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Using Nudging to Incentivize Vegetable and Legume Consumption in Children Diet: A Case Study to Promote Healthier Eating Habits

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Abstract

Promoting healthy eating habits in children is critical for their long-term health, particularly in increasing their intake of vegetables and legumes, which are often under-consumed among young populations. Nudging-based strategies emerged as an effective method for shaping healthier eating behaviors and studies indicate that nudges can significantly increase vegetable and legume consumption among children by leveraging social norms, and the attractiveness of food presentation. Nudges can be defined as "any aspect of the choice architecture that alters people's behavior in a predicable way without forbidding any options or significantly changing their economic incentives are interventions aimed at guiding choices without restricting options. Although nudging shows promise, its efficacy can vary based on factors such as age, context, and cultural preferences.
Thus, nudging-based field experiments were carried out in some elementary schools in Italy to test the effect of nonmonetary incentives in increasing children's vegetable consumption (6-11 years old) during lunch at school. In particular, media and physical priming were used as nudges. A captivating comic story integrating key information on healthy eating was also created. The comics storytelling speaks about two children of different age and inclination towards the consumption of vegetables who suddenly find themselves catapulted into a video game universe, where they face challenges only being overcome thanks to the "superpowers" provided by vegetables and legumes.
Children's daily vegetables and legumes consumption data were gathered through the plate-waste method, (by using weight of vegetable leftover from lunch) before, during, and right after the incentive provision totally for ten consecutive weeks.
Overall, the preliminary results suggest that the use of nonmonetary incentives such as comics and visual cues in school canteens, can be successful in increasing children's vegetable consumption rates and can be of help in the design of nutrition and health policies aimed at improving the dietary behavior of children and potentially reducing childhood obesity.

Keywords: *Nudging, health diet, children case study, school, education, vegetables and legumes*

1. Introduction

In recent years, several industrialized countries in the world have experienced a worrying increase in obesity cases, including childhood obesity, an increase that unfortunately continues to grow. Over the past decade, significant efforts have been undertaken to tackle Children Obesity Overweight (COO) problems. COO can compromise children's well-being by increasing their probability of developing several diseases such as diabetes, cardiovascular diseases, metabolic syndrome, and impairing their cognitive development and educational attainment. As a consequence, it has repercussions to educational attainment. Moreover, once obesity is established it is difficult to reverse and tends to persist during adulthood, causing negative health consequences. In addition, COO and the associated co-morbidities are problematic from an economic standpoint, as they generate negative economic externalities due to direct (e.g., medical cares) and indirect (e.g., scarce productivity in various activities) costs.
A recent report [1] shows that more than 20% of Italian children is overweight and almost 10% is obese (Fig. 1a), so Italy shows one of the highest rates of childhood obesity in the EU, together with Cyprus in

Greece, Malta, and Spain. This data has multiple and interrelated causes, which include genetic, biological, developmental, behavioral, and environmental factors. According to [1], children diet is too rich in sugar and fats and with very low amounts of fibers (Fig. 1b). The scarce consumption of vegetables and legumes (V&L) represents a key issue. V&L are fundamental in children's diet for several reasons: they are a good source of mineral, anti-oxidants and vitamin and dietary fibers and they help to protect child against chronic diseases later in life, including heart disease, stroke and some cancers. Therefore, it is important to find effective ways to tackle COO and promote healthy food consumption.

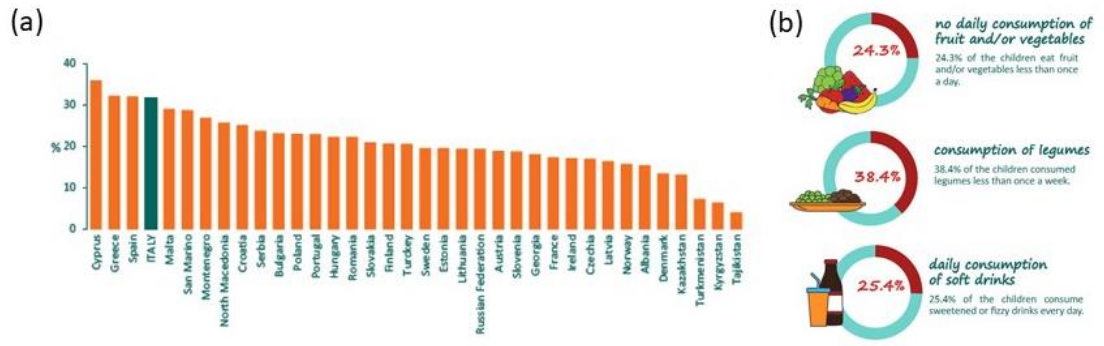

Fig. 1. (a) Percentages of overweight and obese children in many countries (data collected in 2015-2017); (b) Some of the bad habits of children in Italy taken. Images and data taken from [1]

Several information campaigns and school-based interventions have been proposed in many EU and extra EU countries, but their effectiveness in changing children's food behaviors has been limited and sometimes questioned [2].

Among innovative methodological approaches in challenging unhealthy dietary habits, the adoption of nudging-based Field Experiments (FEs) is providing encouraging results [3-5]. Nudging is a behavioral sciences technique that aims to modify people's habits through positive conditioning. Nudges can be defined as *"any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives"* [6]. Nudges are small changes in the usual context (i.e., the choice architecture) where individuals usually make specific actions, which do not enforce people to act in a certain way. Contrary to other policy measures, such as information provision, nudges do not gear at changing behaviors by enhancing individual ability to make rational decisions. Instead, nudges activate very fast, intuitive, and associative responses in mind that eventually guide behaviors towards a specific outcome. Furthermore, nudges are typically very easy to be implemented, cheap, and suitable to be implement in various context.

An example of nudging used in the context of children's food behaviours can be found in food advertising: priming children with exposure to stereotypes or cartoon characters has proven effective in increasing their preferences for products and brands [7,8]. Non-monetary incentives were used in England to encourage children choosing more Fruits & Vegetables (F&V) for their lunch at the elementary school, giving rise to an increased F&V consumption rates during the incentive period [9]. Another study, conducted in Italy [10] demonstrated that non-monetary incentives provision was effective in increasing vegetable consumption during lunch at school. Furthermore, they suggested that incentives might help children overcoming food neophobia (i.e. the fear of tasting new foods) [11-12].

2. Nudging-based Field Experiments

In this paper we present a case-study adopting an empirical approach based on the implementation of nudging-based FEs, that are experiments conducted outside the laboratory setting. The main advantage of this method is that it allows observing individuals' behaviors in the real context, providing results that are not influenced by the experimental setting.

The Nudges-based approach has been chosen for several reasons. Mainly, nudges trigger intuitive and not intrusive but automatic behaviors, making them suitable to be used with children. Moreover, nudges are typically very easy to be implemented and low cost, which implies that their adoption can be extended to several large-scale contexts. They do not require to involve experts; they can become an instrument that also parents can use at home to improve their children's dietary habits. Overall, results of previous studies indicate that nudges can lead to changes in children's food behaviors and can represent an alternative approach to common policies/initiatives.

In this case-study V&L have been selected as the target food category because their adequate intake is essential for a balanced diet and for reducing the COO risk. Moreover, V&L represent the most disliked

food among children whose consumption is hard to be increased. In addition to the nutrition issues, children's dislike of V&L causes significant food waste with negative implications in terms of environmental sustainability.
The V&L FEs involved primary schools; elementary school children (6-11 years old) are in fact a key target because eating habits are not solid yet and can be more easily modified, with increased benefits in the end. Schools are considered an ideal setting for reaching large numbers of children simultaneously, thus increasing the impact of the measures implemented for improving their food habits [13]. Moreover, children spend a significant portion of their day in the school environment, where many of them consume at least one main meal per day. Therefore, an inadequate consumption of V&L at school can compromise the overall balance of children's daily food intake.
Approximately 1000 children were involved in three schools, recruited in Lombardy, a region in the North of Italy: one school was used as "control" (that means to collect baseline data regarding daily V&L consumption by children), and the others two for implementing the nudging treatment based on media and print priming, respectively.
To assess the effectiveness of the nudges in increasing V&L consumption, children's consumption data have been registered daily in elementary school canteens, for the whole duration of the FEs that is, ten weeks of which three before the introduction of the nudge, three weeks of incentive period, and four weeks of monitoring afterwards the behaviours.
The plate-waste method has been used to this purpose: the amount of V&L eaten has been calculated as the difference between the weight of the standard portion size served and the amount of V&L leftovers in each plate. The whole FE was carried out without children being aware of the study, not to influence their behavior during the data collection, such that the results can be unbiased and reflect the true impact of the used nudge.
As regards the nudges, the media priming consisted in reading before lunch time for three weeks to children' episodes of a comic script, developed for this aim and focused on the benefit effect of a health nutrition, and the print priming in some environmental changes done in the school canteen.

2.1 Comics as Nudging Tool

Comics are an effective medium that presents complex ideas in an easily understandable way. According to multiple members of the Arts community, comics have gained prominence as a powerful tool for knowledge dissemination and have successfully addressed complex issues to a diverse audience.
The comic combines verbal (dialogues), graphic (written words), and visual (drawings) aspects. Its peculiar spoken language, with humor and slang, makes it a powerful teaching tool. The integration of text and illustrations facilitates remembering and the ability to reproduce and recognize concepts. Moreover, the use of comic scripts allows keeping children's level of attention high because they are intrigued by the cartoons' drawings. It also makes it easier for children to identify themselves within the context and learn key concepts. In this context, the act of observing media characters eating could activate automatically and unconsciously the same eating goals in the observer [5, 14].
Thus, an innovative and age-specific educational comic script has been developed by some researchers working at National Research Council of Italy (CNR), not only to implement the nudges in the school environment, but also to stimulate learning of the main concepts associated with a healthy and sustainable diet by children and their families. The action to foster youngsters' interest in health and sustainable style of living as well as to promote information and knowledge in scientific topics has been supported by CNR in the latter years by using many different educational approaches, such as the game-based learning, involvement in communication work, and learning-by-doing [15-19]. In fact, "*Education is the most powerful weapon which you can use to change the world*", as said by Nelson Mandel, and it is a primary agent of societal transformation and a mind-set change in young people, because it has the power to transform individuals and societies.
The main difficulty in creating a comic story able to raise awareness and disseminate scientific content on food, is the need to translate concepts related to chemistry, physiology and nutrition science in a language that is scientifically correct but accessible to all. Thanks to the collaboration with an expert cartoonist, a captivating comic story was created which integrates key information on healthy eating. It's the story of *Super-Maria and PacoMan*, two children with a different inclination towards the consumption of vegetables: Maria is a child of 9 yrs, champion of video games, who hates vegetables, whereas her younger brother, Paco, of about 2 yrs, eats everything and loves V&L (Figure 2a). They suddenly find themselves catapulted into a video game universe (Figure 2b), where they have to face challenges that can be overcome only thanks to the "superpowers" provided by V&L.

A similar approach inspired the creation of one of the most well-known cartoon characters, *Popeye the Sailorman*, designed to encourage American children to eat more spinach. In fact, waching a character consume V&L and take immediate benefits (e.g., strength, agility, energy...), as in the case of Paco and Maria, can help children to associate the consumption of certain foods with desirable positive effects in their daily life, involving them emotionally.
The beneficial effects of eating V&L has been represented graphically by the "energy bar" that fills up when the two children eat V&L (Fig. 3). The energy bar is multi-colored, as a rainbow, in order to underline the health values of all vegetables, legumes and fruits divisible in seven groups based on the color and to include reference to the famous phrase "*Eat the Rainbow*", frequently used as a slogan to encourage children to eat a variety of fruits and vegetables reflecting the rainbow colors. In fact, certain colours are especially rich in protective compounds and each fruit or vegetable varies in different vitamin and mineral contents [20], so by eating fruits and vegetables of different colours, it is very likely to achieve a good range of vitamins and minerals for maintaining health and wellbeing. Each colour provides various health benefits and no one colour is superior to another, which is why a balance of all colours is most important. Moreover, the beneficial effects of V&L are also explained in the text, thanks to the parents' dialogues with Maria.

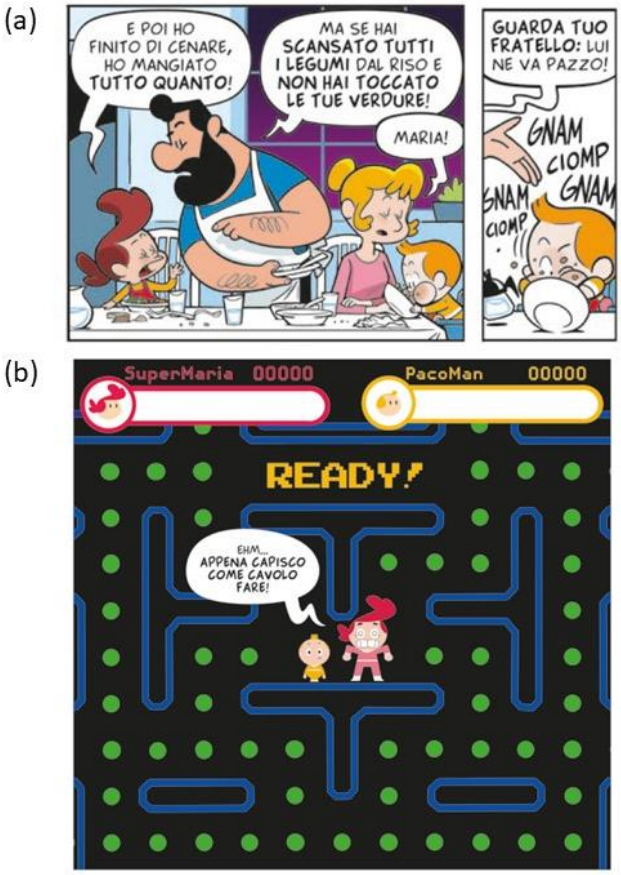

Fig. 2. a) Different attitudes towards V&L between the two main comic characters, Maria and Paco; b) Maria and Paco finding themselves into an old videogame-universe, filled up with peas (green spots) and other legumes.

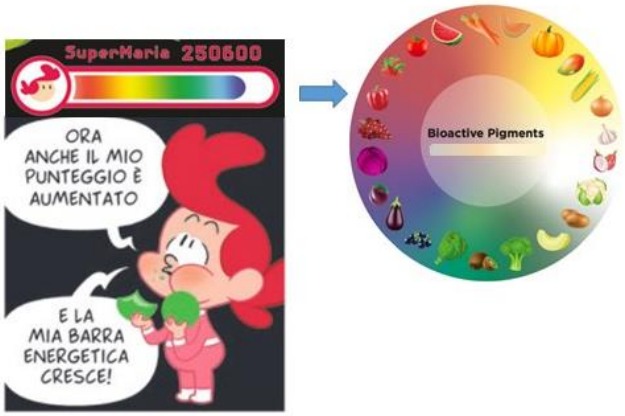

Fig. 3. The filling of the SuperMaria's "*energy bar*" occurring when she eats vegetables, and F&V pigments' colours taken from [20].

The comic story of Paco and Maria also includes references to *pop culture*, such as the famous video games *Pac-Man and Super Mario*. These references, well rooted in the collective imagination, act as a generational bridge, being known by both adults and children, and contribute to make the story more familiar and attractive for all.
Furthermore, considering the key role of parental education and behaviors in affecting children eating habits, the comic has been also made available to general public and the families of children involved in the pilot trial, through the format "*Comics&Science*" (CNR Edizioni), which combines comic strips on scientific topics with informative articles written by researchers. Comics&Science is an editorial series launched in 2012 with the aim of promoting the relationship between science and entertainment (https://www.comicsandscience.it/); in particular, the issue focused on V&L consumption collects articles intended for parents, such as *Healthy eating starts with the right shopping* and *The role of legumes in child health*, as in education for a child's diet change is essential the collaboration of adults.

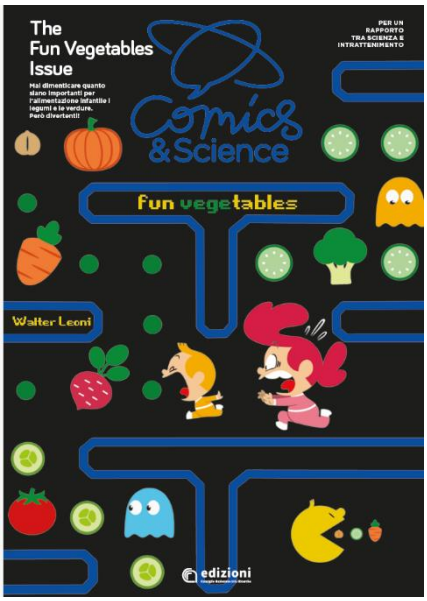

Fig. 4. Cover of the Comics&Science Issue devoted to V&L comsumption

2.2 Physical Priming

Environmental changes have been shown to influence individual behaviours, included eating habits. Recent research has shown that modifying physical surroundings can subtly steer people's choices, specifically rearranging food items on supermarket shelves to make V&L more visible has been found to encourage increased purchases of those products [21]. Based on this evidence, our FEs introduce visual cues in school canteens highlight vegetables and legumes with stickers and posters that shows V&L food in a nice and positive way (Fig. 5). The goal is to increase children's exposure to these items

and subtly encourage their consumption during lunch, leveraging the potential of physical priming to promote healthier eating habits. Additionally, it is anticipated that this nudge may influence children's eating behaviours at home by fostering positive associations with these foods. However, the current body of evidence does not allow for specific predictions regarding behavioural changes beyond the school setting or the long-term effects of this approach on children's dietary habits.

Fig. 5. Visual cues related to V&L inserted in one school canteen

3. Results and Future Developments

Preliminary results, based on the data gathered from the FEs, show that non-monetary incentives are effective in reducing children's V&L leftovers from meals consumed in the school's canteen, then in increasing a little bit children's vegetable consumption during lunch at school. In particular, the comic story had a good effect on all the children, pushing them to eat a little more of V&L, whereas the printed priming sensitively influenced only the youngest children.

Thus, we can consider these nudging-based FEs effective, even if the data are still in phase of analysis, and in particular, the comic's tool as a success for its effectiveness in capturing children's attention at all age, ranging from 6 to 11 yr. Furthermore, these results confirm that nudging tools are not perceived as enforcement, but on the contrary, they can be also pleasant, making them particularly suitable for use in scholar contexts.

As future perspectives, we aim to expand the use of these nudging strategies to other local and national schools, allowing for broader data collection and comparison. This project aspires to serve as a replicable pilot initiative, ultimately shaping local and national policies to address COO in an effective and sustainable way. In fact, the results can provide some guidance for the design of school-based interventions geared at improving children diet quality at school. Future research should focus on refining nudging techniques and assessing their long-term impact on dietary habits, fostering lasting, health-conscious food choices from an early age, as we plan to extend the applicability of our experimental system on a larger scale.

This is an important topic since gaining a better understanding of effects of non-monetary incentives can help in the formulation and implementation of future nutrition and health policies aimed at improving public health by reducing the prevalence of diet-related diseases and increasing environmental sustainability which represent two of the major 21st century food policy challenges.

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