**INtroduction**

Children spend a substantial portion of their lives in front of a screen, from TVs and laptops to smartphones and tablets. Food advertising on TV that targets children ranges from 11% to 29% of all total advertisements, with unhealthy foods present in 53% to 87% of food advertisements and higher percentages found during children’s peak viewing periods.1 According to previous systematic reviews,2–4 food promotion directly affects children’s nutrition knowledge, preferences, purchasing behavior, consumption patterns and diet-related health. In addition, food advertising on TV has a critical indirect influence on children´s food choices. A recent meta-analysis5 of the effect of food advertising exposure on food intake showed that acute exposure to unhealthy food advertisements increased food intake amongst children even with short-term exposure.6 Although the effect of food advertising in unhealthy food choices and preferences is well established, few studies have evaluated the effects of advertisements of healthy food on food choice. Dixon and colleagues7 studied 10- to 11-year-olds and found that advertising for nutritious foods promoted positive attitudes and beliefs regarding the foods advertised. Bannon and Schwartz8 designed a study to test the influence of nutritional message framing on young children’s snack choices and concluded that children who viewed nutritional message videos (i.e., a nutritional message related to the positive benefits of eating apples) chose more apples than children in a control condition. However, Dovey and colleagues9 studied 5- to 7-year-olds and found that, after exposure to healthy food advertising, although some children consumed fewer chocolate items, they did not increase their intake of healthy snacks.

Recent research has also focused on the influence of media characters (e.g., cartoon characters) on food preferences and choices. For instance, Kotler and colleagues10 examined 2- to 6-year-olds and showed that the association between cartoon characters and healthy/unhealthy food items did not significantly change children’s food choices; however, children were significantly more willing to try foods in the same category if the foods were branded with cartoons characters. Kraak and Story11 concluded that cartoon characters used in branding can have a positive influence on fruit and vegetables choices when compared with no branding. However, this effect is larger with regard to children’s preferences and choices when cartoon character branding is used for unhealthy foods.

According to the developmental systems perspective,12 the development of food choices and preferences can be understood in terms of exposure, social learning and associative learning. Developmental models of food choice highlight the central role that learning plays through the observation of important models. On the other hand, according to the Theory of Planned Behaviour,13 an individual's behavioral intention is a result of his or her attitudes towards the behavior and the perceived social pressure (subjective norm) to perform that behavior.

Another line of research suggests that children develop “parasocial relationships” with media characters, creating an emotional relationship that can facilitate learning messages conveyed by their favorite characters and draw attention to the potential use of cartoons and cartoon characters in the promotion of healthy eating messages.14Although the literature has established the effect of food advertising on food preferences and choices, less research has focused on the role that healthy food advertisements and entertainment characters play in healthy food choices.. This study is the first to test whether healthy eating TV cartoon characters, which are widely available and can be delivered over a large scale, can be effective in convey healthy eating messages and impact children’s food preferences and choices. Therefore, this study aims to evaluate the effect of healthy food messages delivered by cartoon characters on the food preferences and choices of 4- to 8-year-olds using a randomized controlled trial with a between-participants design. It is hypothesized that children who viewed the cartoons promoting healthy eating would (i) chose healthier food items and (ii) prefer more healthy foods than children who viewed cartoons with no nutritional content.

**Methods**

**PARTICIPANTS**

A total of 142 children were recruited from 4 different elementary schools in the Northern region of Portugal. The inclusion criterion was being aged between 4 and 8 years old. School directors were contacted, and permission was obtained to conduct this study. Researchers distributed informed consents and socio-demographic questionnaires in a sealed envelope to the responsible teachers in the classes who then delivered it to the parents for completention. Parents who agreed to allow their children to participate returned their informed consent documents and questionnaires to the responsible teacher in the class. Then, the teachers would refer the children who were allowed to participate in the study to the research team. Anonymity was assured for all participant data collected. An ID code was given to all of the participants, and no other information (e.g., school) was recorded. Children provided verbal assent before any study procedure was undertaken.

The exclusion criteria were not fluently speaking or understanding Portuguese. In addition, participants were excluded if they had been referred to a special educational needs and disabilities team or an early intervention team because of cognitive developmental problems. The inclusion and exclusion criteria for the study were communicated to the responsible teacher of each class who then referred participants for study enrolment according to the above criteria and parental consent.

Participants were randomly assigned to an intervention group (n=69) or a comparison group (n=73) using a computer-assisted program ([www.randomizer.org](http://www.randomizer.org))

**PROCEDURE**

The Ethics Committee of each institution involved approved the study protocol (Portuguese Educational Board and University of Minho). Children were tested individually by a trained researcher to complete the questionnaires (see Figure 1). After completing the questionnaires, children viewed cartoons in small groups of 4 or 5. Children in the comparison group viewed 2 sequential 10-minute episodes of cartoons without content regarding eating or food. Children from the intervention group viewed 2 sequential 10-minute episodes of Nutri Ventures® that included healthy eating content and messages promoting healthy eating.

After watching the videos, each child was individually invited to a separate room where 4 bowls containing different food items (healthy foods such as grapes and baby carrots as well as non-healthy foods such as chips and chocolates) were available. Four researchers simultaneously conducted the experimental task with the children. During a 10-minute period, the child was allowed to choose and eat *ad libitum.* Food quantities were controlled (10 chips, 20 chocolates, 15 grapes, and 6 baby carrots), and the exact quantity of the food items ingested was calculated. No information was provided regarding the snacks. Children were informed that they would answer some questionnaires and that they could eat whatever they liked from the bowls. The bowls were refilled if needed without explanation or commentary. The researchers counted and registered the exact number of food items eaten (e.g., 5 grapes and 10 chocolates). This procedure was made as discreetly as possible so that children were unaware. Researchers maintained neutral body language during the task and conducted the experiment without making any comments about the food or giving any feedback regarding the type or quantity of food chosen or the quantity of food ingested.

After the food choice task, children were invited to complete a food preferences questionnaire. All questionnaires were verbally administered to children. Finally, the children's height and weight measurements were recorded using a wall-mounted tape measure and calibrated weighing scales (scale Seca 899). Figure 1 shows a representation of the experimental procedure.

**Stimuli and measures used in the study.**

*Cartoons with healthy eating content:* Nutri Ventures® (NV) is a children’s cartoon series developed by the Nutri Ventures Corporation (www.nutri-ventures.com) to entertain children while also promoting healthy eating through stories about 4 heroes. The premise of the series is that the NV heroes live in a grey city, where food does not exist. To restore food diversity to the world, the 4 little heroes start a journey to the 7 kingdoms of nutrition in search of the missing foods. Two episodes were developed by blending together material to include 2 kingdoms to promote fruit and milk consumption.

*Cartoons without eating content:* Two episodes of a popular cartoon show in Portugal were specially selected so that they did not include any reference to food or healthy eating.

**Measures**

*Hunger:* Ratings of hunger were recorded based on the question, “How hungry are you at this moment?” using a visual analogue scale ranging from “hungry” (5) to “full” (1).

NutriVentures® *character recognition and liking measure:* Because NV materials were already available in Portugal, recognition of these cartoons was assessed to control for prior knowledge with regard to affecting responsiveness. Children were asked if they recognized the NV characters with a yes-or-no answer. Another question assessed how much the children liked the NV characters using a 5-point Likert scale ranging from “like a lot” to “hate”.

*Adaptation of the Leeds Food Preference Measure* (LFPM): The LFPM is a food preference checklist of 32 non-branded food items. The version used was described by Hill and colleagues.15 The participant must make a mark next to an item if they would like to eat that specific food item at that particular moment. The list is composed of 8 high-fat items (e.g., large chocolate bar), 8 high-carbohydrate items (e.g., roast potatoes), 8 high-protein items (e.g., roasted chicken breast), and 8 low-energy-density items (e.g., strawberries). Food preference checklists are long-established tools used in human appetite research and have been validated with regard to actual food preferences and selection in children.16 This measure has also been used previously to demonstrate the short-term effects of TV advertisement exposure on food preferences in young children.17 The questionnaire was translated and back translated into Portuguese by 2 Portuguese nutritionists fluent in English. The items were selected from commercially available foods in Portugal and portioned so that the items had similar energy and nutritional contents to the original checklist.

*BMI percentile and Weight Status*: Height (m) and weight (kg) measurements were used to calculate the body mass index (BMI) of each child (kg/m2), converted into a BMI percentile. The children were placed into a particular weight status percentile category (normal weight, overweight, and obese) according to the **Word Heath Organization.18**

*Sociodemographic questionnaire* *(parental completion)*: A set of questions regarding family income, occupational status, and occupation were used to classify children according to sociodemographic status.

**Data analysis**

An exploratory analysis was conducted. Data were tested for normality using the Kolmogorov-Smirnov test. When the variables were not normally distributed, non-parametric tests were used. If parametric and non-parametric testing presented the same results, then parametric tests were presented based on the suggestion of Martins.19 To analyze the differences between the intervention and comparison groups regarding age, BMI percentile and hunger, t-tests were used for each variable. To investigate whether between-group differences were present with regard to sex or previous knowledge of the cartoons, chi-square tests of independence (χ2) were conducted. Spearman’s rho correlation was used to investigate group and sociodemographic status.

The effect of watching cartoons on children’s food choices was tested using a generalized linear models (GLM), with group as the factor variable and healthy and unhealthy food choices as the response variables. Because both response variables were assessed through the number food items ingested, the negative binomial family was selected to create the corresponding models. Negative binomial regression is a generalization of the Poisson regression because it has the same mean structure as well as an extra parameter to model over-dispersion. These models then assessed the significant effects of BMI percentile and age. To investigate the effect of watching cartoons on food preferences a different GLM was used, where group was the factor variable and food preference was the response variable. In addition, age and BMI percentile were used as covariates and included in the model. The model was tested using a Poisson distribution. Power analysis was conducted using using G-Power software. A conservative effect size of .25 and a power of.95 was computed for each variable. Minimum sample size required was 80 participants. All analyses were conducted using Statistical Package for Social Sciences ((version 24.0, SPSS, IBM® CORP, Armonk, NY, 2016).

**Results**

**Participant Characteristics**

Most students were of Portuguese nationality (98%). Approximately half of the sample (52%) was above the BMI percentile for overweight or obesity, which is in accordance with the prevalence of obesity in northern Portugal.20 Table 1 describes the sociodemographic and anthropometric characteristics of the sample with differences between the comparison and intervention groups.

# Effects of watching healthy eating cartoons on food choices

A significant effect of group was found with regard to healthy food choice (B=-.600 [.19]; p<.05; Table 2). When added to the model, no significant effect was found for BMI percentile (B=.003 [.004]; p=.441) or age (B=.128 [.08]; p=.126). No significant group effect was found for non-healthy food choices. Table 2 presents the mean numbers (and SDs) of healthy and unhealthy food items chosen by the comparison and intervention groups.

# Effect of watching healthy-eating-promoting cartoons on food preference

 A non-significant effect was found with regard to food preference, suggesting that no between-group differences exist regarding preferences (Table 3). Table 3 shows a detailed description of the effect of viewing cartoons promoting healthy eating on children’s food preferences.

**Discussion**

The present study tested the effect of watching healthy-eating-promoting cartoons on the food preferences and choices of children. This study found that viewing these cartoons had a positive effect on food choice with children who viewed the cartoons promoting healthy eating choosing more healthy food items **than children in the comparison group**. The results of this study corroborate those of previous studies.8,21

These results did not reveal differences between children exposed to cartoons promoting healthy eating and comparison cartoons regarding their food preferences. Research has shown that the use of cartoon characters in advertising increases children’s preferences for these foods and their liking of the foods advertised.22 The lack of an effect in this study might be explained by the use of different methods for measuring food preferences (e.g., “How good or bad do you think this product is?” *vs.* “Would you like to eat this food at this moment”; LPFM). Boyland and colleagues17 found that acute experimental exposure to unhealthy food messaging in food advertising affects children’s food preferences; however, these authors did not find an effect with regard to low-energy food preferences (using the LPFM), which is in line with current results.

Another reason for the difference in the results might be that most research on food advertising has focused on the effects of the consumption of or preferences for unhealthy foods.16,17,23 Less research has focused on the effect of food advertising in promoting healthy eating. Dovey and colleagues9 concluded that healthy food advertising appears to affect food intake amongst children. However, these authors claim that such advertising might not have the same strength as unhealthy food advertising and therefore might not be sufficiently effective to overcome the innate and reinforced (via commercial food promotion) food preferences of children for unhealthy foods. The lack of a food preference effect in the current study is partially explained by the fact that changing food preferences towards healthy food items such as fruits and vegetables is more difficult to achieve, requires more exposure, and is less preferred by children.24In addition, this study assessed food preferences after the food choice task, which might have influenced the results. At the same time, food preferences develop early in life and seem to be maintained during the life course25 and are difficult to change.26

This study results show that children who were exposed to cartoons promoting healthy eating chose more healthy food items than those in the comparison group. However, no between-group differences were found regarding the number of unhealthy food items chosen. These results might be explained by the fact that the themes of the cartoon episodes with healthy eating content included the 2 NV “kingdoms” of fruit and milk. No content was presented with regard to other food groups, i.e., the “bad kingdoms” of sugars and fats. Exposure to this content might have discouraged the choice of unhealthy food items. Another possible explanation for these results is that the presence of the research team, the nature of the task (watching cartoons) and the presentation of food in the classroom by the research team might have created a “party environment”, allowing the children to eat unhealthy foods such as chocolates and chips.

The present study has limitations. One limitation refers to the absence of data regarding children’s family eating behaviors (i.e., food habits) that might better inform the researchers about the variables that might have affected these results (e.g., food preferences).27 In addition, the food preference measure is not validated to Portuguese what should be considered when interpreting the results.

In this study participants were only exposed to healthy messages during a single 20-minute exposure, which might have contributed to the lack of an effect on food preferences

Another limitation refers to the lack of control regarding the time of the day that the experimental food task choice was conducted due to practical reasons (i.e., so as not to interfere with academic activities or the time needed to recruit the sample). Although the hunger level before the experimental task was controlled, the time of the day of the food choice task might have influenced the results. Another limitation is related to the fact that because study was designed for studying food choices the energy ingested by children in both groups was not calculated. Researchers involved with the implementation of the experiment were not blind to the objectives of the study, although all procedures were conducted so that no interference with the eating choice task would occur. Despite the care taken by the research team, a social desirability bias might have influenced the results. Moreover, although not significantly different, the intervention group had a higher percentage of participants who were overweight or obese, which might have influenced the results. Therefore, these results should be generalized with caution, and the results require replication in other countries were NV cartoons are available.

**Implications for Research and Practice**

The current study has important implications for the promotion of healthy eating amongst children because it revealed that entertainment media characters and cartoons have the power to promote healthier food choices. Future studies may consider including content that frames unhealthy eating in a negative way to test the potential of cartoons to reduce the likelihood of choosing unhealthy food items. Additionally, it is important to study the effect of cartoons promoting healthy eating using an experimental design that tests the effect of prolonged exposure to positive nutritional messages on children’s eating behavior. In future studies the use of different food preference measures would be important to better compare the current results with other studies. Furthermore, it is important to study the effect of watching cartoons alone with regard to food preferences and choices.

In addition, neophobia is an important variable that might have influenced the results of the present study and may be examined in future studies as a moderating variable of the number of unhealthy food items chosen by children in the food choice task. The current results highlight the potential effect of cartoons to promote healthy eating and might have implications for the large-scale delivery of healthy eating promotion strategies to children. Future research will test intervention educational programs that promote healthy eating using cartoon characters and cartoons.

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Figure 1. Schematic representation of the experimental procedure for testing the effect of healthy eating cartoons viewing in food choices and preferences.