

The use of metaphors in dietary visual displays around the world

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Abstract

Many countries have developed visual displays summarizing key scientific information on diet and health for the general public. The article analyzes the use of metaphors in dietary visual displays in seven countries. The objective is to examine how spatial organization and its graphical representation reflect conceptual organization. It investigates the correspondences between metaphors, schemas and visual depictions in the diagrams vis-à-vis the nutrition concepts they stand for: Do the displays foster understanding of dietary information? Do they support perceptual inferences? Do they facilitate decision-making in food consumption?

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Several countries around the world are committed to devising dietary strategies that promote and protect health through healthy eating and physical activity. Many of these countries have delineated national dietary goals and nutrition systems in the form of food-based dietary guidelines. Guidelines are educational tools designed to provide practical guidance with the purpose of promoting wellness and preventing chronic diseases among the general public. They synthesize current scientific research as well as national food consumption patterns and policies (e.g., Truswell, 1987; FAO, 1996; Painter, 2002; WHO, 2003). In many cases, they also reflect the influences of the local food industry (Nestle, 2002).

National food guidance systems vary according to geography, cultural and ethnical traditions and year of publication. Most systems share a common set of wellness principles that promotes variety in food intake, emphasizing the consumption of fruits, vegetables and grains and limiting the consumption of fats. A recent trend is acknowledgment of different nutritional requirements for different age and gender. For example, the most recent American (USDA, 2005) and Canadian (Health Canada, 2007) food guidance systems offer online tools with personalization of food recommendations.

Dietary guidance systems are disseminated in various ways, including brochures, labels with nutrition information on packaging and most recently online resources. Most countries provide a visual display presenting the key concepts. These graphics may be considered snap-shots of the dietary guidelines. The World Health Organization (WHO) emphasizes

the need for visual graphics by recommending that the guidelines should "be accompanied by posters or food selection guides. These visual guides should assist users to select a diet ... reflect a concern for promoting food choices ... be culturally inclusive and incorporate foods that are generally available.... In addition a guide should be based on sound educational principles and be accessible to a wide range of educational levels" (2003, p. 6).

This article examines eight dietary visual displays of seven countries: Australia (figure 1), Canada (figure 5), China (figure 6), Portugal, (figure 2) Sweden (figure 4), the United Kingdom (figure 3) and the United States (figures 7 and 8).

Dietary visual displays

The graphics examined in this article represent information that is not inherently visible: a healthy diet. The concept of a healthy diet involves many aspects, among them nutrition advice. Because nutrients are a hard concept to grasp, all countries provide information about food, which is a concrete entity. All graphics categorize food according to nutritional properties. Information is presented in the form of food groups (e.g., Milk and Dairy Products). Each group is represented by a selection of food choices (e.g., milk, yogurt, cheese). Quantitative information is measured in terms of recommended daily servings for each group (e.g., gram, ounce, cup).

The number of food groups and the suggested servings vary depending on the country and the year of publication (e.g., Truswell, 1987; FAO, 1996; Painter, 2002; WHO, 2003). In the selected food diagrams the country with the largest number of food groups is Portugal, with eight groups. It is also the only country with distinct groups for Meat and Beans

(grouped together in all other countries) and to include a Fluid group within the main visual schema. The history of American food guidelines shows how the number of food groups has changed over time: from seven food groups in the '40s, to four groups in the '60s, to six groups in the '90s, and to five food groups in the 2005 system. It is relevant to mention that it is outside the scope of this article to analyze the appropriateness of the scientific data depicted. The focus is on the visual representation of health information.

Because the different countries are dealing with a similar problem—a system of food groups that involves food choices and quantities—the strategies used to depict the information are also very similar. The selected food graphics use spatial metaphors to represent information in a diagrammatic form.

Metaphors

Traditionally, metaphors are considered figures of speech "in which a name or descriptive word or phrase is transferred to an object or action different from, but analogous to, that to which it is literally applicable" (Oxford English Dictionary Online, 2007).

Recent studies in cognition and in linguistics, however, claim that "the locus of metaphor is not in language at all, but in the way we conceptualize one mental domain in terms of another" (Lakoff, 1993, p. 206). This new approach to the study of metaphors, was led mainly by George Lakoff and Mark Johnson, and introduced in their book *Metaphors We Live By* (1980).

Lakoff and Johnson (1980) contend that abstract concepts are metaphorically understood in terms of more concrete and typically spatial concepts. The role of metaphors in our conceptual system is

described as a mechanism: in order to grasp concepts that are abstract or not clearly delineated in experience, we use other concepts that are clear to us such as spatial orientations, physical experiences, known objects, etc. Metaphors are part of our conceptualizing processes and help us understand one domain of experience in terms of another.

This article uses metaphor as a "cross-domain mapping in the conceptual system" (Lakoff & Johnson, 1980; Lakoff, 1987, 1993) to analyze the food diagrams.

Visual representations of data

Visual representations of data have a long history and can take different forms, such as notation systems, maps, diagrams and other graphical inventions (e.g., Tufte, 1997; Tversky, 2001; Wainer, 2005). Independent of the medium, of data type and of function, all visualizations are spatial representations of data. They make use of graphic elements and properties to encode data into a schema. The visual schema can reflect knowledge schemata, the use of metaphors, or involve the creation of new models. The schema makes the system—elements and relations—and the patterns within the system readily visible, explicit and easily perceived.

Diagrams (in general) represent and communicate information in a way that is easy to perceive and to understand because they tend to exploit general perceptual and cognitive mechanisms effectively. Diagrammatic representations are dependent on visual perception for both their creation (encoding) and their use (decoding). Literature in visual perception explains that spatial properties (position and size) and object properties (e.g., shape, color, texture) are processed separately by the brain (Cleveland, 1994;

Kosslyn, 1994; Tversky, 2001). And that position in space and time has a dominant role in perceptual organization (MacEachren, 1995; Card et al, 1999). Central to informational schemas is the way data is indexed in space, how elements and relationships are graphically represented.

Meaning is conveyed by means of visual references, where the graphic elements and the graphic structure in a diagrammatic representation stand for elements and relations in another domain. Efficiency in conveying meaning will depend on how the visual description stands for the content being depicted, whether the correspondences are well defined, reliable, readily recognizable and easy to learn (Pinker, 1990).

Visual representations support visual spatial reasoning and they can serve as an effective interface between perception and cognition. They can be considered cognitive artifacts, in that they can complement and strengthen our mental abilities. Literature in Cognition and in Information Visualization (e.g., Bertin, 1967/1983; Norman, 1993; Ware, 2000; Tversky, 2001) suggests that the cognitive principles underlying graphic displays are: to record information, to convey meaning; to increase working memory, to facilitate search; to facilitate discovery, to support perceptual inference, to enhance detection and recognition and to provide models of actual and theoretical worlds.

If a dietary visual display is effective it will enhance reasoning and foster understanding of fundamental health guidance, thus facilitating good decision-making in daily food consumption, resulting in a healthier population.

Metaphors and dietary visual displays

Lakoff claims that "image schemas define most of what we commonly mean by the term 'structure' when we talk about abstract domains. When we understand something as having an abstract structure, we understand that structure in terms of image schemas" (1987, p. 283). Basic-level and image-schematic concepts structure our experience of space and they are used metaphorically to structure other concepts.

Two image schemas play a major role in the selected graphics: the container and the part-whole. Lakoff (1987) explains that these schemas are meaningful because they structure our direct experience, and in particular, our bodily experience. We experience ourselves as entities, as containers with a bounding surface and an in-out orientation. We tend to project this view onto other physical objects, events and actions and to conceptualize them as entities and most often as containers. The result is an act of quantification, in that we are defining territories, bounded areas, that can be quantified in terms of the amount they contain. We also experience our bodies as wholes with parts. We tend to use the metaphorical projection of part-whole configurations to structure other concepts. The structural elements of a container schema are: interior, boundary and exterior. The structural elements of a part-whole schema are: a whole, parts and a configuration. The configuration is a crucial structuring factor in the part-whole schema.

Because the parts can exist without constituting a whole, it is the configuration that makes it an image-schema. Lakoff explains that "we have general capacities for dealing with part-whole structure in real world objects via gestalt perception, motor

movement and the formation of rich mental images. These impose a pre-conceptual structure on our experience" (1987, p. 270).

All countries depict qualitative and quantitative information in enclosed shapes—containers. The choice of the container metaphor doesn't appear to be arbitrary. Containers are the most appropriate schemas to structure categories (Lakoff, 1987, 1993; Tversky, 2001). As observed earlier, all diagrams represent daily nutritional goals in the form of food groups. The food groups are represented in the system as sub-containers and also as parts of the part-whole schema.

What distinguishes the various diagrams is the source metaphor that structures the target domain of daily food intake. Australia (figure 1), Portugal (figure 2), Sweden (figure 4) and the United Kingdom (figure 3) use a circle that corresponds to a plate, a pie or even a pizza. The plate metaphor is depicted directly in the British diagram, where a fork and knife are placed on its sides. It is worth noting that we commonly call graphs that use a circle to structure quantitative data "pie graphs." Canada (figure 5) depicts a healthy diet using the rainbow metaphor. And, two countries use architectonic metaphors: a pyramid in the case of the United States (figures 7 and 8) and a pagoda in China (figure 6).

The food graphics can be divided into two groups: non-hierarchical and hierarchical informational structures.

Non-hierarchical schemas: circle and rainbow

The circle is universal and unspecific and it doesn't single out one direction. The attraction to the center creates a centric symmetry. Circles have been extensively used throughout the years as schemas in the

representation of both physical and nonphysical data. For example, wheels were the most common organizing form used in medieval manuscripts (Murdoch, 1984). These circular schemas were mainly used to display calendric, astronomical and cosmographic information. In other words, doctrines where information would fit well with the circular form.

The use of circular schemas to represent quantitative data is more recent. The "pie graph" as a graphical invention is attributed to William Playfair who devised and published a series of statistical graphs between 1786 and 1801 (Wainer, 2005). Pie graphs are among the most common displays of quantitative data nowadays, specially in mass media and business publications (Cleveland, 1994).

In the selected diagrams, circles are divided into segments that originate at the center and end at the edge. The segments are clearly bounded wedges, perceptually well segregated from each other as enclosed areas (sub-containers). In the Australian, Portuguese and British diagrams (figures 1, 2, 3) the wedges map both categorical and quantitative data. Each wedge stands for a food group and its area represents the recommended serving size. Each serving size is perceived in relation to the whole of a healthy daily diet (main container).

These three food displays use the same graphical method of encoding data as pie graphs. The advantage of using a familiar schema is that it helps comprehension by the general public. Research on the cognitive operations a person executes in the process of reading quantitative graphs indicates that "people create schemas for specific types of graphs using a general graph schema, embodying their knowledge of what graphs are

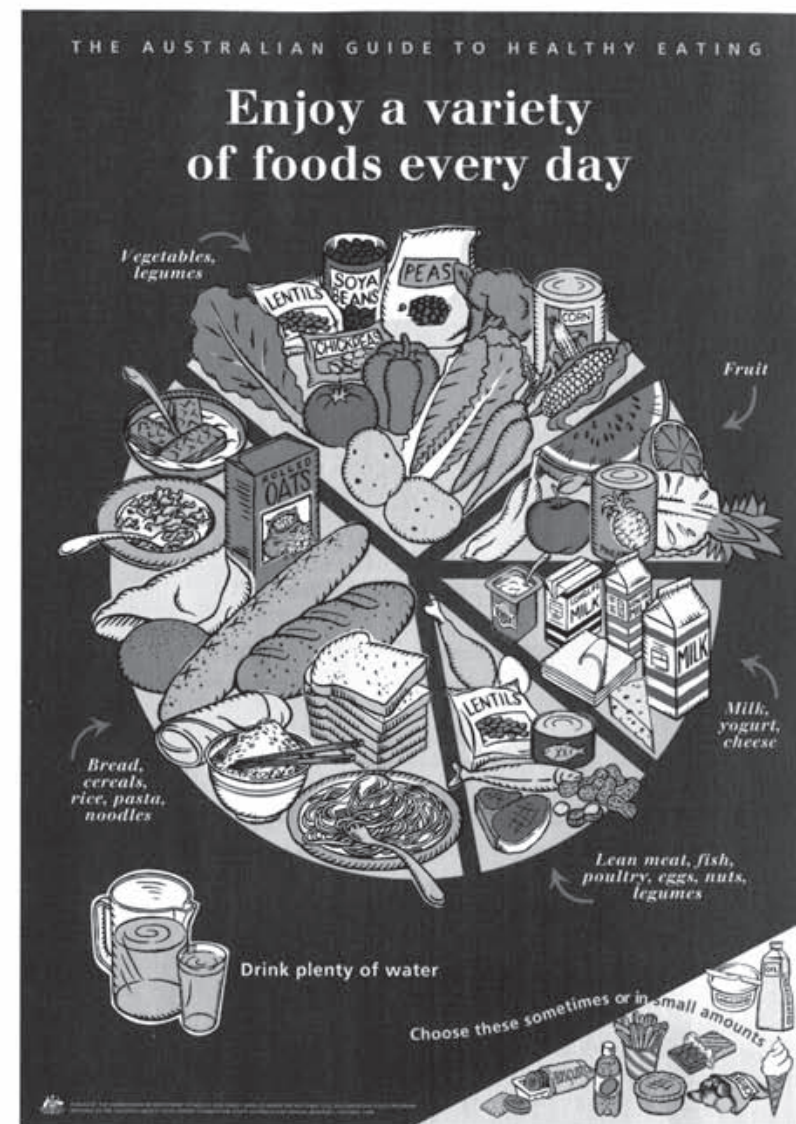


Figure 1 The Australian Guide to Healthy Eating, The Australian Government Department of Health and Ageing, Australia, 1998. Image © Commonwealth of Australia, reproduced by permission. Source: <http://www.health.gov.au>

Figure 2 A Nova Roda dos Alimentos, Direcção – Geral de Saúde, Portugal, 2004. Source: <http://www.dgs.pt>



Figure 3 The Balance of Good Health, The British Nutrition Foundation, UK, 2001. Image © British Nutrition Foundation, reproduced by permission. Source: <http://www.nutrition.org.uk>

Figure 5 Canada's Food Guide, Health Canada, 1997. Image © Minister of Public Works and Government Services Canada. Source: <http://www.hc-sc.gc.ca>



Figure 4 Swedish Food Circle, National Food Administration, Sweden, 2004. Image © National Food Administration, Sweden, reproduced by permission. Source: <http://www.slv.se>

for and how they are interpreted in general" (Pinker, 1990, p. 104, italics in original). Pinker suggests that the theory can be easily extended to diagrams used to represent qualitative information, where again, the reader would use schemas to mediate between perception and memory.

Pie graphs are good at conveying general information about proportions of a whole. Because our visual system tends to distort the dimensions of area sizes (Cleveland, 1994; Kosslyn, 1994, 2006), we cannot infer absolute amounts from the perception of the wedges. Area sizes represent relative amounts in comparison with each other and in relation to the whole. Kosslyn explains that "about one-fourth of graph readers apparently focus on relative areas of wedges when they read such [pie] graphs—which means that they will systematically underestimate the sizes of larger wedges" (2006, p. 39). The only country to provide labels with absolute amounts of recommended portions is Portugal.

It is through discrimination (same-different dichotomy) in early stages of object perception that elements and patterns are detected and ordered. Patterns are central to how visual information is structured and organized. Literature in perception and graphical methods (Cleveland, 1994; Kosslyn, 1994, 2006) explains that it is easier to detect patterns if categories are ordered. This principle complies with Lakoff's (1987) Form Hypothesis that linear quantity scales are understood in terms of linear order schemas. In the case of pie graphs, segments should increase circularly in a clockwise progression to enhance comparison of quantitative data (Kosslyn, 1994, 2006). The only diagram to conform—in part—to this rule is the Australian, where the food groups are ordered according to serving sizes.

It is worth noting that in the British diagram, even though the food groups are unordered, the configuration allows for easy comparison of relative serving sizes. The diagram uses the vertical axis as a main structuring divider to position food groups in an almost symmetrical relationship.

In the Swedish food graphic (figure 4) the wedges are all the same size; different from the previous three circular diagrams, this is not a pie graph. At first, familiarity with the general pie graph schema might impair the public's comprehension of the graph. The recommended serving sizes are represented by the amount of food entities depicted within each food group. It is clear that the Oil and Dairy groups have less food examples than all the others. However, actual differences in the data are not easily perceived and it is hard to infer relative amounts of food intake.

In all four circular diagrams, the source domain, a plate as a container that holds food, corresponds to the target domain, a healthy daily diet with recommended food choices. The metaphor of the plate is appropriate to structure the kinds of food and the servings for each category—"what" and "how much" to eat every day. However, in general, discrimination of recommended serving sizes is poor. Canada uses the rainbow as the source metaphor for its visual display (figure 5). A rainbow is an arch of colors. The schema has a meaningful configuration from which the basic logic of the metaphorical mapping follows. In the diagram each colored ring represents a food group. The rings are well defined enclosed areas, making the distinction between categories easy to detect. All rings have the same width. Quantitative values

are expressed by the radius of each ring in relation to the center of the main (invisible) circle, and can be detected by the length of the arcs. Food groups are ordered according to area size—from larger to smaller—enhancing perception of food consumption patterns. Groups follow a center-periphery schema, where the orientation maps amount of food consumption rather than categorical relevance. The smaller the arc, the least important the food group, and the types of food that should be least ingested.

It could be said that the rainbow schema is a variation of the circular schema, in that it uses the circle—in this particular case one-quarter of a circle—as the container. The difference is in the configuration: in the rainbow schema the circle is divided into rings in polar coordinates, rather than in wedges.

Hierarchical schemas: pyramid and pagoda

Pyramid schemas are used to map things or actions that are structured more or less in a pyramidal form. Examples we commonly find in language descriptions are of piles arranged with fewer elements at the top (pyramidal piles), social structures (social pyramids), the dubious building up of finances (pyramid schemes). In general, "up" is designated as more, better, good and so on (Lakoff & Johnson, 1980; Lakoff, 1987). Visual representations of hierarchical data have repeatedly used the pyramidal schema. A common use has been in what we call "tree diagrams," such as genealogical structures showing the lines of descent of a family.

The overall shape of the Chinese pagoda (figure 6) fits in a triangular schema of the same configuration as the 1992 American pyramid (figure 7). Similarity is also found in the use of architectonic structures as the metaphorical mappings. Pagodas are familiar and

common buildings in China, whereas pyramids are not particularly embedded in the American culture. (One could argue that Americans face a pyramid in their daily lives, in that a Masonic pyramid is printed on the one dollar bill. But that would be pushing a cultural concept a bit too far.)

In these two diagrams the triangular shape is used as the main container with the base coinciding with the horizontal axis with the apex opposite. The container is divided horizontally with food groups stacked on top of each other. The configuration follows an architectonic structure in which the base is larger so as to hold the upper levels. In this model, the lowest level food group could be considered the foundation for a healthy diet, in that it is the largest food group and represents the largest amount necessary for maintenance of a healthy body. If we look only at the representation of quantitative information, it could be said that the structure of the image-schema is preserved by the metaphor. The food groups are ordered according to quantitative values and facilitate detection of food intake patterns.

However, there is another mechanism which plays an important role in these diagrams: the up-down orientation mapping. Lakoff and Johnson (1980) contend that there is a coherence in this orientation, where up is mainly used to map concepts related to well-being (e.g., happy is up, health is up, alive is up, good is up) and to power (e.g., control is up, status is up). In these diagrams, the Fat (or Oil) group is at the very top and could be interpreted hierarchically as the "best."

Lakoff's Invariance Principle hypothesizes that "metaphorical mappings preserve the cognitive topology (that is, the

image-schema structure) of the source domain, in a way consistent with the inherent structure of the target domain" (1994, p. 218).

The 1992 pyramid and the pagoda diagrams are well suited for the depiction of the quantitative values of food intake, but not the best schema to represent the reversed hierarchy in food consumption. The hierarchical mapping conflicts with the quantitative organization of the data to such an extent that it violates the inherent structure of the target domain. This would not be the case, for example, if the triangle was rotated 180 degrees with the vertex at the base line.

While the majority of health and nutrition experts condemned the food pyramid, hierarchy was one of the few aspects of the 1992 graphic that they applauded (Harvard University, 2006). When the Harvard School of Public Health redesigned the food graphics to reflect their scientific research, they maintained the pyramid image-schema as the container with a hierarchical configuration (Harvard University, 2006). It is worth noting that the 1992 pyramid became "the most widely distributed and best-recognized nutrition education device ever produced in this country. The Pyramid now is an icon" (Nestle, 2002, p. 65).

The 2005 pyramid (figure 8) uses a very different configuration: the main container is divided into triangular sections that start at the apex and end at the base. The up-down orientation is obliterated. The result is that the 2005 pyramid is a non-hierarchical schema that could be grouped with the non-hierarchical schemas discussed above. It was kept here for easy comparison between the two pyramid versions.

The 2005 pyramid is the only graphic to depict examples of recommended food choices outside

the food groups that they stand for. This spatial arrangement violates the schema's inherent structure. Recall that the logic is that interiors will be mapped to interiors, and so on. Both the pyramid and the food groups stop functioning as container metaphors. Detection of what food entity belongs to what group is also impaired, mainly because they all seem to be clustered and spatially associated. The Gestalt Principle of Proximity (Wertheimer, 1923/50) states that we tend to group into a perceptual unit visual elements that are near one another.

Several factors hamper understanding of food intake patterns in the 2005 pyramid. First, the food groups are not arranged in any specific order. Second, the area sizes vary only slightly and actual differences are not easily perceived. The food depictions also effect the perception of area sizes, in that they obliterate the visibility of the base of the triangles. Finally, there is a conflict between how proportionality is conveyed in the diagram and in the rectangular bands carrying the names of food groups at the bottom of the display. All the rectangles have equal areas and as such carry no information in terms of proportionality. Research in cognition has shown that we "are impaired when the two messages, that from the physical stimulus itself and that from the meaning, conflict. The brain attempts to fit all inputs into a single coherent pattern and balks when there is a conflict" (Kosslyn, 1994, p. 8).

Soon after the release of the 2005 pyramid, a series of alternative diagrams appeared in major media vehicles in the US. The newspaper *USA Today* (2005) and the web magazine *Slate* (2005) were among those that invited well known designers to discuss and respond to

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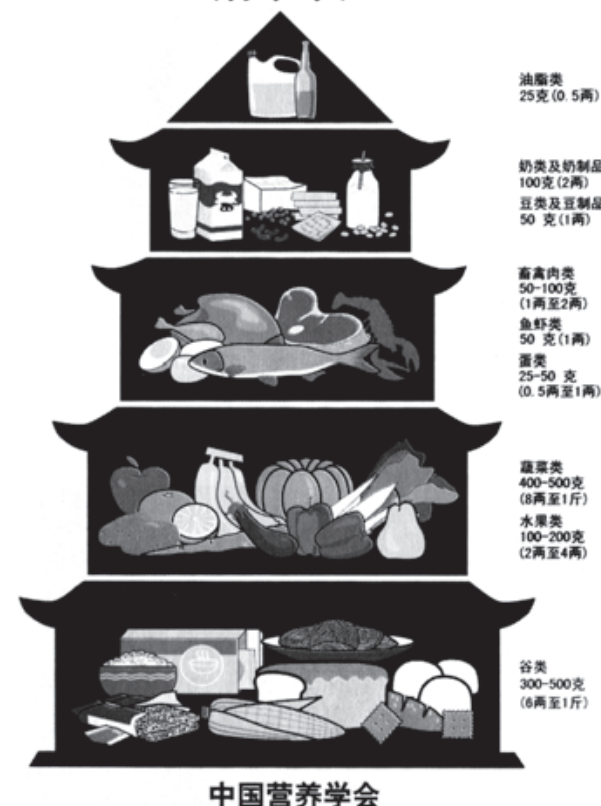


Figure 6 Balance Dietary Pagoda. Image © Chinese Nutrition Society, China, 1997. Source: <http://www.cnsoc.org>

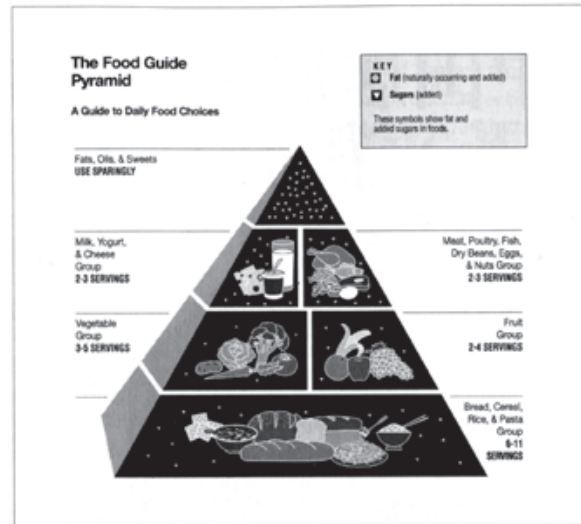


Figure 7 The Food Guide Pyramid, U.S. Department of Agriculture, Center for Nutrition Policy and Promotion, USA, 1992. Source: <http://www.cnpp.usda.gov>

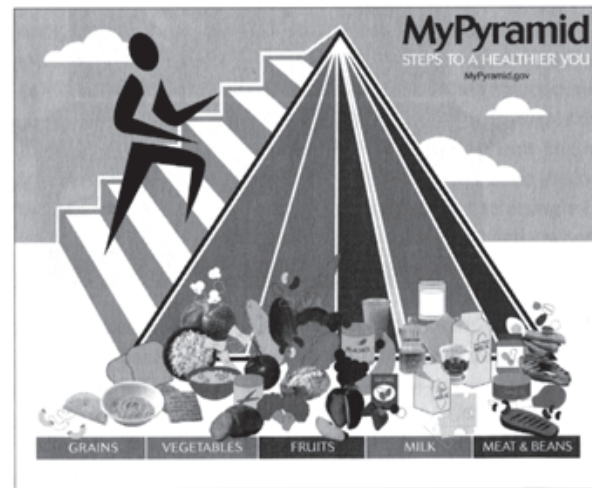


Figure 8 MyPyramid, U.S. Department of Agriculture, Center for Nutrition Policy and Promotion, USA, 2005. Source: <http://www.mypyramid.gov>

the controversial display. It would take another article to analyze these diagrams which included graphics by Roger Black, Nigel Holmes, Visual i/o among others. But it is worth noting that five of the nine diagrams reproduced in the two articles used circular schemas, of which three maintained the compound of whole-part and container image-schemas and the remainder represented isolated food groups without a main container connecting them. Finally, only Black represented data in a typographical inverted pyramid schema (base at top).

Conclusions

This article investigated the use of metaphors in the visual representation of dietary information. Metaphor was used not as a figure of speech or poetic expression, but rather as a cross-domain conceptual mechanism. Lakoff's theories on metaphor and categorization were used to scrutinize the visual displays. The article investigated the correspondences between source and target domains and whether the structure of the source domain was projected onto the target domain in a consistent way.

The study of the selected food diagrams showed that:

- ▲ The target domain—a healthy diet with food recommendations—was not inherently visible and required the use of metaphor to structure the information.
- ▲ The concrete (and in some cases cultural) experiences of physical space served as source metaphors.
- ▲ Three metaphors were used as source domains: the plate, the rainbow and the building (pyramid and pagoda).
- ▲ Two metaphorical mechanisms played a major role in structuring the target domain: image schemas and orientation mappings.
- ▲ A compound of two

image schemas was used to structure information: the container and the part-whole.

- ▲ Information was structured in three levels: 1) the whole: representing the daily food recommendations as the main container; 2) the parts: sub-containers standing for the categories (food groups) with associated quantitative values; 3) the individual entities of food choices: standing for prototypical examples of the food categories they represent.
- ▲ Orientation mappings played a role in three displays: the up-down (in the 1992 pyramid and pagoda diagrams) and the center-periphery (in the rainbow diagram).

- ▲ Conflicting metaphors were used to structure data in the hierarchical schemas causing interpretation problems: "up" meaning good or healthy (qualitative data), as opposed to "up" meaning the least recommended amount (quantitative data).
- ▲ Previous experience with graph schemas, especially in relation to "pie graphs" played a role in graph comprehension (note difficulties in relation to the Swedish display).
- ▲ The depiction of food entities in the 2005 pyramid violated the inherent structure of the container metaphor.
- ▲ In most graphics, detection of recommended serving sizes was impaired, which affected the perception and cognition of food intake patterns.

Several issues remain to be investigated with respect to the visual representation of dietary information, including the study of how the visual displays are being interpreted and used by their target audiences. Important graphical methods used in the representation of nutritional data were also not analyzed here.

For example, the color code systems used to differentiate food groups, the graphical vocabularies used in the depiction of food entities and the verbal information provided in titles, labels and captions.

To conclude, I would like to suggest that metaphorical mappings are essential mechanisms in diagrammatic representations of information. It is possible to argue that visual/spatial representations of abstract (not inherently visible) domains rely extensively on metaphorical correspondences and orientation mappings.

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