Visualizing Food Ingredients for Children by Utilizing Glyph-Based Characters

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ABSTRACT

We present a system for visualizing food ingredients with a glyph-based approach aimed at children between the ages of four and eight, approximately. The intention is to visually explain and to visually argue that a certain food a child is eager to eat is healthy or, more often, is not healthy. Therefore, we introduced two comic-like characters whose shape and features depend on the main ingredients of food products. These characters can be directly displayed on a parent's smartphone by scanning the barcode of a food product. Our study showed that children are able to recognize several ingredient manifestations encoded as visual attributes and thus to consider a food product as being healthy or not.

Categories and Subject Descriptors

H.5.2 [**User Interfaces**]: Graphical user interfaces

General Terms

Design, Human Factors, Theory, Verification

Keywords

Information Visualization, Glyph-based Visualization, Visualization for Children, Character-based Visualization

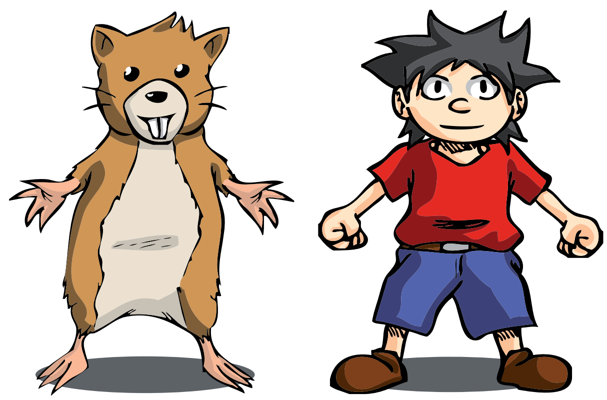

Figure 1: The two characters in their ideal shapes, where every main food ingredient (sugar, fat and salt), as well as caloric intake, are consumed as recommended.

1. INTRODUCTION

Malnutrition is a changing term. In the past it meant (and in some areas of the world it still means) poor nutrition and undernourishment. However, in the first world, as well as in some emerging countries, malnutrition has become a synonym for overnutrition. The average weight of children in industrial nations has been continuously rising during the past four decades (see [5]). In light of the increasing probability of secondary diseases that accompany overnutrition and obesity, such as cardiovascular diseases, diabetes and cancers, this appears as one of most serious health problems at the present time (see [6] for further information). Children should be enlightened about certain food products, their ingredients, and their possible health consequences. However, the reading skills of children between those particular ages are usually not fully developed. Even if a child can read quite fluently, it is one thing to read a sequence of words and another to recognize and immediately understand complex information contained in several tables printed on the packages which contain different values normalized by different weights and calculated as percentages. For gaining access to this information in a visual and light-hearted manner depicted on the parent's smartphone, we developed a comic-like visualization based on glyphs to inform children what is inside the food they want to eat.

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2. RELATED WORK

The so-called Chernoff Faces [1] were introduced to take advantage of human sensitivity with respect to recognizing facial characteristics. Different features, for example, eye size or nose length, were utilized to map different attributes of a data set. In the original approach, up to eighteen attributes were mapped, which is a number that we do not believe is applicable for children. In our opinion, a convincing application of Chernoff's concept is the map by Dorling [2], which surveys the social and economical differences in the United Kingdom with four different visual attributes. Picket [3] proposed the usage of stick figures to generate textures. This glyph is a 2-dimensional figure with 4 arms which encodes data in their length and the angle to the main axis. Together, several stick figures form a texture. Spence and Parr [4] used miniature house icons to encode eight attributes of houses purchases. Their study revealed significant time savings of such direct metaphorical icons over textual descriptions for choosing an appropriate estate. A common concept for visualizing nutrition values is related to traffic lights, which is used by several organizations. The amount of nutritional value in food is measured against recommended values. The chosen nutritional values (fat, saturated fats, sugar and salt) can receive the following labels: *red*, if the amount is high, *yellow*, if the amount is moderate and *green*, if the amount is low.

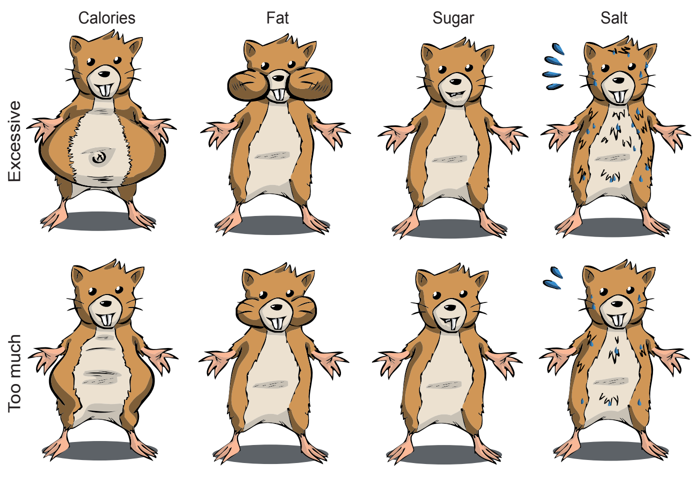

Figure 2: Attribute manifestations of the hamster character. The baseline manifestations for each attribute can be seen in Figure 1.

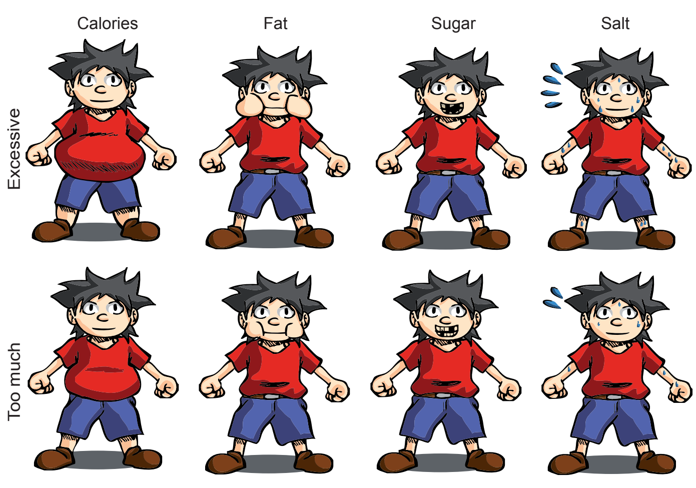

Figure 3: Attribute manifestations of the kid character. The baseline manifestations for each attribute can be seen in Figure 1.

3. VISUAL APPROACH

Starting with a premature idea, we defined certain requirements for visualizing information for kids.

- The visual approach must be easy to recognize. Abstract visualizations like parallel coordinates cannot be applied. A glyph-based depiction might be appropriate for children.
- The visualization itself must be child-oriented and therefore appealing to kids. In our case, the child should be able to recognize that the picture could be a depiction of himself (herself) or he (she) should be concerned about what the graphics illustrates.
- The density of information that we would like to visualize should not be too high. We want to focus on the most important information children are able to recognize.
- Maybe most important: It should be educational, but it must also be fun to play with so a child is inclined to do it again.

Based on these requirements, our idea matured and we developed two comic-like characters. The first one represents a kid (Figure 1 right) that is intended to act as mirror for the children: "If I eat this a lot, then I'm going to look like the kid on the display." The second character, a hamster (Figure 1 left), acts as a metaphor for a critter or a stuffed animal, a small, cute toy a child cares about. "The little hamster shouldn't eat this product so often because he is gaining so much weight. Maybe I shouldn't eat it, either." From early on, we focused on a small set of values to be displayed by the characters. We decided to map the four most relevant health-concerning data (general caloric intake, amount of sugar, fat and salt) in a particular food product to different attributes of the character (see Figures 2 and 3, see also Figure 1 for the ideal shape).

1. The overall number of calories is mapped to the size of the belly. It bulges out if the caloric value is higher than recommended. Even further, if the contained constituents are extremely high-caloric and the intake becomes excessive, it eventually results in an obese-looking belly (see first columns). The entire caloric intake is the most important attribute, regardless of whether it comes from fat, sugar or proteins. Therefore, it is so dominantly depicted and somewhat integrates and emphasizes information that can also be seen in other attributes, such as the amount of sugar or fat.
2. A similar approach is used to map the amount of fat contained in the product by the roundness of the cheeks. They become rounder if the share of fat increases and they become really thick if the fat share is far too high (see second columns).
3. The amount of sugar is linked to tooth decay. Originally, the hamster has two teeth. He loses one if the amount of sugar increases to a more than moderate level of consumption. The second tooth vanishes, too, if the food product contains an excessive level of sugar. The kid's teeth get cavities and fall out with an increasing amount of sugar intake. Eventually, only stubs remain for excessive intake (see third columns).
4. The value of salt can be seen in terms of whether the figure is sweating or not. Additionally, the salt intake is shown by the hamster's fur. The healthier it looks, the less salt is contained in the food product (see fourth columns).

Although it was theoretically possible to directly map the values to a character's attribute, we chose to simplify it further in order to present more distinctive shapes to the children. We quantized each value's range into three categories: the recommended amount, too much and excessive concentration contained in the food product.

4. TOOLCHAIN

The toolchain is built upon on a web-service which assembles and delivers a visualization according to a certain food product. Therefore, the client application on a smartphone only needs to take a picture of the barcode, detect the EAN (European Article Number) and submit it to our web-service. The ZBar library [7] is used for detecting and converting the barcode. The information of every EAN the web-service does not know is requested and extracted on the fly from topic-related websites. The gathered information is cached for recurring requests. Based upon the ingredients contained, the values are ranged and transferred into an SVG path for every visual attribute. The single paths are assembled, scaled, and delivered to a web-based panel embedded in the client GUI.

5. CHILDREN'S FEEDBACK AND STUDY

We gathered feedback at certain stages of the development from children at the target age. Their opinions heavily influenced the shape and appeal of the comic characters. For example, the belly and the cheeks of the characters were intended to be smaller even for high values of calories and fat, which was why the characters were not designed to look grotesque. The children, however, told us otherwise. They insisted the shapes were too small for the highest and the middle values and encouraged us to enlarge them.

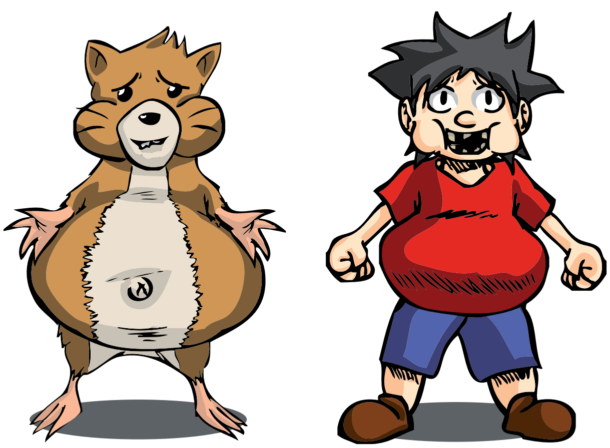

Figure 4: Both characters visualizations generated for a 100g chocolate bar: the biggest bellies for the excessive caloric intake, inflated cheeks for too much fat and the worst kind of tooth decay for an excessive amount of sugar. The lack of perspiration shows that the amount of salt is not an issue.

We performed a study to see how well the children understand and enjoyed our concept. We wanted to know how distinguishable the three visual manifestations of a value range are, which misinterpretations might occur, why they occur, which character the children prefer more, which character is more descriptive to the children and how the results vary in recognizing the different attributes between the characters. Ten children between the ages of 6 and 8 participated in the study. For the test, an iPhone 4 with retina display was utilized to analyze the food products and to display the visualization accordingly. Parental consent was properly obtained for all children. Prior to the study, the children were introduced to both characters, as well as to the visual attributes for caloric value, fat, sugar and salt and their particular manifestations by showing and explaining the Figures 1, 2 and 3. We showed them 8 different food products one by one, along with the corresponding comic characters shaped according to the contained constituents. The food products were selected for variety. An example can be seen in Figure 4. Every manifestation of every visual attribute appeared at least once. One healthy example, where all values were ideal, was also included. For every food product, the children were asked to conclude whether they consider the foods as being healthy, unhealthier or not healthy at all (totally unhealthy) based upon the attribute manifestations they saw on the comic character. Mostly, the children pointed out at least two ingredients their decision was based on. Often attributes that showed the too much or excessive manifestation were mentioned, but not for every one. In case they only responded by simply pointing out the attributes without further explaining the manifestations, they were asked for the manifestations. The visual attributes that were not mentioned of their own accord (meaning spontaneously by the children) were expressly inquired into. The children were separated in two groups, both alternating the hamster and the kid consecutively. Group A started with the hamster for the first product, then continued with the kid for the second product, then the hamster again and so forth. Group B did the same, but starting with the kid.

Table 1: Absolute number of mismatches (in brackets number of possible matches for 5 children in every group and hence 10 overall) along with percentage of positive matches (boldface)

Character	Calories Belly	Fat Cheeks	Sugar Teeth	Salt Trans-piration	Overall
Hamster	3 (40) **92.5%**	3 (40) **92.5%**	0 (40) **100%**	0 (40) **100%**	6 (160) **96.3%**
Kid	10 (40) **75.0%**	3 (40) **92.5%**	3 (40) **92.5%**	0 (40) **100%**	16(160) **90.0%**
Overall	13 (80) **83.8%**	6 (80) **92.5%**	3 (80) **96.3%**	0 (80) **100%**	22 (320) **93.2%**

We observed that the children enjoyed the test very much and were very concentrated, at least until the sixth food product. Despite that, the latter two characters did not show significantly more mismatches. Every child had to recognize and to consider 32 attributes with 3 possible manifestations each. Over all children, the average error rate of attributes that were incorrectly assigned was 2.2, which yields a rate of 93.2% of positive matches over all visual attributes of all food products and participants. This was a very encouraging result. Group A yielded better results (mean of mismatches 1.0) than group B (mean of mismatches 3.4), although the distribution of age was nearly equal and both groups utilized both characters equally often (just in another order).

If one considers the characters themselves, one can see that mismatches with the kid character occur three times as often as with the hamster (Table 1). A look at the visual attributes in detail reveals that most errors occur while considering the belly of the kid (as well as the hamster, but also three times as often). The second most mismatches arose when the children considered the cheeks of both characters, although the rate of positive matches is above 90%. The misinterpretation of these attributes was somehow surprising, especially since we performed the test with previously enlarged shapes of both attributes. However, there is still some potential to exaggerate the manifestations for too much and for excessive further and for facilitating the discriminability of the kid character better (and maybe of the hamster, too). No mismatches were received at all for the manifestation of salt, which we originally found to be the most abstract of all visual attributes, nor for the appearance of the hamster's teeth. It seems that it is easier for the children to assess visual attributes that are instantly recognizable (maybe somewhat countable in our case) than to consider a more vague physical impression such as tooth decay of the kid character or different shapes and sizes of a belly. Furthermore, all children assessed our positive example as being healthy. Even more, all of them correctly recognized all four positive manifestations. Generally, one can say that the children are able to distinguish between three manifestations, as well as to say whether a product is healthy or not. However, it seems that identifying a product as being “unhealthier” or “not healthy at all” based upon several manifestations is not so easy for them, which is why the results vary respectively. All children preferred the hamster over the kid. The most mentioned concern was that the kid’s trousers do not rip open if the kid’s belly became larger. Although the study had limitations regarding the sample size and an appropriate control group (maybe, the traffic light approach or the information in textual form), it allowed us to obtain an impression of how well children respond to a child-oriented glyph-based visualization.

Figure 5: The bar code of the chocolate bar is evaluated by the smartphone, the EAN is sent to our web service and the corresponding hamster visualization (see also Figure 4) is immediately shown on the display. The wrapping was removed to anonymize the product.

6. CONCLUSION AND FUTURE WORK

In this paper, we presented a prototype for visualizing food ingredients suited for children. This new kind of glyph-based approach depicts two comic-like characters whose shape and features depend on the ingredients contained in a food product. Their purpose is to visually explain how healthy or unhealthy a food is and why it is so. The application is intended to support parents while explaining that a particular food product is not wholesome for their kids. With a parent’s mobile device, the barcode of a food product can be scanned and the resulting character displayed (see Figure 5). It could be a more playful way to argue with a small child at the checkout counter in a supermarket since he/she can herself consider a food product as being healthy or not without having to read the package.

Our study showed that children between ages 6 and 8 (after being briefly taught about the visual concept) are able to quite reliably recognize three ingredient manifestations encoded as visual attributes in one character and to draw conclusion regarding the health consequences. Furthermore, we realized that it is important to significantly exaggerate the visualizations and use only few quantization steps to encode the ingredient values. It also became clear that one must not be afraid of using less obvious mappings such as representing the amount of salt by a number of sweat drops. Even more so, the children could easily differentiate between no, few and many sweat drops. whereas the size and shape of the belly or the cheeks were harder to differentiate. This is an indication that attribute mappings which visually relate to the actual attribute but use also countable glyph manifestations facilitate the interpretation for children, e.g. rather than just increasing the belly size of the hamster, it should also wear a segmented belt around its belly.

Although, the study was performed with children between 6 and 8, the low rate of mismatches and hence the very good results indicate the concept is also applicable to younger children, likely with higher error rates. In general, it would be interesting to know how many features with how many manifestations a child is ultimately able to cope with. More studies are needed for this purpose, most likely, with more precise delineation of the children’s ages. A longer term observation might reveal some interesting aspects in how this kind of visualization actually influences the children’s behavior. A similar approach, less playful maybe, could be of use for illiterate people worldwide, no matter the age. Similar to Chernoff, taking facial expression into account could also improve our approach. We also did some designs for a female character, which will appear later on. A more specific idea is to utilize the hamster’s fur for displaying contained food chemicals instead of using it as an additional remark for salt. Furthermore, we would like to display information as to whether the food is raised or manufactured by certain organic guidelines or seals. Nevertheless, we think that designing and developing a visualization particularly aimed at children is very enjoyable and also very meaningful, which is why this topic should gain more attention than it has received in the past.

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