Learning about good nutrition with the 5-color front-of-package label “Nutri-Score”: an experimental study

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ABSTRACT: The Nutri-Score is a 5-color front-of-pack nutrition label designed to provide consumers with an easily understandable guideline to the healthiness of food products. The impact that the Nutri-Score may have on consumers’ choices is unclear since different experimental paradigms have found vastly different effect sizes. In the present study, we have investigated how student participants change a hypothetical personal one-day-dietary plan after a learning phase during which they learn about the Nutri-Scores of the available food items. Participants were instructed to compose a healthy diet plan in order that the question of whether the Nutri-Score would improve their ability to compose a healthy dietary plan could be investigated, independent of the question of whether they would apply this knowledge in their ordinary lives. We found a substantial ($d = 0.86$) positive impact on nutritional quality (as measured by the Nutrient Profiling System score of the Food Standards Agency) and a medium-sized ($d = 0.43$) reduction of calories. Calorie reduction was larger for participants who had initially composed plans with higher calorie-content. The results suggest that the Nutri-Score has the potential to guide consumers to healthier food choices. It remains unclear, however, whether this potential will be reflected in real-life dietary choices.

Keywords: Nutri-Score; Front-of-package label; Nudge; Nutrition; Health

1. Introduction

High-, middle- and low-income countries struggle with the implications for health of an environment that fosters unhealthy eating. Countermeasures are urgently needed, since an estimated 11 million people die each year from poor diet [1]. Although this number includes people who die from insufficient food, the majority of diet-related deaths afflict people who have access to sufficiently healthy food and could improve both their life expectancy and well-being if they chose to eat more healthily. Worryingly, this state of affairs appears to be worsening. Obesity rates are increasing, diet-related health issues, such as food intolerances are becoming more frequent and the so-called obesity pandemic is spreading increasingly from high-income western industrial nations to low-income nations [2,3]. This development is likely to have resulted from the evolution of dietary decision-making mechanisms in an environment where food was scarce, costly and/or risky to
acquire, and raw. The minds shaped in this kind of environment are now faced with a situation where food is abundant, cheap, risk-free to acquire and highly processed.

1.1 The future of nutrition – from bad to worse?

A negative trend in nutrition-related health issues has been observed for more than four decades [4]. Few policies, however, have been successful in counteracting the detrimental impact of today’s environment (termed “obesogenic” by some researchers [5-7]). This is due, in part, to the manifest economic interests of the food industry. Analogous to the massive disinformation campaigns run by the tobacco industry in the 1960s [8] and the associated lobbying efforts [9], food producers have lobbied intensively to influence official communication regarding their products [10]. Furthermore, food producers are both able and incentivized to contribute to a health-detrimental environment [11,12]. Marketing departments devise strategies to make products appealing to consumers through attractive packaging and appetite-inducing visuals, or by employing packaging designs that consumers associate with healthfulness [13-18]. The layouts of supermarkets are optimized by consumer psychologists to maximize spending and therefore consumption [19-21]. “Supersizing”, i.e. offering substantially larger portion sizes for marginally higher prices, increases vendors’ sales but leads to overeating [22]. Products designed for children are higher in sugar than those for adults, contributing to the formation of unhealthy eating patterns during a life phase that is particularly conductive to the shaping of future habits and preferences. [23]. This is reinforced by marketing targeted specifically at children [24,25]. Food producers disingenuously link attributes commonly associated with healthy food, such as high vitamin or milk content, to calorie-rich, nutrient-poor products, confusing consumers and impeding the development of dietary competency [26].

1.2 A lack of reliable intervention strategies

The deleterious influence exerted by the food industry is compounded by a lack of successful public policies and by a marked absence of strategies that have proven effective in combating unhealthy nutrition, particularly in the long term. At an individual level, calorie-restricted diets have been found to have long-term effects only in a minority of dieters [27,28], and may even lead to rebound effects [29] and hamper weight loss maintenance by reducing dieters’ resting energy expenditure [30]. Offering healthier options in canteens is also often met with limited acceptance by patrons. The challenge of devising measures that reliably improve nutrition therefore remains to be effectively addressed.

From a decision-making point of view, there are essentially two competencies that are required to eat healthily in an environment where both healthy and unhealthy food options are freely available. First, consumers need the knowledge to identify healthy and unhealthy options. Second, consumers need the self-control to act on their knowledge and to choose healthy options, even if unhealthy ones appear more palatable.

Neither of these competencies can be taken for granted. Overweight and obese people have been found to struggle even with the task of estimating the quantity of food they consume on a given day [31]. Furthermore, sapping people’s self-control in an experimental setting has been found to increase consumption of unhealthy
snacks, demonstrating the importance of this factor for eating behavior [32]. It should be noted that the existence of the latter effect (so-called ego depletion) is the subject of considerable controversy [33].

On the basis of these considerations, there are at least three approaches that may be attempted — with varying degrees of anticipated success — by policymakers seeking to improve the nutrition of the general public. First, they may endeavor to improve public knowledge regarding nutrition. Second, they may strengthen self-control, e.g. by offering programs that utilize psychological effects, such as peer pressure, or by banning tactics employed to weaken self-control, such as the placement of pester power items in supermarkets. Third, they may re-structure the environment in which dietary decisions will be made differently, so that consumers are led to make healthier choices without being consciously aware of this (the “Nudge” approach [34]).

1.3 The Nutri-Score front-of-package label

A relatively novel approach to improving nutrition is the so-called Nutri-Score [35], a front-of-package label categorizing food products into five color-coded levels of nutritional quality. High-quality food is marked by a dark green label “A”, while low-quality food is indicated by a bright red label “E”. The classification of food items into these five levels is based on the nutrient profiling system (NPS) score by the Food Standards Agency (FSA). The NPS score is intended to represent nutritional quality on a fine-grained scale ranging from –15 (best possible score) to +40 (worst possible score). The NPS score grades the energy, sugar, saturated fat and sodium content of a food item with a negative value, while fruit, vegetables, legumes, fiber and protein are given a positive value. The Nutri-Score translates this fine-grained scale into its more coarse five-color scale by defining cutoffs on the NPS score, which are separate for food and beverages.

Several European countries, including France, Spain, Italy and Germany have passed laws that allow food producers to print the Nutri-Score on the packaging of their products (such laws are necessary due to rather strict legislation limiting what may and may not be printed on food packaging). Some food companies have already started adopting the Nutri-Score, sometimes leading to a division within lobby groups, as some companies endorse adoption and others resist it.

The way in which the Nutri-Score may improve nutrition is not entirely clear as it combines aspects of all three approaches considered above. Its most obvious function is to improve consumer knowledge by providing an easy-to-understand guideline on food healthfulness [36]. The colorful visual design of the label could, moreover, act on a more visceral level, warning of unhealthy food with a bright red signal and guiding choices towards the soothing greens of healthier options, thus acting as a booster for consumer self-control in situations of temptation. Lastly, the coarseness of the Nutri-Score scale may induce food producers to change their recipes to obtain an improved score for their products, thus contributing to an overall healthier food choice environment.

During its development, the Nutri-Score was examined in numerous studies. Of several alternative systems, it was found to be both the easiest to understand and the preferred system for the majority of consumers. While an easy-to-understand system is clearly desirable, the primary measure in assessing the
value of the Nutri-Score must be its ability to influence, and consequently improve, food choices. An elaborate study by Julia et al. [37] casts doubt on the ability of the Nutri-Score to achieve this. The authors constructed a building realistically resembling a supermarket and invited people who were on their way to go shopping to buy some of their groceries in this controlled environment. Displaying the Nutri-Score on the available products and providing information leaflets on how to utilize the label had no significant effect on the overall nutritional quality (as measured by the NPS score) of the food items in the shoppers’ baskets at checkout and led to only a small improvement for sweet biscuits (Cohen’s $d = 0.3$). Field studies of the effect of other kinds of labels have also revealed little substantial effect on purchases [38,39].

The apparently limited impact of the Nutri-Score and other front-of-package labels on actual food choices suggests that policymakers should not rely on these measures to win the battle for healthy eating. Nevertheless, some benefits may be reaped from an understanding of the reasons underlying this lack of efficacy. The ascertaining of which mechanisms of consumer choice are affected by the Nutri-Score and which are not may facilitate the development of more effective measures. Alternatively, auxiliary measures that boost the effectiveness of the Nutri-Score may be established.

In the present study, we examined whether the Nutri-Score can help consumers improve their knowledge and their ability to compose a healthy diet. This question is independent of whether improvements in knowledge would be applied when making real choices. We aimed to separate these two aspects. As we were interested in the improvement of individual knowledge, the participants were required to learn about the healthfulness of food products in a learning phase, rather than being provided with the Nutri-Score while choosing food items.

**2. Methods**

**2.1 Participants**

A total of 115 German student participants were recruited for the study by student experimenters (77 females, 38 males). The participants received course credit for participation.

Due to the recruitment of volunteers by the experimenters among relatives and acquaintances, the age distribution was bimodal around the ages of their own peer group (around 21 years) and of parents and other older relatives (around 50 years). Mean age was 34.1 years (standard deviation 17.8 years, range 18–84 years, 25%-quartile 21 years, median 24 years, 75%-quartile 51 years).

**2.2 Material**

One hundred food and drink items were selected as stimuli for all stages of the experiment. The items were selected with a view to covering a broad range of typical German foods, including vegetarian and vegan food items. The items covered four categories: breakfast (30 items, e.g. bread rolls, sliced meat, cereal), beverages (20 items, e.g. water, sodas, coffee; also including milk and hot cocoa, although those are classified as liquid food by the FSA), main dishes (30 items, e.g. stews, pizza, vegetable mix; including soups and salads; mainly sampled from the catalogue of a provider of frozen food), and snacks and desserts (20 items,
e.g. chocolate, yoghurt, fruits). Full-fat milk was available in two portion sizes, 200 and 50 mL, to allow participants to select it both as a drink and an add-on to their coffee or tea. The Nutri-Score and nutritional contents of each item were retrieved from the producer’s catalogue or the website openfoodfacts.org.

2.3 Procedure

Participants underwent the experiment in individual sessions with only the experimenter present. The procedure was identical for all participants. First, they filled out a questionnaire providing personal information and answering several questions regarding eating and health habits. They then worked on three tasks sequentially, the diet plan at t1, the learning phase and the diet plan at t2. The entire experiment lasted approximately 45–60 minutes.

2.4 Diet plan at t1

Participants were seated at a table and received a written instruction to compile a plan for a healthy and palatable diet for a single day. They were presented with 100 full-color cards approximately 6 cm × 7 cm in size, each depicting a food or drink item along with its designation (e.g. “Ham”) above and information regarding the portion size (e.g. “Slice (= 20g)”) below. They were free to choose as many items from the set of cards as they wished and could indicate a desire to include multiples of the printed portions by adding post-it notes to the cards. During the entire time, the experimenter was available to answer questions. When participants indicated that they were satisfied with their selection, the experimenter photographed the diet plan and asked them to proceed to the learning phase.

2.5 Learning phase

In the learning phase, participants were seated in front of a standard laptop computer. Instructions were presented on the screen, but participants were free to ask the experimenter for clarification at any time. In the instructions, participants received rudimentary information about the Nutri-Score and which nutritional information is considered in its calculation. They were instructed that they were to judge which of the five Nutri-Score levels corresponded to a given food or drink item. The laptop’s keys “A”, “D”, “G”, “J”, and “L” were marked with stickers in the colors of the five Nutri-Score levels and labeled with the corresponding letters A through E (from left to right). The items were presented centered on the screen with their designation above but no information regarding portion size (which is irrelevant for the Nutri-Score). The presentation continued until the participants indicated their choice of answer by pressing one of the marked keys. The participants were then shown the correct Nutri-Score symbol for the item for one second, centered on the screen, before the next item was presented. The learning phase began with six trial runs using items not utilized in the diet plan tasks. When the participants indicated that they had no further questions following trial runs, they underwent 99 trials using the target items (full-fat milk was only presented once, although it was available in two portion sizes for the diet plan tasks). The sequence of items was randomized for each participant. Participants could self-pace the learning phase and take breaks whenever they wished. When participants were finished, the experimenter asked them to complete another iteration of the diet plan task.
2.6 Diet plan at t2

The second diet plan task proceeded in the same form as the first. The same food items were made available, and participants were informed that they were free to compose the same plan as they had in diet plan t1 if they so wished.

2.7 Calculation of nutritional quality

The main outcome measure for nutritional quality in this study was the average NPS scores of the diet plans. First, the FSA NPS score for each food and drink item was calculated from its nutrient composition. Next, each diet plan’s NPS scores for liquids (beverages and liquid food, i.e. all items for which nutrients are listed per 100 milliliters) and solid foods (all items for which nutrients are listed per 100 grams) were calculated. Within the two categories, the NPS scores of the items were averaged and weighted by amount (grams or milliliters). Finally, the simple average of the liquid and solid NPS scores was calculated to arrive at a final “average” NPS score for each diet plan. This procedure was necessary to ensure that the scores of the solid food items were not outweighed by the scores of the liquid items, which were typically present in much larger quantities in the diet plans.

3. Results

3.1 Effect of learning about the Nutri-Score on diet plans

After the learning phase, the participants compiled diet plans of substantially better nutritional quality, with an average improvement of 1.1 points (from $M_{t1} = 1.6$ to $M_{t2} = 0.5$). Fig. 1 displays the NPS scores of participants’ diet plans before (t1) and after the learning phase (t2). Points on the diagonal line represent participants whose diet plans did not vary in NPS score from t1 to t2. Participants with improved scores fall below the line, participants with deteriorated scores fall above the line. The effect size of the pre-post difference is large (Cohen’s $d = 0.86$).
The participants also reduced the calorie content of their diet plans by an average of 300 calories (from $M_{t1} = 2062$ kcal to $M_{t2} = 1760$ kcal). This effect was smaller than for the NPS score (Cohen’s $d = 0.43$, Fig. 2).

A reduction of calories does not, however, necessarily constitute an improvement of the diet plan; it merely represents a positive change for those participants who initially compiled plans with too many calories. A closer inspection of the data reveals that particularly those participants with a high calorie count at $t1$ tended to decrease their calories, while those with a very low calorie count at $t1$ tended to slightly increase their calories (correlation between calorie count at $t1$ and change in calories: $r = –0.58$) (Fig. 3). Thus, although there was only a medium-sized average reduction of calories, the improvement of caloric content should be considered larger than this, as participants adjusted their calorie content differentially.

Age did not correlate with either the NPS score at $t1$ ($r = 0.11$) and $t2$ ($r = 0.11$) or the calorie content at $t1$ ($r = 0.16$) and $t2$ ($r = 0.07$). Sex had no marked impact on the NPS score at $t1$ ($d = 0.14$) or $t2$ ($d = 0.10$) but showed an effect on the calorie content. Male participants chose around 560 calories more than females at $t1$ ($M_m = 2436$ kcal versus $M_w = 1879$ kcal, $d = 0.74$), and around 480 calories more at $t2$ ($M_m = 2079$ kcal versus $M_w = 1602$ kcal, $d = 0.75$). This difference cannot be accounted for by a difference in body weight between men and women and the resulting calorie demand, since there was only a very weak correlation between
participants’ self-reported body weight and the calorie content of their diet plans at t1 ($r = 0.17$) and t2 ($r = 0.18$).

Fig. 2  Scatterplot depicting calorie content of diet plans before (t1) and after (t2) the learning phase. Points above the diagonal indicate increasing calorie content, points below the diagonal indicate decreasing calorie content.
Fig. 3  Scatterplot depicting diet plans’ initial calorie content (t1) and change of caloric content after the learning phase (t2).

3.2 Performance in the learning phase

The participants judged the Nutri-Score of the food items in the learning phase only moderately better than by chance (average hit-rate 35%, chance 20%). With the exception of one participant with a hit-rate of 16% (below chance), the distribution of hit-rates (standard deviation 5%, range 24%–47%) conforms well with a binomial distribution with $P = 0.35$. This means that the variation in the number of correct responses across participants does not necessarily indicate differences in ability to judge Nutri-Scores but may rather be accounted for by chance. This may explain why the participants’ hit rate in the learning phase was not significantly correlated with their NPS score at t1 ($r = 0.03$) or t2 ($r = 0.11$).

4. Discussion

The present findings indicate that the Nutri-Score may substantially enhance consumers’ ability to compile a healthy diet. After gathering experience with the Nutri-Scores of available food items, our participants not only compiled one-day-diet plans that had a higher nutritional quality, as measured by the NPS score, but also calculated a more appropriate calorie content. It would be premature, however, to suggest
that the introduction of the Nutri-Score would automatically improve general nutrition. Our study was intentionally designed to encourage use of the Nutri-Score by the participants. Instructions asked participants to compose a healthy diet, and the temporal proximity of the learning phase to the second diet plan task probably induced them to utilize the information. Furthermore, participants knew that they would not eat the foods they had chosen and thus did not require self-control to prioritize healthfulness over taste. The effects we found were correspondingly large.

Therefore, the small effects found in real-life shopping settings remain to be explained [37,40]. It seems plausible that factors such as hedonic value of food and self-control play a larger role in purchasing and probably eating decisions when choosing actual food items rather than mere representations. The difference cannot be explained by the distinction between theoretical and real food choices. Even real purchasing decisions are substantially influenced by the Nutri-Score and other front-of-package labels when participants choose their groceries from a virtual catalogue resembling an online-shopping portal [41].

A further indication that artificial tasks not involving real food during the decision-making stage do not faithfully represent behavior outside of the laboratory is found in the weak correlation between participants’ body weight and the calorie content of the diet plans they compiled. If the diet plans represented participants’ actual eating behavior, we would have expected that individuals’ diet plans would contain around the number of calories required to maintain their weight.

It is too early to pass a final verdict on the utility of the Nutri-Score for improving general nutrition. Although the effect of simply printing the Nutri-Score on as many food items as possible appears unlikely to have a major effect on consumers’ shopping and eating behavior, it may prove beneficial in at least three ways.

First, if the Nutri-Score is introduced, food producers may modify their recipes to achieve a more positive classification. Second, the Nutri-Score may help in educating people about good nutrition. Poor education is highly correlated with poor nutrition, and obesity is often found to afflict people of low socio-economic status [42]. If consumers lack the information to distinguish between healthy and unhealthy foods, it is virtually impossible for them to improve their nutrition, even if they have the required motivation and self-control. The question of whether people with poor knowledge in the food domain achieve a greater benefit from easy-to-understand labels such as the Nutri-Score should be further investigated. Third, the Nutri-Score may prove effective in situations where consumers choose food items in the absence of actual food, e.g. when ordering a menu at a restaurant or when stocking up on frozen food through an online catalogue.

Most decisions that have an impact on nutrition involve real food and may not therefore be susceptible, to any great degree, to the influence of the Nutri-Score or other front-of-package labels. To make progress in the battle for healthy eating, it will be necessary for researchers to focus on real-life situations where consumers make actual purchasing and eating decisions rather than on experimental studies. Well-designed field experiments may be able to establish the conditions under which the Nutri-Score has a more substantial impact on these decisions or may discover other ways to steer or nudge consumers towards healthier choices. Many researchers shy away from field experiments, with the limits they place on experimental control and the effort
needed to exclude confounding variables. Nevertheless, we believe the potential gains outweigh these
difficulties as even small successes in the battle for healthy eating may contribute to the saving of a large
number of life years and an improvement in the well-being of many people.

5. Conclusion

In order to examine the impact of the Nutri-Score on food choices and the ability to compose a healthy
dietary plan, the present study investigated how students changed a hypothetical personal one-day-dietary
plan following a learning phase during which they learned about the Nutri-Scores of the available food items.
A substantial positive impact on nutritional quality and a medium-sized reduction of calories were found after
the intervention. These findings suggest that the Nutri-Score has the potential to guide consumers to healthier
food choices. However, it remains unclear whether this potential will be reflected in real-life dietary choices.

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