Graphic alternatives to numerical representation of nutrition facts on food labels

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Abstract

The purpose of this dissertation is to discuss nutrition labelling formats on food labels, and to find out whether an alternative graphic format improves comprehension and effectiveness of the standard tabular form of presenting nutrition information on the European Union markets.

The majority of shoppers in the EU do not use nutrition labels when purchasing groceries to make informed choices regarding available healthier products. There are many reasons for this, starting with shoppers' *internal* characteristics such as literacy and health knowledge, *external* characteristics such as advertisements and other influences from the food industry. The *design* of the label is a third variable that affects the use of nutrition information.

The legislative regulated numerical display is commonly represented in a tabular form and is not mandatory, but can be presented in other graphic formats as well. Many options have been in use and they have been reviewed in numerous studies, whose results vary considerably. Nevertheless, some formats can be highlighted. Overall, best performing graphic displays are *hybrids* between two main alternative labelling schemes in use today, *Traffic Lights* and GDA. Shoppers demand a unified system that could transcend food industry's interests and offer more informed buying choices.

For the nutrition label format to be effective all indirect influences on nutrition label comprehension need to be first taken into account through a dialog between all interested parties, shoppers, educators and manufacturers as well as designers.

Contents

Introduction

Only a quarter of British customers look for information about nutrients in the buying process. In some European countries, for instance France, this share is as low as 9 percent (EUFIC, 2009a). Furthermore, two thirds of shoppers expect this information on the front of the food package. All legislative regulated schemes currently in use present nutrition information in numerical form on the back of the pack. Although nutrition knowledge in the European Union is relatively high (EUFIC, 2009a) the standard tabular format of nutrition label has been proven confusing and not understandable (Cowburn and Stockley, 2005). A logical task is to find reasons as well as solutions to this problem.

A quarter of British adults are obese and projections show this number could increase to 40 percent in the next twenty years (Cabinet Office, 2008). Nutrition labelling serves as a tool for prevention of health-related issues, therefore it needs to be as effective as possible in order for the obesity rates to decline.

Nutrition information in the European Union is not mandatory and only prescribes the content which should be presented in numerical form. This dissertation will try to answer whether this numerical form, commonly presented in nutrition table on the back of the food package can be improved with an alternative graphic format(s).

This dissertation covers:

- the introduction to nutrition labelling and legislative background for examples currently in use (CHAPTER 1)
- analysis of graphic displays currently in use (CHAPTER 2)
- evaluation of studies concerning nutrition label design (CHAPTER 3)
- proposals for future development of nutrition labelling (CONCLUSION)

This dissertation does not deal with graphic symbols and other elements of food packaging that do not present the composition of food, such as organic and fairtrade logos, presentation of ingredients and vitamin content.

Focus is on the European Union, although literature from other markets was discussed as well if it had been applicable to the European market. Only a few studies have been done in the South and Eastern European countries. Most of discussed research was done in the UK and USA (see Cowburn and Stockley, 2003). After a brief evaluation it could be seen that studies had often contradicted each other and that no single format of presenting information could be pointed out fo being the best. A reason for this should be discovered.

A typical reader that is interested in this subject comes from higher social class and is well educated. Most of the research was devoted to finding solutions that would attract less interested and lower-educated public.

1 Background

This chapter introduces some key aspects that affect the effectiveness of nutritional labelling. Designing a more effective label is not an easy task for a designer. The effect of even the best nutrition labelling display can be jeopardised by issues a designer cannot solve by himself. However, knowing these problems is a key step towards the process of finding the proper content and form of the effective nutrition label.

The chapter opens with the introduction of the field of nutrition and food labelling, it continues with the history of nutrition labelling and issues concerning its universal acceptability, use and comprehension.

Legislative context

Packaging and labelling food

Policies regarding labelling food are aimed at informing the consumer about the content, standards and methods used in preparation of the product. Regulations can be "institutional, statutory or embodied in a voluntary code accepted by particular industry"[1]. Information on the food package includes specification of ingredients and their origin, weight, recommended date of use and nutrition information (Food Standards Agency, 2009b).

Nutrition

"Process by which substances in food are transformed into body tissues and provide energy for the full range of physical and mental activities that make up human life."[2]. Seven main classes of nutrients are *carbohydrates* (including sugars), *fats* (including saturated fats), *fibre*, *minerals* (including *sodium*, more often referred to as salt[3]), *vitamins* and *water*. They provide energy and other resources for the human body to function properly. Most foods contain a mix of some or all classes of nutrients. Improper diet may lead to health related problems, some of them being malnutrition, obesity, cardiovascular diseases and diabetes.

Nutrition label or Nutrition information panel

Nutrition label or nutrition information panel is a quantitative representation of nutrient content, required for labelling pre-packed foods. Its goal is to help consumers find healthier choices of foods, consequently leading to an overall healthier diet as well as, according to Baltas (1999), to raise demand for healthier products. "[Nutrition] label is an inherently complex piece of information that assumes that all users are literate, familiar with the metric system of measure, understand nutrients and their relative value" (Greenfield Belser, 2009). Nutrition label is mandatory in only a few countries. In the European Union it is regulated by the EU Council Directive

1 Consumer Advocacy (2009). In Encyclopædia Britannica Online. URL: http://www.britannica.com/EBchecked/topic/134566/consumer-advocacy [7 September, 2009].

2 Human Nutrition (2009). In Encyclopædia Britannica Online. URL: http://www.britannica.com/EBchecked/topic/422896/human-nutrition [7 September, 2009].

3 Amount of salt in the food can be calculated based on sodium content, multiplied by approximately 2.5 (Euro Coop, 2003)

4 This European Council Directive was developed in cooperation with all interested parties, including food industry.

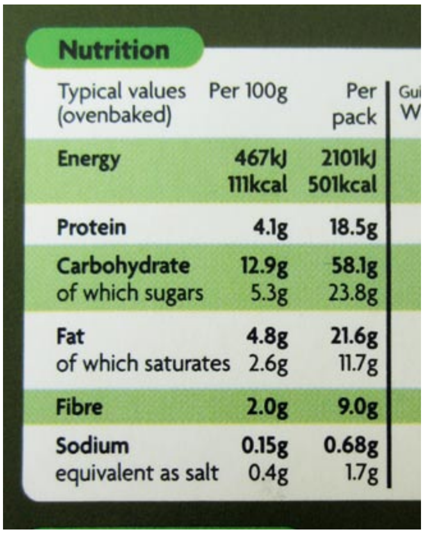
90/496/EEC[4], by which a nutrition label becomes compulsory when a specific health-related claim is made in the presentation or in advertising of this food.

[**1**] ***Example of the Big 4* nutrition label.**
Mars, Maltesers.

Nutrition labelling in the European Union

Origins of nutrition labelling date back to the 1970s, although the first serious debate in the UK started in 1983, when first research papers introduced the idea of labelling foods that have higher impact on cardiovascular diseases, therefore they were focusing on fat, saturated fat and protein content as well as energy value (Freckleton, 1985). This type of labelling is now commonly referred to as *Big 4* [**1**]. A detailed labelling, *Full 8* [**2**], would additionally provide amounts for carbohydrates, sugar, dietary fibre and sodium. Both options should always present nutrients in *grams per 100 g* of the product, unless a single pack is less than 100 g. In this case *per-pack* amounts should be displayed.

Both systems were voluntary, thus their applications started predominantly with products considered healthy. Calls were made to focus on less healthy products as well, but were fiercely opposed by the food industry (Freckleton, 1985). First consistent labelling schemes in the UK were introduced by supermarket chains on specific ranges of their products. Initial studies were conducted to test consumer's understanding of nutrition labelling. Freckleton (1986) claims that one of the first reports by the Ministry of Agriculture, Fisheries and Food[5] proved that the users wished to see more information, and that it should have been presented in plain English, which in some cases still has not been resolved today.



[**2**] **Full 8 nutrition label with per 100 g and per-pack values.**
Asda, Vegetable lasagna.

Form of the nutrition label

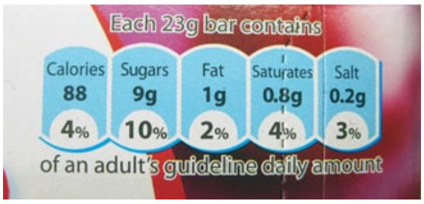
Legislative prescribed nutrition labels always employ tabular format of presenting data in numerical form. Unlike the USA, Canada, Australia and New Zealand, where the form is standardised, the European Council directions only prescribe the content of the label which should be in numerical form, with information presented for 100 g or 100 ml of the product. Nutrition information "may also be given in graphical form according to formats to be determined" (EU Council Directive 90/496/EEC). Such numerous alternative formats have been established on voluntary basis.

[**3**] **Vertical format of the nutrition label.**
Marks & Spencer, orange juice.

Nutrition labels, commonly used in the European Union (EU) today are (EUFIC, 2009b):

- Numerical format
  - Vertical format (Nutrition table) [**1, 2**]
  - Horizontal format (nutrient values separated by commas instead of tabular form) [**3**]
  - Guideline Daily Amounts (GDA) [**4**]
- Verbal banding format
- Diagrammatic formats
  - Colour-coded banding systems (Traffic Lights) [**5**]
  - Colour-coded GDA (Nutri-pass) and other hybrids [**6**]
  - Integrated labelling (health logos) [**7**]

5 Replaced in 2000 by Food Standard Agency (FSA) as the main body responsible for protecting public health in the UK. This particular report is discussed in Freckleton (1986).



[4] **Nutrition label showing percentages of guideline daily amounts (GDA).** Kellogs.

[5] **Traffic lights label.** The Co-operative.

[6] **Colour-coded GDA: a hybrid between GDA and Traffic ligths.** Asda.

[7] **Keyhole logo, an example of integrated nutrition labelling.** SOURCE: Lobstein (2007), p. 3

[8] **The *Wheel of Health* label.** Sainsbury's.

Only *Nutrition table* and *Horizontal format* are regulated by the EU directive. Some schemes are endorsed by non-governmental bodies in specific countries, such as Food Standard Agency's *Traffic lights* scheme and *Verbal banding* format in the UK and integrated label *Keyhole* in Sweden.

Verbal banding formats use verbal descriptions to define nutrient values as high, medium and low. They are used as additions to the numerical values in *Nutrition table*. Traffic Lights share the same cut-off points, but presenting values using colour (red for high, amber for medium, green for low).

Monochrome and *Colour-coded Guideline Daily Amounts (GDA)* are numerical systems that present nutrient amounts in relation to recommended daily values for average woman. Hybrids between *Traffic Lights* and *Colour-coded* GDA use colour or verbal banding to qualitatively evaluate the nutrient.

Health logos are used to point out healthier products in specific food category only (such as yoghurt with lower amount of fat).

Position of the label

Nutrition label's position is not prescribed by the legislation. Vertical and horizontal formats are usually positioned on the back side of the packaging (back-of-pack or BOP). All other formats were introduced as front-of-pack (FOP) labelling schemes in order to aid better consumer awareness and facilitate better use of nutrition labelling (Feunekes, 2006).

What affects the use of nutrition labelling

Nutrition labelling is not the only source of information regarding nutrient content of the product and it cannot work in isolation. Nutrition education in schools as well as doctor's medical advice are two examples that can have positive effects on reading the nutrition information, while advertisement claims and other tools in order to deceive the customer have a strong effect as well (Nestle, 2007). Food politics is a serious issue and the question whether a better graphic format improves health cannot be discussed without looking more at this problem.

Food industry's influence

Primary concern of food lobbies is increasing their profits (Nestle, 2007), and interest in clear and understandable food labelling is of secondary importance unless it can generate higher earnings (Drichoutis, 2006). Nutrition labelling is revealing, therefore a clear portrayal of food's credentials would mean decline in sales of low quality products.

Which? (2009) report argues that mandatory nutrition labelling would force manufacturers to make products of higher quality. An example of this is British supermarket chain Sainsbury's whose goal has been enhancing products to appear healthier using their new graphic system, *Wheel of Health* [8]. Tesco on the other hand, has endorsed a less revealing scheme after conducting a user research among its customers (BBC News, 2005).

Lack of support for better nutrition labelling by Food companies shows in numerous badly conducted research, as Rayner (1995) admits, which has been of key importance for finding the most effective nutrition labelling format. Only a few manufacturers have been supporters of better understandable labels, funding some studies that were testing the effectiveness of alternative nutrition labelling formats, one of them is the Co-operative group which was the first manufacturer to introduce verbal banding format on all products as well as one of the first to use graphic nutrition labelling (*Traffic lights*) with a goal to improve consumers' understanding of their labels (Euro Coop, 2003).

People strongly approve the labelling scheme that is endorsed by "independent trusted organisation", according to Synovate (2005a) study. Feunekes (2006) agrees, stating that endorsing the nutritional labelling schemes by national health organisations would improve *trust* in nutrition labelling.

Label-specific influences

Design of the label is an important part of the process of reading the nutrition label, however by far not the only one (Malam et al., 2003). Two other issues need attention first, shopper's *internal* characteristics and *external* stimulants from the environment.

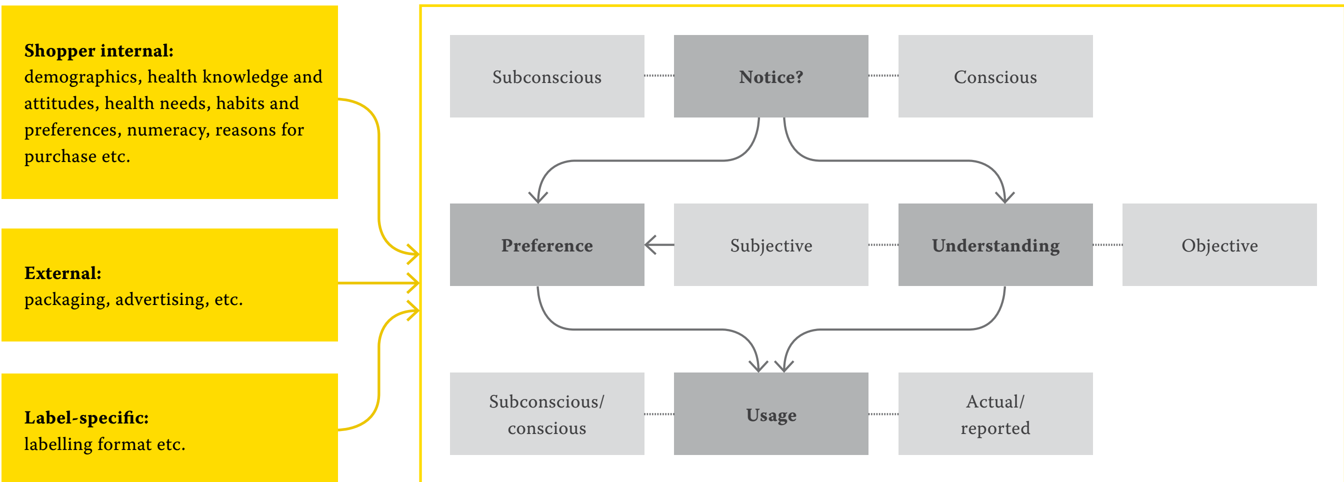
Shopper's characteristics

Malam et al. (2003, p. 19) presents a conceptual model for defining issues that affect people's use of nutrition labels [**9**]. Demographics, health knowledge, shopping patterns and preferences as well as numeracy are shoppers' *internal* characteristics. These attributes can be influenced by *external* issues.

Advertising claims, brands, price and design of the packaging

These influences can be defined as *external*, according to Malam et al. A nutritional label has to compete with overall appearance of the packaging, such as brand image, colour, attractive imagery, health claims (such as low-fat) and advertisements, and these all affect the overall

[**9**] **A conceptual model of influences on the use of nutrition labels.**
SOURCE: Malam et al. (2009), p. 19



[**10**] **The eatwell plate.** SOURCE: FSA (2009a).

impression of food quality. Human mind tends to "judge a book by its cover" (Kosslyn, 1994) and thus the first appearance may affect the overall impression. Ippolito and Mathios (1990) have shown that advertisements have a strong influence on consumers' perceived healthiness of the product and consecutively the purchasing behaviour. For example, Borgmeier (2009) discovered that perceived healthiness of dark chocolate was much higher than the nutrition label would suggest[6].

Appropriate balance of nutrients is not in human nature, making people more prone to manipulative impulses from the environment (Nestle, 2007). Less healthy but more desirable meals can win over healthier alternatives.

Information is more likely to be attended and processed when it is easily legible (Macdonald-Ross 1977b), as well as personally relevant (Mazis and Staelin, 1982). If we compare the nutrition label with advertisement claims, we can see that the former is more passive communication device, waiting for it to be read. If other claims concerning a specific product speak 'louder', then the nutrition label fails to communicate. It therefore needs catch attention by being more engaging and attractive as well as useful and understandable.

Nutrition education

Nutrition education is essential for the users' understanding of food labels (Nagya 1997). Food industry often argues that no food is bad by itself, there are only bad diets (Nestle, 2007), hence the nutrition label cannot be more effective without improvement of nutrition education which is only beneficial when it reaches noteworthy audiences, leading to behavioural change (Engesveen and Shrimpton, 2007).

An example of graphic tools for teaching nutrition in schools is the *eatwell plate*[7] [**10**] whose focus is on presenting the right balance between food groups the individual should enjoy. However, presenting food groups instead of nutrients makes it substantially different from the nutrition label[8].

6 Borgmeier insists that this was because of an ongoing campaign that had been portraying chocolate as rich in flavonoids.

7 Graphic tools for learning about nutrition can have many forms, another common example is the Food Pyramid.

8 For instance, if a person is advised to eat more meat using the eatwell plate, he needs to translate this information to protein, found on the nutrition label. To understand these relationship nutrients and their sources, education is of the key importance.

Currently, relationships between salt and sodium, carbohydrate and sugar and also the quality of saturated fat are often not clearly understandable (Euro Coop, 2003).

Unlike Olson (1985) who thinks that communication is not enough for an individual to do something and that this has to be done by force, Frascara supports the teaching process, stating that "it is necessary to make every design as act of learning, not of preaching, and to see it as part of an ongoing process of communication and culture building." (Frascara, 2000). We are able to extend this thought onto nutrition labelling as well – a nutrition label can be a tool for learning and in combination with improved nutrition education "a productive way forward in nutrition labelling"[9] can be achieved.

"Perception is modified by knowledge" (Twyman, 1985)

How do people use nutrition label?

Readers do not engage in reading when they are not sure their attainments will be rewarded (Kosslyn, 1994). This has been proven by Russo et al.'s (1986) study that found the users would only use the nutrition label when product's benefits (such as being healthier) outweighed the effort and time needed to process the information.

Nutrition labelling appears too technical and too difficult to be understood (Black and Rayner, 1992) which might be one of the reasons for its failure to communicate to broader public. A simpler and engaging display of data needs to be found, but only after a detailed knowledge of what could the reader had answered from the data is acquired (Kosslyn, 1994).

A common thought found in most of the studies (such as Euro Coop, 2003) is that nutrition labelling cannot be an effective tool for informing consumers about healthier products. According to the Euro Coop, an improved legislation has to be established which would design the label with the user in mind, checking usefulness and efficiency of available implementations and find the appropriate form of the label that would facilitate better health choices.

To see whether a nutrition label is successful we must evaluate it on four levels (Baltas, 1999): *attention*, *acquisition*, *comprehension* and *effectiveness*.

How much information is enough?

When reading data, understanding means simplifying the information to deal with the specific problem. Number of elements taken in account is around three, maximum is seven (Bertin, 1983). Kosslyn (1994) claims that the reader needs the right amount of information to answer a specific question. If more information is presented, more time is needed and more errors are made, but when the information is not sufficient, a reader would have to keep searching and this again requires more effort. For example, *Full 8* table might present too much information when comparing values of two products (the user needs to search for specific values he is interested in), while the *Big 4* excludes some key information when the evaluation of single product is performed.

9 Higginson et al. (2002b)

Calls were made for simpler nutrition labelling (Feunekes, 2006), stating that substantial and detailed information is too much for a lay reader. A simple summary of product's nutrients on the front of the pack would reduce the cognitive load and time needed for accurate comparisons (Geiger, 1991). Such front-of-pack displays (*Traffic lights* for example) have always scored among the best in most of the comparative studies (Cowburn and Stockley, 2003), although often being criticised as being oversimplified for some (Bussel, 2005). A major criticism of this scheme has been that such simplification takes away too much information, making the user unable to make an informed decision. These issues are further discussed in chapter 3.

A question remains, for which task specific displays are suitable and when do they fail. We must first find who are the users and what do they expect from the nutrition label.

Who is the user?

A profile of a typical user can be described as *a woman in her 40s with higher income who has achieved a higher degree of education and who is interested in health-related issues*. In general, people with more interest in their diet are more likely to report the use of labels (Cowburn and Stockley, 2003) as well as people with more available time for grocery shopping. Elderly people use the nutrition labels in a much lower extent (Mueller, 1991). Living environment affects the acquisition as well, people from smaller households and households with small children are more common users. Nutrition labelling among adolescents has not been thoroughly researched to this date.

What do people expect from the label?

According to the Cowburn and Stockley (2003), the predominant task is spotting nutrients that people wish to avoid. These are energy and fat content, as well as sugar. Users wish to evaluate products and put them into the context of the overall diet. Most of the people at least look at the label but they use it in a much lower extent, especially on products they are not yet familiar with. These findings are consistent with Black and Rayner's (1992) study, which showed that users isolated nutrients when evaluating two products simultaneously, comparing only the nutrients they were interested in (usually energy and fat). If one of the compared products was high in sugar and salt, it would still be considered healthier if its values of fat and energy were lower, which is a wrong assumption.

Freckleton (1986) and Higginson et al. (2002b) discovered that people use the nutrition information mostly to compare profiles of two similar products from competing brands and less often for judging relative healthiness of one product which they find too hard. Reading exact values is less common for people with less interest in nutrition labelling.

As a contrast, Levy et al. (1996) offers a much different set of results. Users look at the nutrition information for "dietary planning, managing a medical or special diet, comparing brands and different product categories, evaluating healthfulness of a specific food, learning about nutrition characteristics of different food products and verifying advertising claims".

It seems obvious that these tasks cannot be expected from less interested readers and that this study had specific profile of more interested users[10].

Higginson et al. (2002b) also suggest that users do not properly process the nutrition information which is acquired very briefly on the point of purchase. Detailed use at home is less common. Front-of-pack labelling systems addresses this single issue, focusing on faster and effortless comparison of competing products, making buying decision quicker through better attention, acquisition and comprehension.

100 g or per-portion debate

Expressing nutrients per 100 g of the product, as prescribed by the EU Council directive, may not always be the best option. Studies comparing labels which had added per-portion values suggest that the latter information is more often looked at (Higginson et al., 2002b), nevertheless, there is no agreement regarding effective processing of both.

Unlike in the USA, portion sizes in the EU are not standardised. A major drawback of standard portion sizes is inability of comparing different product groups, such as a cereal portion (50 g) with a cereal bar (35 g).

This issue is especially important when introducing diagrammatic nutrition labelling. All currently available alternatives take portion size as a basis. However, a portion needs to be reasonable, otherwise this information is redundant. For example, a small portion of mayonnaise appears healthier, although the overall composition of this food may be considered harmful (Stop GDA, 2009).

Effect of the nutrition label on buying decision

Evidence available so far suggests that understanding the label has no influence on buying decision and consumption. Borgmeier (2009) compared some variations of food labelling and found out that even though one option was highlighted as being the best (*Traffic lights*), it was still unlikely that its understanding facilitated behavioural change, proving that only the properly presented nutrition label could not be a sufficient tool in fighting obesity and other dietary conditions, calling for finding solutions on broader level.

It is difficult to define how to motivate people to use nutrition information and also which types of aids can help with better understanding of the labels, suggesting immediate research in this field (Cowburn and Stockley, 2003).

Limitations of nutrition labelling

All nutrition labelling schemes fail to address one important issue – they are unable to distinguish between foods which are high in naturally occurring nutrients, such as pure orange juice, from beverages with added sugar[11] (Feunekes et al., 2008). This issue cannot be expressed using numerical information and calls for additional verbal explanation on the packaging. Nutrition claims and health logos partly address this issue (100% natural juice, no cholesterol).

10 See also discussion on p. 32

11 Orange soda, for example, is rich in added processed sugar and is discouraged by nutritionists (Stop GDA, 2009) although its nutrition information would read exactly the same.

As nutrition information is more often referred to in the retail environment than reading at home (Malam et al., 2009), time available for reading the label is substantially shorter. Average time spent looking at a single product is relatively short, 25 seconds in the UK and 47 seconds in Hungary. This fact also suggest that different levels of information can be processed in both environments.

Malam et al.'s study also suggests that coexistence of various formats in retail environment creates confusion between shoppers who demand a unified system.

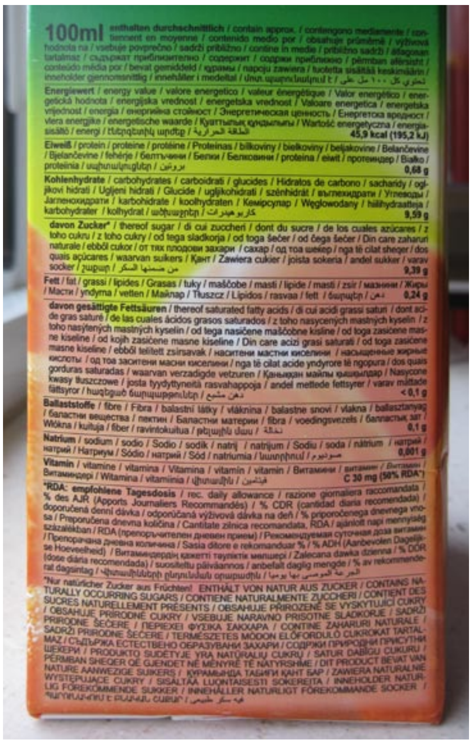
"The homogenisation of the world makes marketing more efficient" (Frascara, 2000)

Multilingual environments

A specific problem regarding food labelling can be seen in [**11**]. Manufacturers often use the same packaging for multiple markets around the EU in order to cut down costs. Consequentially, the food label has to present nutrition information in as much as 23 official languages of the EU. Food labels in multiple languages may be cheaper to reproduce but the abundance of unnecessary information for the consumer worsens speed and accuracy of reading, comprehension, and therefore effectiveness.

A partial solution is either the production of language-specific packaging or the use of additional labelling in one language, which both substantially raise the production costs, especially if the nutritional label uses colour[12].

Alternative solution is the application of graphic symbols for nutrients (see p. 28 [**25, 26**]), as used by fast food restaurants[13]. According to Euro Coop (2003), similar symbols were discussed in the UK and the USA[14], calling for user testing in this field. Symbols can be understood faster and can achieve better accuracy, however both "provider and receiver must share the same language" (Foster, 1990) and have the ability of "transcending language to people who have no knowledge of each other's language".



[**11**] **This tabular display presents nutrition information in 23 languages, demanding from the user to read through the whole table.** Rauch orange juice.

12 For example, to print *Traffic lights*.

13 See p. 28 for their evaluation.

14 See Food Navigator USA (2007)

2 Graphic displays of information

Macdonald-Ross (1977a) argues that for a graphic format to work it needs to be attractive and motivating. The nutrition table is often considered to appear technical (Black and Rayner, 1992) and to attain a broader public, another format should be developed. This chapter starts with a brief introduction to graphic formats and discusses current alternatives to tabular format of presenting nutrition information with a goal of gaining more attention as well as achieving better effectiveness.

Introduction

Numerical values of nutrition information as defined by the EU Council Directive[15] are usually presented in *tabular format* (see p. 22 [**12**]). This transcription into a graphic system needs to be done in order for the numerical values to be read easily[16]. Comprehending *graphics* differs from reading *numbers* and *abstract imagery*. Elements of graphics need to be known beforehand to know their meaning.

Perceptual structure of graphics and mathematics (numbers) differs: graphics can facilitate immediate responses in comparison with numbers, when the mind needs many instants of perception in order to compare values. Abstract cognition is needed less when using diagrammatic displays (Macdonald-Ross, 1977a).

Content (information to present) and form (properties of graphic system) need to be independent (Bertin, 1981). *Content*, in case of nutrition labelling, is numerical representation of nutrients' amounts, while *form* is the graphical format in which these values are presented (tabular, diagrammatic). Variables for representing content work on three levels, *quantitative* (presenting countable numbers), *ordered* (concepts that allow ranking in agreed order, such as high-medium-low) and *qualitative* level (evaluating by similarity or difference).

Nutrition information in tabular format work only on *quantitative* level. User needs to interpret and evaluate on *ordered* ('does this food have more fat than sugar?') or *qualitative* level ('does this product fit within my diet; should I eat a food with this much salt?'). If displayed nutrients were arranged by size, they would be ordered. Ehrenberg (1975) supports this operation, arguing that ordered arrangement facilitates easier reading of the table. For 'graphics to reveal the data' (Tufte, 1983), quantitative information has to be presented in a way that the reader is able to *qualitatively* evaluate it to make informed choices. Tufte continues that "a numerical result cannot be interpreted in isolation".

According to Ehrenberg (1975), the user must be able to compare

15 EU Council Directive 90/496/EEC (2009)

16 Bertin (1983) introduces graphic representation as "... the transcription, into the graphic sign-system, of 'information' known through the intermediary of any given sign-system".

and evaluate values of numerical result as high, medium and low. Human perceptual system cannot perceive absolutes, only comparisons (Macdonald-Ross 1977a) which can be *implicit* (comparing presented fact with previous knowledge from memory and *explicit* (comparing side by side).

When the reader is not proficient in reading nutrition information (not able to *implicitly* compare the information), presented numbers are useless unless an *explicit* comparison is made (such as comparing one nutrition table with another). In nutrition label, some kind of benchmark needs to be established for the *explicit* comparisons. The comparison can be accomplished either through displaying guideline user's needs (quantitative information), using benchmarks to evaluate amounts of nutrients (qualitative information) or defining amounts according to the scale (ordered by amounts).

According to Macdonald-Ross (1977b), a table is an example of quantitative formats that allows for reading *exact numbers*, as well as seeing *trends and comparisons*, unlike diagrams, which only offer the latter.

We can see that for judging overall healthiness of the product and comparison of two labels, a detailed presentation of *exact numbers* is unnecessary, therefore the displays only need to present *trends and comparisons*.

Tables can present the maximum amount of information in the smallest available space (Macdonald-Ross, 1977b) and are better suited for smaller sets of information (Tufte, 1983), but are less powerful and straightforward than diagrams. The crucial difference between reading tables and diagrams is that the former demands sequential reading, one value after another in a row or a column before comparing values. Reading diagrams is different, components are scanned simultaneously (Few, 2004) and invite the eye to compare chunks of data (Tufte, 1983).

Macdonald-Ross (1977b) thinks that tabular formats are not suitable for a lay reader due to too abstract nature and should be avoided in non-technical communication[17]. Macdonald-Ross in this case favourises bar charts which have the advantage of easier comparison with perceptual mechanisms (Brinton, 1916) when comparing to other diagrams because lengths can be easier compared than area and volume. Vertical compared to horizontal orientations easier communicate high and low values, as high is recognised as more (Kosslyn, 1994).

No format is superior to others and certain tasks demand specific displays of the data (Macdonald-Ross, 1977b). Difference between readers was found by Kosslyn (1980), who argues that children rely more on visual representations (imagery) while older people tend to consider verbal data. People with different attitudes towards nutrition information therefore have different needs. Experienced readers may wish to see verbal messages, while less experienced users may better use visual representations.

Nutrition labels present many variations of graphic displays. Nutrition table is still the most commonly used graphic format, although as we have seen, theoretically it is not the most suitable option for most of the tasks performed using nutrition labelling.

17 Nutrition information can be considered technical communication only to nutrition professionals, for others ('unsophisticated general audience' as Macdonald-Ross put it) an alternative format is more suitable.

Graphic displays used in current nutrition labelling schemes

Graphic displays of nutrition information are voluntary additions to prescribed tabular format. Because of this fact numerous variations have been developed since the introduction of the nutrition label. Until 1993, these alternatives had been researched very thoroughly in numerous studies in the subject[18], where alternative formats were often preferred to commonly used tabular format. The UK market today sees numerous competing nutritional labelling formats, supported by supermarket chains and associations of manufacturers who attempt to enhance the understanding of prescribed label in tabular form (Euro Coop, 2003).

All alternative schemes are a front-of-pack systems, positioned away from the prescribed tabular format on the back of the pack. Front-of-pack labels are often found to have too little information for detailed readings (Synovate, 2005b), but provide a brief qualitative or quantitative information about composition of nutrients in a product. Studies suggest that both tabular format and alternative schemes should be available.

"Graphs present a memorable summary of the results" (Ehrenberg, 1975).

Tabular formats

Two main tabular formats need to be introduced, the EU and the USA examples. The second one needs to be introduced as it was the first consistent nutrition labelling system in use, introduced in 1993 (FDA, 2008). Both systems are examples of back-of-pack labelling.

Tabular format as used in the EU

[**12**] This is the most common type of nutrition labelling in the EU. Since its form is not prescribed[19], numerous variations of this system can be found, including two examples of improved tabular format (see p. 28 [**23, 24**]). Nutrient values are expressed quantitatively, per 100 g, with optional per-portion information. Reference values do not have to be presented, calling for implicit comparisons of data.

Tabular format prescribed in the USA

[**13**] The content and form of this system are mandatory[20] with precise defined layout[21]. Vertical and horizontal variations are allowed. Nutrients are always presented in relation to portion sizes[22] with specified number of portions per pack. Benchmarking is possible through emphasised recommended daily values (GDA). All numbers are rounded as Ehrenberg (1975) suggests, therefore allowing for easier reading compared to the EU format. Moreover, consistent design simplifies comparison between displays.

18 See chapter 3 for their evaluation.

19 Except defining the numeric format.

20 Defined by the U.S. Food and Drug Administration (FDA, 2008).

21 See http://www.fda.gov/Food/GuidanceComplianceRegulatoryInformation/GuidanceDocuments/FoodLabelingNutrition/FoodLabelingGuide/ucm064904.htm

22 Portion sizes are prescribed by the FDA (2008).

[**12**] **LEFT: An example of nutrition table as used in the EU.** Tesco cereal bars.

[**13**] **RIGHT: Nutrition table prescribed by the FDA.** SOURCE: http://www.flickr.com/photos/cxg231/3098830482/. [retrieved 14 september, 2009]

Traffic Lights

Traffic lights scheme is front-of-pack graphic system that uses banding scores to order nutrients as high, medium or low. It uses colour to qualitatively (as well as quantitatively) evaluate a nutrient in relation to recommended daily allowances. The scheme was introduced by Food Standards Agency with a goal of presenting "information at a glance" (FSA, 2009c).

The system uses cut-off points as prescribed by the EU regulation[23], high values are presented in red, medium are amber and low amounts use green. Values are not related to recommended daily intake of a person but rather to composition of the product itself. The values are defined for a portion, which should be defined realistically, FSA (2007) suggests.

Advantages and limitations

Overall quality of food can be judged using a pattern – the more greens, the healthier the food. Because of relying on colour only, this system has a major drawback. According to Tufte (1983, 1990) colour should allow even colour-deficient people to use the display and key differences should never be made using red and green. Some Traffic lights variations address this issue[24]. Another problems was pointed out by Levy (1992), people tend to miss fine variations between values in the same category when banding is used. For example, if a product had four nutrients just below the cut-off point between low and medium, its overall quality might be worse than a product that has two values low and others in medium or even high range.

23 EU Regulation No 1924/2006 on Nutrition and Health Claims (2009)

24 See hybrid systems on p. 26

[**14**] LEFT: **Traffic lights.** The Co-operative.

[**15**] RIGHT: **Traffic lights with added verbal banding.** New Covent Garden Food.

Traffic light scheme has a tendency to show certain foods that are considered an essential part of a healthy diet, unhealthy. For example, certain cheeses would be high in fat, saturated fat and salt which could discourage the users from buying them (Kelly et al., 2009). This, however, is one of major drawbacks of all nutrition labelling[25], although because of stronger emotional response using colour bad foods are easier to spot (Susie Fisher Research, 1985).

Guidelines for use

FSA's guidelines define only basic layout properties, such as colour, typeface, position on the pack, as well as minimum sizes of displays. Manufacturers can choose to customise the label design[26]. A discussion on four key variations follows.

Linear form without verbal banding

[**14**] This form uses colour only to qualitatively evaluate the amounts of nutrients. Energy is presented quantitatively only (this example) or evaluated using colour[27]. Readers with colour deficiencies need to read quantitative information (precise values of amounts of nutrient), to evaluate the product and compare it with another, making explicit comparison not possible.

Linear form with verbal banding

[**15**] This example adds verbal banding and thus presents qualitative information twice, providing a benchmark for readers that are not able to read colour. Name of the nutrient and its exact amounts is positioned outside of the coloured area, where the verbal descriptor is. Calories are only presented quantitatively. This display exists in horizontal or vertical format.

25 See discussion on p. 16

26 For example, Sainsbury's circular format [**16**] and Co-operative's Traffic Lights are designed according to the same guidelines, but their form is much different as well as their comprehension. Guidelines are avaliable in FSA, 2007.

27 See *circular form without banding* example on next page.

[**16**] **Circular Traffic lights without verbal banding.**
Sainsbury's.

Circular without verbal banding

[**16**] Circular form reminds the reader of a pie chart which tends to confuse some consumers (Feunekes, 2008), because they would try to compare area sizes instead of colour only. This particular example, Sainsbury's 'Wheel of Health', is often liked by the majority of users because of its less technical appearance. On the other hand, people tend to use it less accurately than *linear forms with or without verbal banding* (Malam et al., 2009). Qualitative information is presented using colour only, which can be used to evaluate energy as well. Some displays omit this information from the display.

[**17**] **Circular Traffic lights with verbal banding.**
Lockwood Muchy Peas. SOURCE: http://www.food.gov.uk/multimedia/pdfs/tladopters26mar09.pdf
[retrieved 14 september, 2009]

Circular form with verbal banding

[**17**] This example adds verbal banding to circular form. In contrast with *linear form with verbal banding*, all components are positioned in the same area: name of the nutrient, amount in grams and verbal evaluation.

There are many other options employing *Traffic lights* colours, varying in shape and orientation (including vertical, horizontal and even diagonal position), but they can be put in one of the groups presented in this chapter. Traffic lights principle of using colour to qualitatively evaluate the amount of nutrient has been applied to *GDA* scheme [**21, 22**], as well as more common nutrition table [**23, 24**].

GDA (Guideline Daily Amounts) scheme

This scheme was introduced by the Institute of Grocery Distribution (IGD) in the UK in 1998 as an additional element in the nutrition table[28] and was introduced as a front-of-pack labelling format in 2004, according to Bussel (2005). Supported by the Confederation of the Food and Drink Industries of the EU (CIAA), an association of major manufacturers and retailers, who have considered *Traffic lights* as too simplifying (Bussel, 2005). The GDA scheme is a part of the proposal for the new regulated nutrition label in the EU (Stop GDA, 2009).

Many discussions can be found in the media, comparing both schemes (BBC News, 2007). Critics of *Traffic lights* state that it offers too little information to be useful, and that their proposed scheme, *GDA* is superior in this case.

GDA relates the amount of key four nutrients (same as the *Traffic lights*) in a portion to recommended daily intake of average woman using percentages, allowing for informed quantitative evaluation regarding shopper's daily needs. Two hybrid systems have already been in use, combining GDA's quantitative information with Traffic Lights' qualitative use of colour.

Advantages and limitations

In practice, this system has less variations between manufacturers and therefore the scheme appears more consistent and recognisable.

Food and Drink Manifesto (2005) manages to find only one advantage of the *GDA* scheme in comparison to banding scheme such as Traffic lights – consumers are able to relate displayed values to their average daily requirements. Other presented arguments cannot be substantiated (see Bussell, 2005).

Major criticism of this approach is that daily requirements for specific groups of people can differ considerably. A yoghurt can be promoted as a product for children but GDA values would still consider average woman. Differences between daily allowances for both are much different, making the product appear healthier than it actually is[29].

Many initiatives that demand this scheme to be banned have been established (Stop GDA, 2009), stating that the user needs to calculate the amounts in order to compare two products. This format presents only quantitative information, demanding from the user to make qualitative judgements, where the user also has to know what presented values relate to. Displayed values are presented per portion, therefore manufacturers can select their own serving amounts and consequently deceive the user[30].

One issue severely limits the comprehension of the GDA label. Names of nutrients differ from the ones that are usually used by people as well as displayed in Traffic lights panel: *kcal* instead of calories, *saturates* instead of saturated fat and *sodium* instead of salt[31].

Guidelines for use

GDA style guide (CIAA, 2009) recommends several variations that can be considered (including horizontal and vertical format). The style guide

28 Similar to the FDA's mandatory label in the USA.

29 A Danonino yoghurt advertised as a product for children has 10% of daily allowance of sugar for adult woman (2000 calories, displayed on the pack), which doubles to 20% of GDA for a 2-year old (1000 calories), according to Stop GDA (2009).

30 A pack of crisps is perceived healthier when a serving size is 25 g (only 1/7 of the pack), which is 11% of daily recommendations of fat. For 100 g, this number is much higher, 44%.

31 Considerding the fact that the term sodium is very often not understood (Euro Coop, 2003), these nutrients should be displayed using more common names.

[**18**] **LEFT: An example of simple GDA format that displays enregy only.** Mars.

[**19**] **RIGHT: Standard Monochrome GDA format.** Kellogs.

[**20**] **This monochrome GDA format is using colour only to enliven the display.** Tesco.

prefers one form (cylindrical shape) and one order of the nutrients. Percentages should be whole numbers while amounts in grams should be presented using one decimal space.

Monochrome GDA system

In comparison with basic GDA system that presents five variables: four nutrients and energy value [**19**], the simplified GDA label presents energy only energy [**18**] which is not sufficient for informed evaluation of the product[32]. *Monochrome GDA* scheme can use colour [**20**], but only to "enliven and decorate"[33].

Hybrid systems

Colour-coded GDA system (without verbal banding)

[**21**] Some manufacturers introduced the upgraded version of GDA system that combines main advantage of *Traffic lights* (qualitative evaluation using colour) and more detailed GDA percentages. In recent studies this display was the most preferred graphic format (Synovate, 2005)[34].

32 See discussion on p. 36.

33 Tufte (1983).

34 See also discussion on p. 33

[**21**] LEFT: **Colour-coded GDA system.** Marks & Spencer.

[**22**] RIGHT: **Colour-coded GDA system that adds verbal banding.** Asda.

Colour-coded GDA system with verbal banding

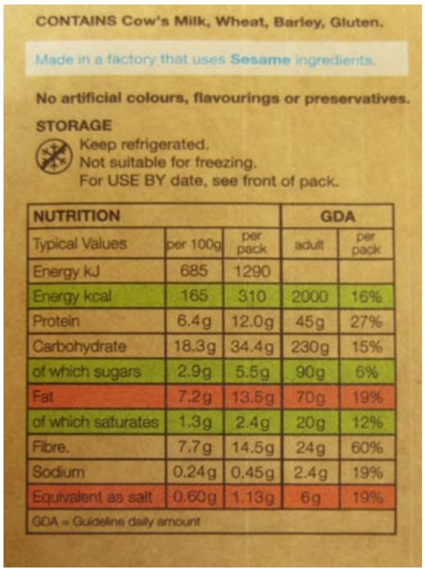
[22] A combination of all features of the GDA system and *Traffic lights*, where quantitative data using GDA is upgraded with qualitative descriptors using both colour and verbal banding. This display is considered the best performing graphic format, according to Malam et al. (2009).

Tabular format with *Traffic lights with verbal banding* or *Colour-coded GDA* values (back-of-pack[35])

Two examples from the Co-operative Group (using verbal descriptors [**23**]) and Marks & Spencer (using GDA values [**24**]) apply *Traffic lights* to highlight nutrients in the table on the back of pack. Qualitative evaluation of values is made easier as the reader does not have to rely on explicit knowledge (as in table with numerical values only). User can relate the front-of-pack information with detailed readings in the back-of-pack table as the same information is highlighted in both displays.

[**23**] LEFT: **An improved tabular format with Traffic lights with verbal banding.** The Co-operative.

[**24**] RIGHT: **Colour-coded GDA values in the tabular format.** Marks & Spencer.



35 This system is always used in combination to *Traffic lights* system on front-of-pack.

[**25**] LEFT: **Nutrition information in restaurants using diagrammatic display.** McDonalds. SOURCE: http://www.flickr.com/photos/kelly_hirano/275152328/ [retrieved 14 september, 2009]

[**26**] RIGHT: **Quick's version of bar chart display.** Quick. source: http://www.flickr.com/photos/diversionary/346503154/ [retrieved 14 september, 2009]

Nutrition displays in restaurants

Although two examples presented here are not in use in same environment as other displays presented earlier, they need to be introduced due to their specific form which could be applied to retail environment as well. Both examples operate in restaurant environment, presenting nutrition information on meal packs. A user makes a buying decision before reading this type of display, therefore its reading time can be much longer and more information can be presented accordingly. Numeric and diagrammatic form of presenting data are employed in the same display, eliminating the need for a combination of 'on-a-glance' display and detailed nutrition information as some previous examples suggested.

McDonald's public announcement for the nutrition labelling system used on their product [**25**] stated that "the new format converts scientific information into a customer-friendly snapshot of a product's nutrition value and how it relates to daily nutrient recommendations using bar charts and icons." (The New York Times, 2005a). The GDA values are expressed using horizontal bar chart with added numerical values.

The second example [**26**] presents nutrition information more thoroughly[36], using separate values for average man and woman, this time using vertical bar charts.

The most significant features of this display are symbols to represent nutrients which the reader must know in order to read the display in cases when nutrient names are not positioned next to symbols – in multilingual environments, for instance. Both formats are using similar symbols and colour scheme to identify nutrients. No research has been conducted to find whether these displays can be considered effective.

Integrated labelling

Integrated labelling uses a single symbol to evaluate the quality of the food, trying to qualitatively evaluate a product as a whole instead of presenting a breakdown of specific values. This display comes into question when a simple descriptive message needs to be communicated, such as in advertising.

They can be misleading, however (Feunekes, 2003), since they only highlight products that can be considered healthier in the same food group

36 This display presents values for nutrients that McDonald's display excludes.

and not throughout the whole range of available foods. This is the major limitation of displays of this kind. A study, discussing the use of the Keyhole symbol in Sweden (Lobstein and Davies, 2009) showed that although the majority of consumers in Sweden considered it when they were making buying decisions, there was a substantial percentage of respondents who tended to choose only products with this symbol, although a healthier option was available without Keyhole symbol displayed.

Integrated labelling has been thoroughly tested in comparison to other forms of nutrition information and were usually considered not helpful[37]. We can see that although they present a simple alternative to complex nutrition information, they cannot be used for making precise judgements of specific nutrients.

Discussion

This chapter presented basic groups of alternative nutrition labelling currently in use in the EU environment.

As we see, all examples use very similar approaches to presenting data. Comparing with Bertin's (1981) and Macdonald-Ross's (1977b) discussions on graphic formats, we can see that a very narrow selection of alternatives has been considered. Many variations (such as pictorial charts, polar charts, pie charts or divided bar charts) could be explored to see whether displays presented in this chapter are in fact the best possible solutions to the nutrition labelling problem.

There has been no in-depth design project with the goal of finding the best nutrition label for the European market. Various forms of labels were instead independently tried, revised and improved through various qualitative and quantitative studies using testing materials with different levels of graphic quality.

In the following chapter we must discus the results of most important studies that formed displays presented in this chapter.

37 Results of these tests are not discussed in this paper. For their evaluation see Cowburn and Stockley (2003).

3 Nutrition labelling research

To see how well current alternatives to tabular presentation of nutrition information perform in real life situations and to properly evaluate their comprehension, we must discuss the studies that compared graphic formats in nutrition labelling. These studies often proved superiority of alternatives to tabular format, and we can often read that novel displays became more understandable after they had been used for an extended period of time[38].

This chapter starts with general discussion about nutrition labelling research, emphasising the importance of the quality of tested materials, continues with comparison of graphic formats and concludes with a discussion about recommendations for future development of nutrition labelling.

Some early studies (for example, Levy et al., 1992) suggested that numerical formats were superior to diagrammatic displays, while recent studies have proven the opposite (Synovate, 2005b). At this point we must not ask whether the alternative nutrition labelling formats *work*, but *what type* of graphic format works better. Macdonald-Ross (1997b) claims that dismissal of a diagrammatic display may be attributed to improper *type* of display which has a major influence on comprehension. Moreover, the *quality* of execution may be even more important. “A diagram which in one person’s hands is a visual disaster might be transformed into excellence in the hands of another” (Macdonald-Ross, 1977b).

A question, which formats initially tested but proven ineffective due to improperly designed study would perform better if they were redesigned properly. For example, would a *Bar chart* be considered an improvement with added *Traffic lights*?

General observations

Quality of testing material

Macdonald-Ross (1977b) argues that we cannot draw conclusions from studies that were using improperly designed testing material, stating that it is impossible to compare a well designed table with substandard execution of a graph.

All diagrammatic formats are especially vulnerable, as they are designed for visual comparison, rather than numerical. In many of the studies done in the field of nutrition labelling graphs were not designed by skilled professionals, therefore their explicit comparisons are difficult.

38 Such as the Food Standards Agency’s study (Synovate, 2005b)

Differences between types of studies

Qualitative and quantitative studies' outcomes can differ significantly (Cowburn and Stockley, 2003; Malam et al., 2009). Some studies, such as Black & Rayner (1992) or Synovate (2005a, 2005b) involved both qualitative and quantitative tasks from which we can see that perceived easiness and understandability of a specific format does not necessarily suggest actual comprehension. For example, a *Colour-coded GDA* was often preferred to simpler *Traffic Lights* in qualitative studies, but the latter performed better in terms of tested comprehension in quantitative studies. Often studies have not presented their tested material, so their outcomes cannot be properly assesed[39].

There are three most important researches presented in this chapter: Black and Rayner (1992), Synovate (2005b) and Malam et al. (2009). All of them presented their tested materials which had been designed appropriately so we can establish conclusions based on their outcomes. A review papers by Cowburn and Stockley (2003) and Baltas (1999) helped with the evaluation of some of the studies discussed in this chapter.

Studies employ different methods, examples, and demographic profiles of participants, therefore their outcomes cannot be accurately compared. Nevertheless, most studies, with minor exceptions, show similar patterns – variations of *Traffic lights* and *Colour-coded GDA*, whenever tested, were consistently best.

Badly designed study offers flawed results

Before the introduction of the new mandatory nutrition labelling in 1993 in the US market, the Food and Drug Administration (FDA) conducted an extensive research[40] which was criticised for not comparing best graphic formats as well as testing improper tasks. Levy et al. (1996) defended this study and presented findings of extended testing that tried to respond to this debate. The new study did not focus on testing various graphic alternatives. Levy et al. dismissed diagrammatic formats due to limited space on certain packages as well as their proven unacceptability for use in nutrition labelling (Levy et al., 1992).

This study contradicts most of other researches conducted in the European markets. Verbal descriptors performed worse than control format[41], extending the time necessary to judge overall healthiness. No significant differences were found between formats on accuracy, while percentages of GDA performed best. The study concludes that the best performing formats were currently mandatory format (control format with added percentages of GDA [**13**, see p. 22]), while verbal banding and highlighting of nutrients[42] failed to improve the understanding of basic format.

Inspecting the demographic profile of respondents shows that the study was not using the average demographic profile[43]. Comparing with similar study by Black and Rayner (1992) which showed strong preference to diagrammatic and verbal formats between lower educated respondents, we can draw a conclusion that results of Levy's study would be substantially different if tested correctly.

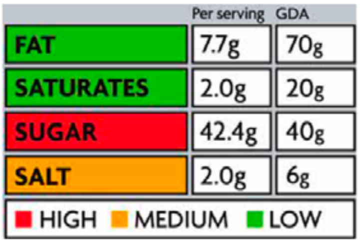
39 In this chapter, when presented figures are not taken from the specific research report, they are marked with asterisk next to figure number, for example: "... by verbal banding (fig. 50*) performed best ..."

40 Discussed in Levy et al. (1996).

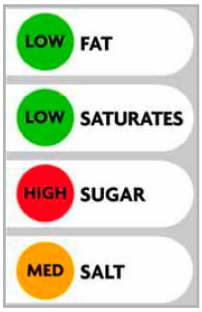
41 Control format presented amounts of nutrients in grams only, similar to the table used in the EU.

42 Highligting high and low values of nutrients; no illustration presented in the study.

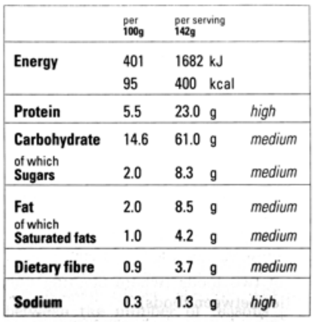
43 The study tested 8% of people with lower education while 30% of respondents were college graduates. This cannot be considered a typical demographic profile (see also Synovate, 2005)



[**27**] **Colour-coded GDA sample from the Synovate study.** SOURCE: Synovate (2005b), p. 96



[**28**] **Traffic lights sample from the Synovate study.** SOURCE: Synovate (2005b), p. 95



	per 100g	per serving 142g		
Energy	401	1682	kJ	
	95	400	kcal	
Protein	5.5	23.0	g	high
Carbohydrate	14.6	61.0	g	medium
of which Sugars	2.0	8.3	g	medium
Fat	2.0	8.5	g	medium
of which Saturated fats	1.0	4.2	g	medium
Dietary fibre	0.9	3.7	g	medium
Sodium	0.3	1.3	g	high

[**29**] **Tabular format with verbal banding tested in the Black and Rayner's study.** SOURCE: Black and Rayner (1992), p. 100

Black and Rayner present a criticism of Levy's first study (1991) which tested diagrammatic displays without any numeric representation and instructing people to read exact numbers, which is "cognitively demanding task"[44]. Cowburn and Stockley (2003) labelled both Levy's studies as badly designed. Studies that Levy et al. (1996) was referring to served as a basis for the first mandatory nutrition labelling system put to use in the world. Was choosing a badly designed study as a basis for regulated labelling system an error or a deliberate action[45]?

It is remarkably simple to substantiate a specific graphic format citing studies that are flawed. Associations with specific interests have the ability to substantiate their claims using studies that favoured a specific format. To prevent this, more precisely designed independent research in this subject is necessary[46].

Well conducted study can give reliable results

Synovate's (2005b) extensive and thorough user testing, where nearly 2700 people were interviewed, evaluated four signposting variants of front-of-pack nutrition labelling and compared them to standard back-of-pack nutrition table. Tested displays were applied to real products, thus simulating real life buying experience. Both qualitative and quantitative tasks were performed. The demographic profile was equivalent to typical UK consumer, unlike Levy's 1996 study.

A similar quantitative studies by Kelly et al. (2009) and Malam et al. (2009) were comparing similar labelling formats, although their form and testing methodology differed. Outcomes of both studies confirm findings from Synovate's research. However, Malam et al.'s best performing display was not tested by Synovate.

The most important finding of Synovate (2005b) study was that nearly all participants were certain that a simpler information display was necessary. Comparing these findings with Levy et al. (1996), who showed no significant differences between nutrition table and additional displays, we can see that there must have been a significant flaw in the design of the Levy's study.

Even though Synovate recommended graphic display [**27**] performed consistently well in all tasks, it had some important flaws[47]. In this study testing materials were taken from different sources, with some examples identical to those used in actual retail environment (*Traffic lights* [**28**]) and other designed specifically for this study (*Colour-coded GDA* [**27**]). Outcomes of the study might be different if samples developed to the same level were used.

Performance of graphic displays

Numerous studies preferred diagrammatic formats in early studies in 1980s. Russo (1986) discovered that adding a Star label format[48] improved understanding of the information, but it did not perform better than the standard numerical label. Yeomans (1986) discovered that *tabular format*, accompanied by *verbal banding* [**29***] performed best in quantitative tests.

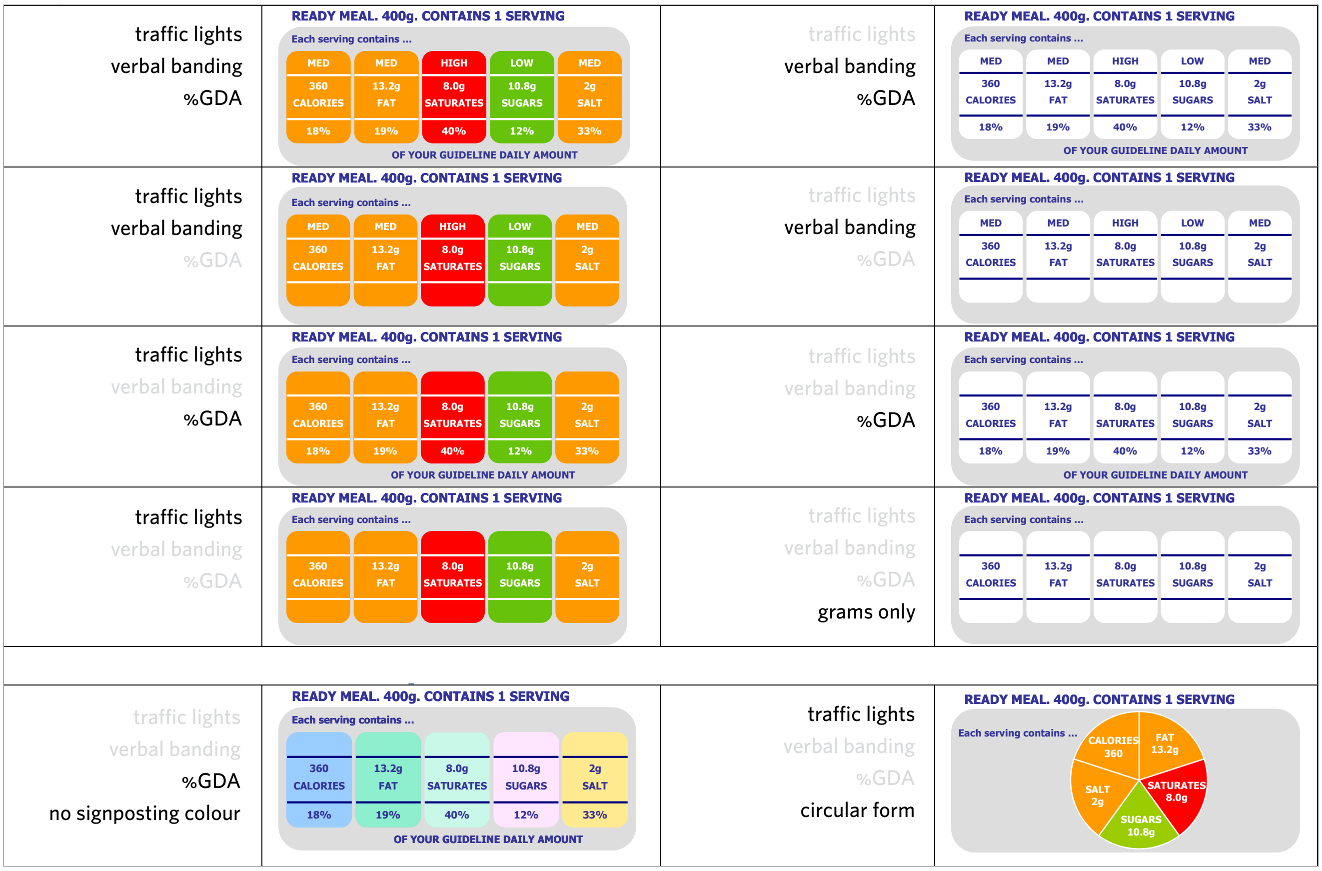
44 Black and Rayner (1992)

45 See discussion on Food industry's influence on nutrition labelling on p. 11.

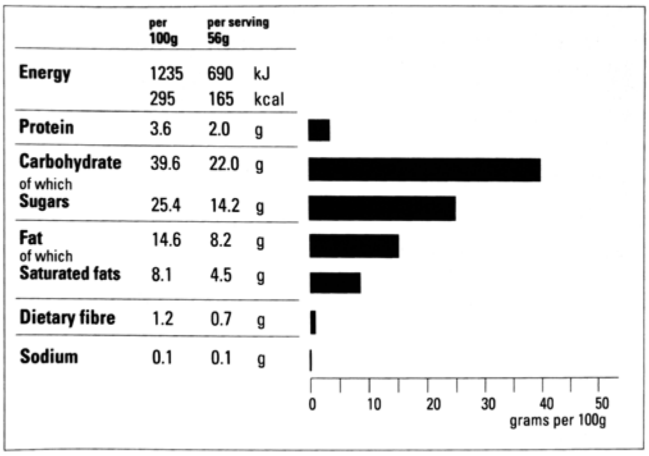
46 See Baltas (1999), Cowburn and Stockley (2003) and Drichoutis (2009) for review of studies comparing graphic formats of nutrition labelling.

47 Considering Tufte's idea of data ink and Ehrenberg's concept of simplifying information, the Colour GDA example had a major flaw, carrying more non-data information than Multiple Traffic Lights, this sample could performed better if it had thinner rules (Tufte, 1983) rounded numbers (Ehrenberg, 1975), as well as right alignment of figures in the table (Wright, 1970).

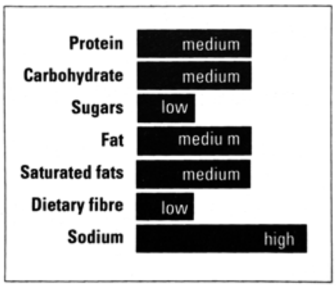
48 No illustration provided.



[30] **Malam et al.'s tested samples.**
SOURCE: Malam et al. (2009), p. 21



[31] **Bar chart display from Black and Rayner's study.** SOURCE: Black and Rayner (1992), p. 137



[31] **Banding bar chart from Black and Rayner's study.** SOURCE: Black and Rayner (1992), p. 100

	per 100g	per serving 340g		percentage of recommended daily intake* (per serving)
Energy	921	3130	kJ	
	221	750	kcal	
Protein	12.5	45.0	g	60%
Carbohydrate	11.0	37.0	g	11%
of which **Sugars**	6.9	23.5	g	33%
Fat	14.4	49.0	g	61%
of which **Saturated fats**	7.3	24.8	g	92%
Dietary fibre	4.5	15.0	g	50%
Sodium	0.4	1.3	g	65%

*recommended daily intake based on a 2400 kcal per day diet

[33] **Table with percentages of GDA.** SOURCE: Black and Rayner (1992), p. 141

[**34**] **Evaluation of the level of individual nutrients within a product.** Percentage of correct answers by label type. SOURCE: Malam et al. (2009), p. 67

[**35**] **Evaluation of the overall healthiness of a product.** Percentage of correct answers by label type. SOURCE: Malam et al. (2009), p. 76

[**36**] **Comparison of two products in terms of healthiness.** Percentage of correct answers by label type. SOURCE: Malam et al. (2009), p. 91

Despite the preference of *Bar charts* [**31***] in Susie Fisher Research (1985) study, a major drawback was pointed out – people tended to compare lengths of bar charts without comparing relative size of display on the pack. Black and Rayner (1992) pointed out that *Banding bar charts* [**32**] performed better than *Bar charts presenting exact amounts* (as in Susie Fisher Research), facilitating quicker response by participants with less interest who were particularly poor in responses using *GDA percentages* [**33**]. No significant differences between both formats were found among interested public. In contrast, Cowburn and Stockley (2003) suggest that GDA percentages are overall better graphic formats than *Bar charts*.

In Kelly et al.'s (2009) study *Colour-coded GDA* and *Traffic Lights with verbal banding* were considered best, with nine out of ten participants thought that all front-of-pack displays were helpful and understandable.

Malam et al.'s (2009) study compared eight combinations of front-of-pack labels[49]. Samples in this study [**30**] were designed consistently, developed from the same template, making results more reliable. The study presented results of three particular tasks[50]:

- focusing on single food, evaluating specific nutrients [**34**],
- single food only, overall judgement of healthiness [**35**],
- two products, choosing a healthier option [**36**].

Colour-coded GDA with verbal banding and *Traffic Lights with verbal banding* were consistently the best displays in both tasks evaluating single

49 No comparison to standard tabular format was made.

50 Each task was further divided into testing of product with lower and higher overall energy value. As results did not differ substantially, only outcomes of testing a product with higher energy value are presented.

product [**34, 35**], the GDA display performed better in evaluating individual nutrients, suggesting that participants were referring to GDA values. In second task both formats showed the same percentages of correct answers. *Monochrome GDA* and a *no-label* situation results were scoring much worse, suggesting that readers need different type of information to evaluate a single product, more specifically, colour and verbal qualitative evaluation. Synovate (2005) found out that *Traffic Lights with verbal banding* [**36**] were substantially better than other tested variants, including *Colour-coded GDA*[51] when evaluating single product.

In terms of comparing two products, Malam et al.'s (2009) study suggested that differences between displays were insignificant. As a contrast Synovate's (2005b) showed that *Colour-coded GDA* was proven to be better than *Multiple traffic lights with verbal banding*. Comparisons between these two formats and other graphic displays (such as *Bar charts*) would need to be addressed in future studies.

Tabular format in comparison to front-of-pack formats

Research papers discussing performance of tabular presentation of nutrition values proved that tables are better in simple task operations as well as for comparisons of products, with qualitative descriptors such as *verbal banding* helping users to relate values with their overall diet (Cowburn and Stockley, 2003). Co-operative (Euro Coop, 2003) studies offer similar conclusions, stating that the addition of verbal format substantially improves the comprehension of numerical values.

Jones and Richardson's (2007) compared effectiveness of a front-of-pack and a back-of-pack label using the eye-tracking method. Traffic Lights were used considerably more often, achieving higher accuracy than back-of-pack nutrition table. Several participants were unable to summarise information to make overall judgement using tabular format only, proving that consumers need a simplified display on the front-of-pack.

Improvements of nutrition table have been proposed in the Synovate (2005 A) study, calling for better integration of front-of-pack and back-of-pack information. Two examples of this are presented in chapter 3 [**23**, **24**, see p. 28], but need to be discussed in future research in order to prove their effectiveness.

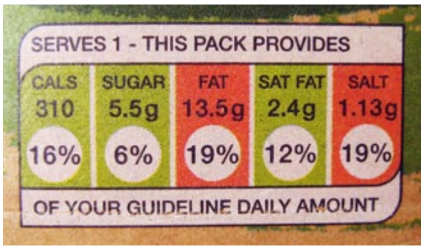
According to Synovate (2005b), people refer to back-of-pack information in much lesser extent when using *Colour-coded GDA* front-of-pack label than when using other graphic displays – only 13% of participants read the nutrition table to find exact amounts of nutrients when using this display. Using *Traffic lights* and *Monochrome GDA* these values were higher, 25% and 26%, respectively.

User preferences for graphic formats (qualitative studies)

User's preferences do not result in better comprehension of the information although attractive displays might attract more people (Malam et al., 2009).

In early studies, such as Yeomans (1986), *Bar chart* [**30***, see p. 33] was the most preferred graphic display, while it was not performing worse than the *standard tabular format* [**37***]. A later study by Black and Rayner (1992)

51 In Synovate (2005) a Colour-coded GDA with verbal banding was not tested. Malam et al. suggested that verbal banding considerably eases the evaluation of single product. We are able to conclude that the addition of verbal banding in Colour-coded GDA example might change this result.



[**37**] **Colour-coded GDA label.**
Marks & Spencer.

[**38**] **Colour-coded GDA with verbal banding.**
Asda.

introduced banding as the most helpful design feature, with participants preferring *Verbal banding* [**29**, see p. 33] as well as *Verbal banding with bar chart* [**31**, see p. 34]. Interested participants preferred GDA percentages, suggesting that nutrition labelling display needs to present information on several levels, from simple qualitative evaluation for less interested public, while still keeping detailed values in tabular form. Verbal banding was highly preferred in nearly all qualitative studies, according to Cowburn and Stockley (2003), yet diagrammatic formats were often selected by some, suggesting that a combination of both displays is an optimal solution.

Using colour for qualitative evaluation of nutrients' amounts was considered a tool for 'preaching' rather than informing and it was strongly disliked by some participants in an early study by Susie Fisher Research (1985). This fact considerably changed, with recent studies suggesting that colour coding was favourable (Synovate, 2005a; Malam et al., 2009). The preferred colour formats were either *Colour-coded GDA* [**37**] or *Colour-coded GDA with verbal banding* [**38**].

The only format all studies were unanimous to be unsuitable for nutrition labelling is a *Pie chart*, both in terms of preference and performance (British Marketing Bureau, 1985; Yeomans, 1986, Cowburn and Stockley, 2003).

Circular Traffic Lights [**16**, see p. 24]presents an interesting paradox. In the Malam et al.'s (2009) study it was seen as a simple and engaging display, closely behind highly preferred *Colour-coded GDA with verbal banding*, but performed badly in many quantitative tasks. It was thought to be confusing in Feunekes (2006) study as well.

The effect of specific elements of displays on overall comprehension

Malam et al. (2009) compared factors that affect the comprehension of the nutrition label. According to their research, two features that affect the reading of the nutrition label to highest extent are the use of *verbal banding*, followed by *colour coding*. Demographic attributes have less effect – age and literacy level are more significant than label-specific numeracy, education and social grade.

The effect of colour and verbal banding was proven by other studies in this field as well. Black and Rayner (1992) suggest that in terms of monochrome performance *verbal banding* is the single most important design feature. Adding *colour coding* further improves comprehension. Malam et al. (2009) report that *GDA percentage information* is less important and tends to be used by interested readers only, when looking for specific values. For them *colour coding* provides key identification of healthiness when rapidly evaluating single foods. An early study by Susie Fisher Research (1985) showed that users expressed strong emotional response towards colour.

Coexistence of graphic formats that use colour for different purposes creates confusion. Malam et al. discovered that people familiar with one labelling scheme using colour as qualitative device tend to be confused when exposed to another example using colour as decoration only[52]. Colour in nutrition labelling should be used in one way only.

Colour and verbal banding are therefore two design features with most

52 Monochrome GDA by Tesco is using colour to define nutrients rather than qualitatively evaluate their values.

significant effect on comprehension, suggesting that immediate improvements in nutrition labelling are possible through appropriate design of the display.

Differences in comprehension between user groups

Less interested users[53] tend to use nutrition labelling in much lesser extent (Malam et al., 2009). Black and Rayner (1992) suggest that this group tends to choose simpler graphic displays, specifically diagrammatic formats. Performance in tasks does not decrease among interested users. Both groups refer to front-of-pack labelling when they need to make quick decisions, but interested users generally select more informative displays (Malam et al., 2009).

In Synovate (2005b) study no significant differences were found between age groups, but general comprehension was much lower for elderly and people from two lowest social classes. Although *Traffic lights with verbal banding* performed slightly better overall in these specific groups, the *Colour-coded GDA* was a better performing in other demographic groups, suggesting it is more suitable as an overall display.

Black and Rayner (1992) suggest that the label should not only respect two types of users, but also specific tasks users perform, proposing a combination of 'information for detailed consideration' and display for 'immediate information reading'. These suggestions were proven correct through later studies (Synovate, 2005b).

Differentiation between two different evaluating tasks can be achieved using *Colour-coded GDA with verbal banding* [**38**, see p. 37], allowing two different readings: colour and verbal banding for immediate reading, while GDA percentages can be used for detailed consideration. Division between front-of-pack (immediate information) and back-of pack numerical labels (detailed information) is the second example of dual display principle, allowing interested public seek for specific amounts from the nutrition table, while achieving a less information-dense display on the front of the pack.

Comprehension of the nutrition information display is not sufficient for behavioural change

Behavioural effectiveness of nutrition labelling is rarely tested even though it should be a priority scope of researches (Feunekes et al., 2008). Studies predominantly focus on the comprehension of the label, while actual effectiveness is not considered due to the lack of available testing methods.

Consumer behaviour is usually tested through interviews, where participants tend to post-rationalise when stating their reasons for buying a specific product (Bell et al., 2007), hence another approach to testing behavioural outcomes needs to be found.

To address this issue, the FSA conducted a preliminary research (Rawson et al., 2008) of effectiveness using the eye-tracking technology for testing behavioural outcomes. Even though results cannot be proven valid at this point, an important aspect was reported: participants spent a limited amount of time reading the label, mostly scanning front of the packaging and spent less time rotating it to find more information on the back side. Product positioning and packaging design were considered by far more important factors when buying a product.

53 As well as specific demographic groups: elderly, participants with lower education and from lower social classes.

Possibility of using a unified nutrition labelling system across the EU
Feunekes et al.'s (2008) qualitative study discovered that there were no substantial differences between comprehension of different front-of-pack formats when compared in four European countries. British participants tend to like *Traffic light* and GDA *scheme* more, which might be a consequence of familiarity[54]. Longer exposure to novel formats improved their acquisition and comprehension. These findings are consistent with Synovate (2005a) study which argues that promotion on public level would increase overall comprehension of alternative graphic displays. Despite not familiar with tested front-of-pack examples, German, Italian and Dutch participants had no troubles reading them. There is a possibility for the establishment of unified nutrition labelling format across the EU, the study concludes, as there were no significant differences in comprehension between countries.

Discussion

Designers of nutritional labels should seek more information from empirical research to get "usable feedback about the effect of their work" (Macdonald-Ross, 1977a) and to avoid repeating mistakes of other designers. Many studies have been done in the field of nutrition labelling design, exposing many facts that need to be taken in account when designing the appropriate nutrition label that works on all Baltas's (1999) suggested levels, from attention, acquisition, comprehension and effectiveness. All user types should be considered as well as specific tasks these users tend to perform.

Attention is easily achieved using colour and non-technical appearance, *acquisition* and *comprehension* can be improved using appropriately designed graphic display as well as better nutrition knowledge of the reader, while *effectiveness* can only be achieved when all factors concerning nutrition labelling are resolved. First three levels have been researched extensively in numerous studies presented in this chapter, while effectiveness is more complex issue and needs to be addressed by correctly conducted studies that test appropriately designed testing material in real environment, using correct profile of consumers.

Studies should be supported by manufacturers and non-governmental bodies by which more sources for these studies could be available and better outcomes possible (Rayner, 1995).

Comparing performances and preferences of formats currently in use with early examples from history of nutrition labelling it can clearly be seen that substantial improvement has been achieved. Some of recent examples are well comprehended but their common use is supported only by few manufacturers and retailers (BBC News, 2005). Furthermore, other formats in existence affect each other (Malam et al., 2009), worsening the overall comprehension and consequentially the ultimate goal of nutrition labelling: effectiveness.

54 Tested front-of-pack labelling examples were not used in other European countries at the time of Feunekes (2006) study.

Conclusion

Current situation of presenting nutrition information is not acceptable. The prescribed tabular format can be easily improved using an alternative graphic format. Studies show that people do engage more with less technical looking formats, which help them with understanding of the information as well as performing specific tasks. However, improving only the form of the nutrition label only is not enough for it to become instantly effective. Many variables affect the perception of the label and need to be addressed first.

Improving education
A nutrition label should be supported by and educational campaign for people to familiarise with the new system (Synovate, 2005a). Certain uncommon graphic displays were often much easier to understand after they had been properly introduced to the reader. Better education in schools is necessary as well (Baltas, 1999) with a focus on understanding nutrients and relationships between them. Older public need attention as well, calling for an education campaign designed specifically for them.

The nutrition labelling in the EU should be mandatory
Since the form of the nutrition label is not specified in detail, many important details regarding legibility and comprehension are left to a broad group of professionals as well as unskilled individuals. Current graphic systems do improve comprehension, but their design guidelines are too loose for a consistent and recognisable nutrition label. Nutritional labelling is a good example of information design in everyday life, therefore information designer's skills should be applied in preparation of labelling guidelines. One well designed system should be developed independent from food politics, with the user in mind, making it more trusted by the public.

Two types of displays for two types of uses
Two graphic formats complement each other. Detailed consideration (specific values) is best achieved using the redesigned tabular display which attracts more interested readers as well. Immediate information (evaluating overall quality and comparing two products) is best acquired using a simple graphic format on front-of-pack which attracts people with less interest in reading nutrition information.

The best nutrition information display for immediate reading should:

- be positioned on the *front* of the food label to allow quick evaluations on the point of purchase;
- use colour banding (*Traffic lights*) for quicker *qualitative* evaluation;

- for people with colour vision deficiencies, high values should be the darkest (red), low values should be the lightest (green) along with another *change* of property, verbal banding;
- present *five* key values using names as *commonly* referred to (Calories, Fat, Saturated fat, Sugar and Salt);
- be attractive and motivating.

A display that currently achieves this to the highest extent is *Colour-coded GDA with verbal banding*. It should be accompanied by a redesigned tabular format. Key steps for the tabular format to achieve better usability, easier processing and qualitative evaluation are:

- *rounding* of the numbers to two digits;
- *ordering* nutrients by their amount are two key steps;
- a *reference* to daily requirements separately for average male and female should be made using percentages of GDA;
- a reference to immediate reading display should be made, preferably using colour banding;
- names of nutrients should be presented as *commonly* in use.

Improving the quality of studies

Future studies should focus on testing behavioural outcomes rather than cognitive outcomes. Their testing material should be appropriately designed with nutrition labels positioned on real packages in real environment, simulating the shopping experience.

A better dialogue between nutritionists, teachers, designers and food industry should be achieved in the search for the best graphic format for presenting nutrition information. Graphics can improve as they go through editing and revision (Tufte, 1983) only after we had established the basics that need to be considered when designing, testing and implementing the nutrition label. Nevertheless, even the most efficient nutrition label cannot be adequately effective without food industry's interest in communicating facts as they are. Only after all interested parties are prepared to cooperate, the seek for the best display of nutrition information can begin.

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