior in Chilean supermarkets over the year-long period in which the warning label scheme was introduced. They found that the warning labels led to "a substantial reduction in purchase probabilities of labeled breakfast cereals" (p. 16). However, they found that the labels had no effect on purchasing habits related to products in the cookies and chocolate ranges.

Overall, warning labels appear to be the most effective system, particularly when it comes to identifying products that should be avoided or limited. Semi-directive systems such as the multiple traffic lights appear to be more effective than the non-directive Facts Up Front systems, and equally as effective as warnings when it comes to identifying healthy options. Finally, in terms of consumer behavior and purchasing habits, the product type also makes a difference to whether the labeling is effective or not. To understand these patterns, I next compare the interpretive processes that consumers go through when they encounter each type and category of label. Implications from this relevance-theoretic analysis then follow in Section 6.

5. Relevance-theoretic analysis

In this section, I use relevance-theoretic assumptions about the processing of communicative inputs to explain the patterns of relative effectiveness of food nutritional labeling systems. As discussed in Section 4, in terms of encouraging consumers to avoid unhealthy products, directive warning labels appear to be the most effective system, followed by semi-directive traffic light systems. Non-directive Facts Up Front style labeling is the least effective system in terms of communicating information about healthfulness and influencing consumer behavior.

To understand how the different label formats might be interpreted by an individual consumer, imagine Rita as a typical health-conscious shopper. Rita is likely to hold a range of assumptions about food, nutrition, health, and food choices. These might include the assumptions in (3) to (7).

(3) If a product is healthy, I want to buy it
(4) If a product is unhealthy, I do not want to buy it
(5) If a product is high in fat, it is unhealthy
(6) If a product is high in sugar, it is unhealthy
(7) If a product is low in salt, it is healthy

How does the information in the various labels interact with these assumptions to yield cognitive effects? First consider warning labels and imagine that the product is high in fat. The warning label will follow a standard format such as the one shown in Figure 1 and with text that says, "High in fat." This input can immediately interact with Rita's assumption in (5), leading her to derive the conclusion in (8).

(8) This product is unhealthy

This conclusion is a new assumption that Rita now holds, and it can combine with the assumption in (4) to lead her to the conclusion that she does not want to buy the product. The inferential path from the input on the label to Rita's conclusion is relatively direct, and the input information combines with accessible assumptions that Rita already holds. Indeed, once health-conscious customers recognize the black octagonal symbols (Figure 1) as warnings, they will hold the assumption in (9), and they need not even read the text to reach a "don't buy" conclusion.

(9) If a product has a warning label on it, it is unhealthy

Next consider the inferential processes involved in the interpretation of the traffic light system label, as illustrated in Figure 3. Rita will see the color-coded sections with the accompanying nutritional information. Imagine that the label indicating fat content is colored red and contains the text in (10).

(10) One serving contains: Fat 6.9 g. 10% of the reference intake of an average adult

Decoding the text will provide Rita with information about the nutritional content of the product. However, the color-coding also makes assumptions accessible that then combine with Rita's existing assumptions to yield cognitive effects. Assuming that Rita is following the relevance-theoretic comprehension procedure and therefore taking the path of least effort, she will test out the most accessible interpretations first, and will stop when she has an optimally relevant interpretation. The red coloring of the label is likely to make certain assumptions accessible to Rita. Red is associated with danger or hazards (Chapanis, 1994; Braun and Silver, 1995; Pravossoudovitch et al., 2014) and has been demonstrated to induce an avoidance motivation (Mehta and Zhu, 2009). Furthermore, in the context of this labeling system, red is used as part of a traffic light system, and it is set in contrast to green and amber, making associations with "stop" highly accessible in the cultural contexts in which these labels are used. When used in the context of nutritional information, these associations with danger, avoidance, and stopping are most likely to be interpreted as communicating the assumption in (11), leading Rita to draw the conclusion in (12).

(11) If the nutritional label is red, the product is unhealthy
(12) This product is unhealthy

As with the warning label, Rita can then combine this new assumption with her existing assumption in (4) to reach the conclusion that she does not want to purchase the product. Although there is further and more detailed information available *via* the text on the traffic light label, Rita does not need to read or process this. The color alone has led her to a conclusion about the food, and there is no need for her to go to the extra effort of decoding and interpreting the nutritional information.

Finally, consider the processes that Rita goes through to interpret the non-directive Facts Up Front style version of the label. The information on these labels is presented against a single color background. In the US version, this is blue across the different nutrient categories and is the same across all labels. The textual information provided is given in (13).

(13) Per serving 6.9 g Sat Fat. 10% of DV

Notice that there are no easily accessible assumptions with which the input from this label can combine. None of the assumptions that Rita holds in (3) to (7) connect with this information, and there are no easily inferable assumptions that can bridge the gap either. The color of the label provides no useful input in this case. To derive cognitive effects from the Facts Up Front labeling, Rita would need to think about what she has already eaten and what else she plans to eat that day (or the day on which she thinks she will consume the product). Even if she has access to this information, it will be much less accessible than the more general assumptions in (3) to (7). Assuming that she persists with her interpretation of the label and works out how much else she will consume (rather than abandoning her search for relevance), she would need to access assumptions along the lines of (14) and (15).

(14) If I have already eaten or plan to eat over 90 per cent of my daily recommended allowance of fat today, it would not be healthy for me to eat a whole portion of this product.
(15) If I have not already eaten or plan to eat over 90 per cent of my daily recommended allowance of fat today, it would be healthy for me to eat a whole portion of this product.

It is only at this point that Rita can assess whether the product is a healthy choice for her and therefore whether she will purchase it or not. There are more inferential steps involved in reaching this point *via* the Facts Up Front labeling, and the steps are more complicated and vulnerable to error. Even health-conscious Rita will be unable to derive cognitive effects from these labels unless she knows and recalls the nutritional value of what else she has eaten that day.

This comparison of the interpretative processes that Rita follows in each case sheds light on the differences in effectiveness and ease of interpretation of the three systems. Warnings and traffic lights require less processing effort than the Facts Up Front system to guide Rita to an assessment of healthfulness and therefore a purchase decision. They involve fewer inferential steps and more accessible / less complicated assumptions.

We can also apply relevance-based interpretative processes to explain the differences identified by Araya et al. (2019). Warning labels reduced the probability that a customer would buy a labeled breakfast cereal but had no effect on cookies and chocolate. To understand why the effect on these products might be different, it is useful to think about the assumptions that consumers are likely to hold about them. It is likely that most consumers will be aware that cookies and chocolate products are high in sugar, fat, and calories. That is, before they see the packaging, the customers are likely to hold the assumptions in (16) to (21).

(16) Cookies are high in fat
(17) Cookies are high in sugar
(18) Cookies are high in calories

(19) Chocolate is high in fat
(20) Chocolate is high in sugar
(21) Chocolate is high in calories

Adding warning labels to these products will, therefore, have little effect. New information is relevant only if it interacts with our assumptions to lead to a cognitive effect. In this case, however, the consumer already holds assumptions about the food products with a high degree of certainty. Therefore, the information on the label is unlikely to strengthen the assumption further. If you are already 100 per cent sure that chocolate is high in sugar, a high in sugar warning label on a chocolate bar has no relevance for you. Breakfast cereals, on the other hand, are not so widely associated with high levels of fat, sugar, and calories as confectionary is. Indeed, it is likely that many consumers consider breakfast cereals to be a healthy (or at least not an unhealthy) option. The packaging designs for cereals are often used to promote properties that are associated with health. They might, for example, state on the package that the product is a source of vitamins, fiber, or iron. This may well mean that the typical consumer holds the assumption in (22).

(22) Breakfast cereals are healthy

A health-conscious consumer who also holds the assumption in (3) ("If a product is healthy, I want to buy it") may decide to purchase cereals on this basis. The information contained in warning labels, and indeed the very presence of the warning labels themselves, will, however, contradict the assumption in (22). If the customer accepts the warning labels as a reliable source of information, she will eliminate her assumption in (22), and this in turn will lead her away from a decision to buy. It is precisely because customers either hold no assumptions about the healthfulness of cereals or may hold incorrect assumptions about this, that the warning labels can change behaviors. Warning labels are relevant in such contexts. However, when the consumer already knows the product is unhealthy, the label will lead to no cognitive effects and will therefore not be relevant.

6. Discussion and implications for communication design

In Section 5, I demonstrated that the relevance-theoretic pragmatic framework can be used to understand the interpretive processes consumers go through when they encounter front of pack nutritional labeling. We can understand the difference in effectiveness of the labeling schemes as related to their relevance in terms of cognitive effects and processing effort. This has implications for both labeling policy and design, and it can inform the practice of communication design more broadly.

As we saw in Section 4, warnings were more effective than the other systems when it comes to identifying unhealthy options. To be effective from a health policy perspective, nutritional labeling needs to guide a consumer to a "buy" or "don't buy" conclusion in as few inferential steps as possible. It should also rely on as few contextual assumptions as possible, and those assumptions should be highly accessible or easily inferable. The information on a label will only be relevant if it can combine with contextual assumptions to yield cognitive effects. While the directive warning labels contain less information than the traffic light or Facts Up Front systems, the information that they do contain easily combines with highly accessible assumptions. Warning labels require the lowest level of background information on health and nutrition to process, and even a consumer with little or no nutritional knowledge and with no interest in healthy eating will recognize a warning sign as marking something to be avoided or treated with caution. Similarly, the avoidance and danger associations of the red color-coding (and likewise, the healthy "go" associations of the color green) do not require an interest in or knowledge of healthy lifestyle choices to interpret. Indeed, in the case of the warning labels, it is not even necessary to read the warning text. As Arrúa et al. (2017; p. 2315) point out, "warnings appeared on the labels only when the content of the target nutrient was high." The very presence of a warning-style label is enough of an input to lead the consumer to the conclusion that the product is unhealthy.

We also saw the impact of the color-coding in the findings from Machín et al. (2017) discussed in Section 4. The use of green rather than white to indicate that a nutrient's levels are low led to a product being perceived as more healthful, despite all other information on the label being the same as the white label. Accessible assumptions about green meaning "go" or being associated with health are enough to produce a different interpretation of the product's nutritional value, and consumers will access and draw conclusions from the most accessible assumptions and associations first.

The review by Hersey et al. (2013) suggests that systems which indicate "high," "medium," or "low" for each nutrient are the easiest to interpret, whether they rely on color, text, or both to communicate this information. A study by Malam et al. (2009) also found that the labels with the highest levels of comprehension overall were those "combining text (the words high, medium, low), traffic light colors and % Guideline Daily Amount (GDA)" and those "combining text and traffic light colors." Again, we can understand this in terms of the assumptions that the consumers hold. Far more consumers will hold a general assumption such as (23) than a specific assumption such as (24).

(23) High fat foods are unhealthy
(24) Men should not consume more than 30g of fat per day and women should not consume more than 20g of fat per day (National Health Service, 2020).

This means that more people will be able to conclude whether a product is healthy or not based on the "high," "medium," and "low" labels. Anyone who does not already hold an assumption such as (24) could, presumably, stop and look up health recommendations and thereby access this information. However, the more effort that is involved, the more likely it is that the customer will abandon the search for relevance and make the purchase decision based on other criteria. While the GDA labels contain the same, and indeed more, information than the "high," "medium," or "low" labels, the information requires more processing effort (for most people) and is therefore less relevant. More information does not necessarily mean better when it comes to communicating health (or other)

information. What is key is the ease of processing for as many consumers as possible. New information is easier to process if it combines with highly accessible assumptions and the more people who hold those assumptions, the wider the reach of the message will be.

It is not, however, simply a matter of the assumptions that a consumer may or may not hold. Designers of communications need to also consider the strength with which a consumer holds an assumption and the sort of information that would convince them to strengthen or eliminate that assumption, thereby generating a cognitive effect. In a report for the Foods Standards Agency, Malam et al. (2009) found that some users who are confident in their knowledge of what is and what is not healthy may not use labels at all. While they may be health conscious, if they are already highly confident in the assumptions they hold, the information on the label will be less likely to be relevant to them. When we are 100 per cent confident about something, it is not possible to strengthen that assumption, and it is much less likely that new information will contradict and eliminate it. At the other end of the customer spectrum, those who are not interested in healthy eating tend to avoid FOP labeling, according to Malam et al., because they consider it to be 'an unwelcome attempt to control their behaviour' (4). Thus, designers of health communication policies must consider not only what information to communicate and how to communicate it, but also how to encourage consumers to trust the source of the information. We will not update our assumptions if we do not trust the source of the information or if we do not consider the source to be credible (Sperber et al., 2010).

The analysis of the nutritional labeling systems also reveals that, when creating health messaging, designers should focus on the conclusion to which they wish to guide the consumers. Effective messaging is not just about the dissemination of information, but rather about producing stimuli which will lead to the intended cognitive effects. For example, encouraging people to eat healthy foods is different to encouraging people not to eat unhealthy foods. The designers must understand what assumptions the consumers already hold and think about how their messaging will interact with those. For example, the information in warning systems can only lead a customer to a "don't buy" conclusion, as it can only combine with assumptions about what not to eat. This aligns with the overall aim of reducing consumption of ultra-processed foods identified by the Pan American Health Organization and so will be an effective strategy to achieve this outcome. However, warnings are less likely to improve consumer's nutritional understanding or guide them to alternatives which are positively healthy as they contain no information which can combine with assumptions about healthful food or nutrition. The reverse is true of health endorsement directive labeling such as health tick logos (van Herpen and Trijp, 2011). These can only combine with existing assumptions about what is a healthy choice, and so while they are effective if the aim is to increase the consumption of healthy products, they have less direct impact if the aim is to decrease the purchase of unhealthy products.

In the discussions here, I have assumed that those designing the labeling want to encourage the consumption of healthy food and discourage the consumption of unhealthy foods. However, food producers may, of course, have other motivations. By understanding the interpretive stages involved in processing nutritional messaging we can also understand how it might be circumvented. For example, one way for producers of less healthy products to maintain the appearance of caring about their customers while avoiding a loss in revenue is to comply with good practice guidelines, but to present information in the least accessible, least relevant way. Therefore, the implications and lessons outlined here are intended for regulatory bodies and policy makers just as much as they are for the food producers and packaging designers.

7. Concluding remarks

Relevance theory as a pragmatic framework for understanding how we interpret utterances and other ostensive acts of communication provides us with a model to analyze the consumer's journey as they process a piece of messaging. We can compare different versions of the same message and link their effectiveness to the ease of interpretation for the intended audience. Communication is a cognitive process in which new information interacts with assumptions to yield effects. To communicate effectively we must consider the assumptions that the intended audience already hold, and we must be clear about the assumptions that we want them to hold. Designing effective messaging is a matter of getting the audience from one set of assumptions to the other in as few interpretative steps as possible. While I have focused on nutritional food labeling in these discussions, the approach and analyses exemplified here can be applied to other communicative contexts and has wide-reaching implications for communication design and policy more generally.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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