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Using pictorial nudges of fruit and vegetables on tableware to increase children's fruit and vegetable consumption

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ABSTRACT

Children's fruit and vegetable consumption is lower than recommended. Increasing consumption is important for children's health. Nudges influence children's eating behaviour, but less is known about the influence of a pictorial nudge on tableware on children's fruit and vegetable consumption. Two studies examined this. Study 1 examined whether a pictorial fruit nudge (a grape image) on a plate influenced children's fruit (grape) consumption relative to a control condition (no image). In a between-subjects design, children (n = 63, Mean age = 8.9 years, SD = 1.41, 38 females, 25 males, 73% had a healthy-weight) were randomly assigned to one of two conditions (fruit nudge vs. control). Study 2 examined the influence of a large portion pictorial nudge (a large portion carrot image) vs. a small portion pictorial nudge (a small portion carrot image) vs. control (no nudge) on children's vegetable (carrot) consumption. In a between-subjects design, children (n = 59, Mean age = 8.57 years, SD = 2.13, 31 females, 28 males, 85% had a healthy-weight) were randomly assigned to a condition. In Study 1 children consumed significantly more fruit in the pictorial nudge condition than the control condition. In Study 2 children ate significantly more vegetables in the large portion pictorial nudge condition than the other two conditions. The small portion pictorial nudge did not affect children's vegetable consumption relative to control. The results indicate that pictorial nudges on tableware influence children's fruit and vegetable consumption, and the portion size of this type of nudge may be key to whether it influences children's eating behaviour.

1. Introduction

Children do not eat a sufficient amount of fruit and vegetables. In 2016 only 16% of children aged 5–15 years old in England ate the recommended five or more portions of fruit and vegetables per day (NatCen Social Research, 2017). Fruit and vegetable consumption is associated with a reduction in the risk of a number of chronic diseases (Boeing et al., 2012; Hu, Huang, Wang, Zhang, & Qu, 2014; Wang et al., 2014). A meta-analysis showed that the risk of all-cause mortality decreased by 5% for each additional serving of fruit and vegetables, up to five portions per day Wang et al., 2014. Since eating behaviours track from childhood into adolescence and adulthood (Birch et al., 2009; Birch & Fisher, 1998), increasing fruit and vegetable consumption at an early age is important.

Nudging is a potential strategy for increasing children's fruit and vegetable consumption. The term nudging was originally coined by Thaler and Sunstein (Thaler & Sunstein, 2008) and was defined as "any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives". More recently Hollands et al. (2013) developed an operational definition of nudging in relation to changing health-related behaviour. Hollands et al (2013) defined nudging as "interventions that involve altering the properties or placement of objects or stimuli within micro-environments with the intention of changing health-related behaviour". A recent review of 39 systematic reviews and meta-analyses showed that a variety of nudges influence eating behaviour and promote healthier eating in adults and children (Bauer & Reisch, 2019). For example, children were more likely to select oranges when the oranges were sliced than when they were whole (Swanson, Branscum, and Nakayima 2009), and were more likely to take a serving of fruit when a verbal prompt ("would you like fruit or juice with your lunch?") was used by the canteen staff than when no prompt was used (Schwartz, 2007). Furthermore, serving vegetables while children waited in the school dinner line increased consumption

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of vegetables (Elsbernd et al., 2016), and the addition of a model-related label ("new carrot/broccoli recipe, special mix for super heroes") increased the likelihood that children would choose the new vegetable dish (Morizet, Depezay, Combris, Picard, & Giboreau, 2012).

Another type of nudge which has been shown to influence children's vegetable consumption is the placement of images of food on a school dinner tray Reicks et al. (2012) placed images of carrots and green beans on a school dinner tray on one occasion and found that children selected and consumed more carrots and green beans when the images were present on their tray in comparison to a control day when no images were present. However, this is the only study to our knowledge which has examined the influence of pictorial nudges on tableware on children's eating behaviour. Therefore, since consumption of both fruit and vegetables is beneficial for health (Boeing et al., 2012), examining the influence of pictorial nudges on children's fruit consumption would be of value. Furthermore, from this previous research (Reicks, Redden, Mann, Mykerezi, & Vickers, 2012) it is not clear how the pictorial nudges influenced children's eating behaviour. One possibility is that the portion size of the nudge image may affect the amount that children eat. Research has consistently shown that children eat more when served a large portion of food than when served a small portion (Birch, Savage, & Fisher, 2015; Fisher, Liu, Birch, & Rolls, 2007; Hetherington & Blundell-Birtill, 2018), which is known as the portion size effect. Pictorial nudges on tableware may act in a similar way to a portion served on a plate, whereby a pictorial nudge of a large portion of a food may encourage children to eat more of that food compared to a pictorial nudge containing an image of a small portion. Understanding whether pictorial nudges elicit the portion size effect will be informative for the development of pictorial nudges to increase children's fruit and vegetable consumption.

In this paper we aimed to understand the influence of pictorial nudges on children's fruit and vegetable consumption. In study 1 we examined whether a pictorial fruit nudge influenced children's fruit consumption. We expected that the pictorial nudge would influence children to increase their consumption of fruit relative to control (no image on a plate). In study 2 we examined whether the portion size of a pictorial vegetable nudge influenced children's vegetable consumption. We expected that if the nudge influenced children's vegetable consumption through eliciting the portion size effect, then children in the large portion nudge condition would consume more vegetables than children in the other two conditions, and children in the small portion condition would consume more vegetables than children in the control condition.

2. Study 1

2.1. Method

2.1.1. Design

Children attended a single experimental session on an individual basis in their primary school. Children were randomly assigned (using the online random number generator http://www.randomizer.org) to one of two conditions (fruit nudge vs. control) in a between-subjects design. In both conditions children were given a plastic white plate (22 cm diameter) and a plastic white bowl containing green seedless grapes (approximately 150 g). In the fruit nudge condition a laminated photographic image of green grapes[1] was placed on the plate (this image was placed on the plate at the start of fruit nudge condition session and was loose and not stuck to the plate). No image was present on the plate in the control condition (see Fig. 1 for images of the two conditions). The plate and the bowl were weighed using digital scales pre and post-consumption to measure children's consumption.

2.1.2. Ethics

Study 1 and study 2 were approved by Coventry University Research Ethics Committee (P69532 and P67529), and have been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments. Fully-informed parental consent was provided, and children who had food allergies, or a history of food allergies were unable to participate in both studies. Children assented to take part on the day of the study.

2.1.3. Questionnaire measures

2.1.3.1. Manipulation check. To examine whether children noticed the image on their plate (manipulation check) children were presented with the question 'You were given a plate to eat off, what did your plate look like?' with two image options; a plate containing no image or a plate containing an image of grapes.

2.1.3.2. Liking of the test food. Liking of grapes was assessed using a smiley face Likert-style scale by asking 'How much do you like grapes?' with five response options ranging from 'not at all' to 'a lot', based on a question previously used by Sharps and Robinson (2015).

2.1.4. zBMI

In both studies, height was measured to the nearest 0.5 cm using a Stadiometer (Seca 213, Seca GmbH & Co.) and weight was measured to the nearest 0.1 kg using a digital scale (Seca 813, Seca GmbH & Co.). BMI was calculated as weight (kg)/height (m^2). Using internationally recognised criteria for children (Cole & Lobstein, 2012), healthy-weight, overweight and obesity were defined based on age and sex-specific BMI cut-off points equivalent to adult BMI of 25–30 kg/m^2 respectively.

2.1.5. Procedure

Children were tested individually during weekdays at a primary school. Children sat at a table in a quiet area of the school and were told a cover story (children were informed that the researcher was interested in how well they played a game). The researcher explained that they needed to 'sort out the game' so the child could have a snack while they waited. The child was presented with a plate (which either contained a fruit nudge or no nudge depending on the condition), and a bowl of grapes. The child was informed that they could help themselves to as much as they liked, and the researcher asked the child to put however much they wanted to eat onto the plate and eat from the plate. The child was left alone for 7 minutes. On return the researcher removed the plate and bowl and presented the child with the game, which involved matching pairs of animals. The child was left for 3 minutes to play the game. The researcher then congratulated the child on their performance on the game to corroborate the cover story, and asked the child the questionnaire measures, and measured their height and weight. All children were debriefed once all of the children had been tested in that school.

2.1.6. Analysis strategy

Pearson's correlations were conducted to examine whether any of the variables (age, zBMI, and liking of grapes) correlated with grape consumption. Variables which significantly correlated with grape consumption were included as covariates. A one-way ANCOVA was conducted to examine the influence of condition on grape consumption. Gender was included in the ANCOVA to examine whether it moderated the effect of condition on grape consumption. For the manipulation check, children's responses were scored based on whether or not they correctly identified the image on their plate and a percentage of correct responses was calculated.

[1] The photographic nudge image constituted a large portion and weighed approximately 240 g. The image was taken of a plate full of grapes, however the image was edited so that only the grapes can be seen.

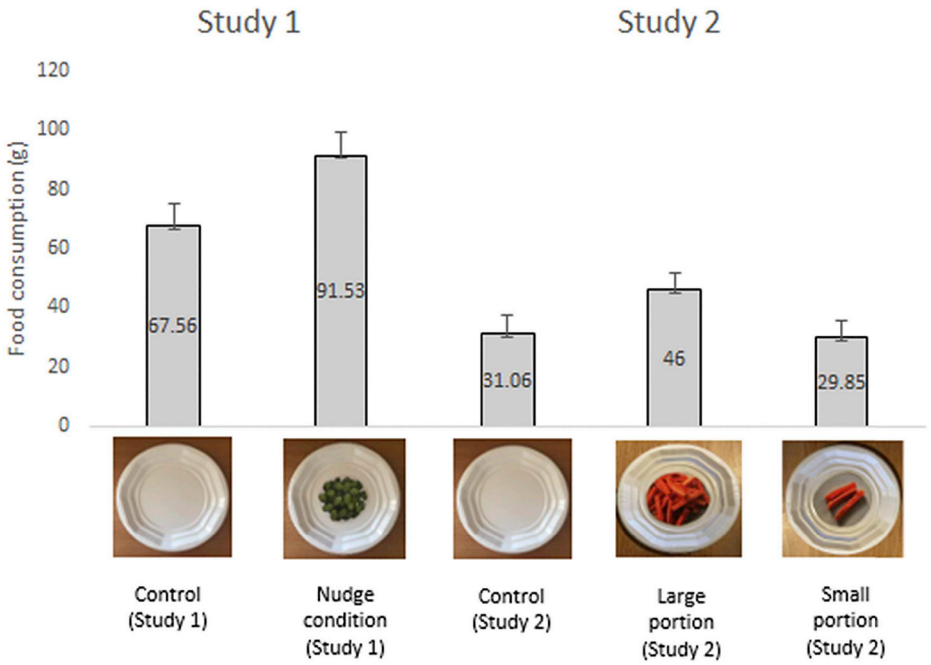

Fig. 1. Mean food consumption and pictorial nudge images for studies 1 and 2.

Table 1
Mean (Min-Max) food consumption, age, gender, zBMI, and study food liking in studies 1 and 2.

Condition	Study 1		Study 2		
	Fruit nudge (n = 32)	Control (n = 31)	Large portion nudge (n = 22)	Small portion nudge (n = 20)	Control (n = 17)
Food consumption[a]	91.53 (0.0–153.0)	67.56 (0.0–151.0)	46.00 (0.0–127.0)	29.85 (0.0–81.0)	31.06 (0.0–76.0)
Age[b]	8.97 (6.40–11.04)	8.80 (6.11–11.08)	8.75 (5.10–12.60)	8.54 (5.11–12.80)	8.38 (5.11–12.80)
Gender	17 Females	21 Females	12 Males	9 Males	7 Males
	15 Males	10 Males	10 Females	11 Females	10 Females
zBMI	0.27 (−3.25 – 2.97)	0.09 (−2.61 – 1.75)	0.22 (−2.14 – 2.37)	0.12 (−2.15 – 2.56)	-.20 (−2.09 – 1.62)
Study food liking	4.34 (1.00–5.00)	4.39 (1.00–5.00)	2.41 (1.00–5.00)	2.20 (1.00–5.00)	2.18 (1.00–5.00)

[a] Food consumption is reported in grams.
[b] Age is reported in years.

2.2. Results

2.2.1. Participants

65 children aged 6–11 years were recruited from one primary school in the Midlands. A power calculation using g-power indicated that for a medium-large effect size at 80% power ($\alpha = 0.05$), a minimum of 60 children were required. One child was excluded due to fasting on the day of testing, and one child did not correctly identify their plate in the manipulation check, so the final sample consisted of 63 children (Mean age = 8.9 years, SD = 1.41, 38 females, 25 males, 73% had a healthy-weight). See Table 1 for mean grape consumption, age, zBMI and gender distribution across the two conditions.

2.2.2. Manipulation check

98.5% of children correctly identified their plate.

2.2.3. Co-variates and moderators

Grape liking significantly correlated with grape consumption [r = 0.45, n = 63, $p = < .001$] and was included as a covariate in the ANCOVA. zBMI and age did not significantly correlate with grape consumption and therefore were not controlled for in the analysis ($ps > .05$). Gender did not moderate the effect of condition on children's grape consumption ($p > .05$).

2.2.4. Grape consumption

There was a significant main effect of condition on grape consumption [F (1, 60) = 6.06, $p = .02$, $np^2 = 0.09$]. Children in the fruit nudge condition consumed significantly more grapes than children in the control condition. See Table 1 for means and range, and Fig. 1 for means and standard error.

3. Study 2

3.1. Method

3.1.1. Design

As in study 1, children were randomly assigned (using the online random number generator http://www.randomizer.org) to a condition in a between-subjects design. Children were either assigned to the large portion nudge condition, the small portion nudge condition, or the control condition. Children in all conditions were given a plastic white plate and a plastic white bowl containing raw carrot batons

(approximately 130 g). In the large portion nudge condition the plate contained a laminated photographic image of a large portion of carrots, in the small portion nudge condition the plate contained a photographic image of a small portion of carrots, and in the control condition there was no image (see Fig. 1 for images of the conditions),[2,3]. The plate and bowl were weighed pre and post-consumption to measure children's carrot consumption.

3.1.2. Questionnaire measures

3.1.2.1. Manipulation check. To examine whether children noticed the image on their plate (manipulation check) children were presented with the question 'You were given a plate to eat off, what did your plate look like?' with three image options; a plate containing no image, a plate containing an image of a small portion of carrots, or a plate containing an image of a large portion of carrots.

3.1.2.2. Typical fruit and vegetable consumption and liking of the test food. To ensure that children's habitual fruit and vegetable consumption did not systematically influence their behaviour, children's typical fruit and vegetable consumption was measured using the Day in the Life Questionnaire (DILQ). The DILQ is a valid and reliable 24 h recall measure for use in children (Edmunds & Ziebland, 2002). Liking of carrots was assessed using a smiley face Likert-style scale by asking 'How much do you like carrots?' with five response options ranging from 'not at all' to 'a lot'. This was based on a question used by Sharps and Robinson (2015).

3.1.3. zBMI

Children's zBMI was calculated in the same way as Study 1.

3.1.4. Procedure

Children were tested individually and were sat at a table in a private section of a larger room at a family science event. The researcher explained the cover story that they had designed a plate and wanted the child's opinion. The researcher presented the child with the plate (either containing a large or small portion nudge or no nudge depending on condition) and asked the child questions about the plate (their opinion on the colour, texture and size). The researcher then explained that they wanted the child to design their own plate but that they were going to have a break first. The researcher placed the plate and the bowl containing the carrots in front of the child. As in study 1 the researcher informed the child that they could eat as much as they wanted, and asked the child to put whatever they wanted to eat onto the plate and eat from the plate. The child was left child alone for 7 minutes. After 7 minutes, the researcher returned and removed the plate and the bowl and presented the child with a worksheet where they could design their own plate. The child was left alone for 3 more minutes to design their plate to corroborate the cover story. On return, the researcher congratulated the child on their plate design and the child completed the questionnaire measures with the researcher. Children were debriefed at the end of their participation in the study.

[2] The large portion nudge image was taken of a large plate of raw carrot batons and weighed 240 g. The small portion nudge image was taken of three carrot batons on a plate and weighed 27 g. The images were edited so that the plate was not visible.

[3] The current recommendation for children's portion sizes is what children can fit into their cupped hand and there are no recommended portion sizes in grams due to differences in children's age, gender and physical activity levels. Therefore, we aimed to create a visibly small portion and a visibly large portion nudge. The small portion pictorial nudge is the equivalent of approximately one third of the recommended portion for adults (which is 80 g per portion), while the large portion is the equivalent of three times the adult recommended portion.

3.1.5. Analysis strategy

As in study 1 Pearson's correlations were conducted to examine whether any of the variables (age, zBMI, typical fruit and vegetable intake, and liking of carrots) correlated with the carrot consumption. Variables which significantly correlated with carrot consumption were included as covariates. A one-way ANCOVA was conducted to examine the influence of condition on carrot consumption. Gender was included as a moderator in the ANCOVA to examine whether gender moderated the effect of condition on children's carrot consumption. As in study 1, for the manipulation check children's responses were scored based on whether or not they correctly identified the image on their plate and a percentage of correct responses was calculated.

3.2. Results

3.2.1. Participants

75 children aged 5–13 years participated in the study which took place at a family science event in the Midlands, United Kingdom. Based on the results of study 1, we conducted a power calculation for a medium-large effect size at 80% power, with $\alpha = 0.05$. A minimum of 74 children were required. This study took place in a private section of a larger room, and children completed the study individually. Parents were asked not to be present during the study, however, in ten cases, the parents remained present, and these children were excluded. Six children were excluded as they did not correctly identify their plate in the manipulation check. The final sample consisted of 59 children (Mean age = 8.57 years, SD = 2.13, 31 females, 28 males, 85% had a healthy-weight). See Table 1 for mean carrot consumption, age, zBMI and gender distribution across the conditions.

3.2.2. Manipulation check

91% of children correctly identified the image on their plate.

3.2.3. Co-variates

Carrot liking significantly correlated with carrot consumption [$r = -0.51$, $n = 59$, $p < .001$] and was included as a covariate in the ANCOVA. There were no other significant correlations between carrot consumption and age, zBMI, and usual fruit and vegetable consumption ($ps > .05$), and gender did not moderate the effect of condition on children's carrot consumption ($p > .05$).

3.2.4. Carrot consumption

There was a significant main effect of condition on carrot consumption [$F(2, 55) = 3.42$, $p = .040$, $np^2 = 0.11$]. Children in the large portion nudge condition ate significantly more carrots than children in the other two conditions, but there was no significant difference between the small portion nudge condition and the control condition. See Table 1 for means and range, and Fig. 1 for means and standard error.

4. General discussion

Across two studies we examined the influence of pictorial nudges (photographic images of fruit or vegetables on tableware (a plate) on children's fruit and vegetable consumption. In study 1 children consumed more grapes when exposed to a pictorial fruit nudge (an image of grapes on a plate) in comparison to the control condition (no image on the plate). In study 2, children increased their consumption of carrots when exposed to a large portion pictorial nudge (an image of a large portion of carrots on a plate) in comparison to a small portion pictorial nudge (an image of a small portion of carrots on a plate) and control (no image). The results build on the work by Reicks, Redden, Mann, Mykerezi, & Vickers, 2012 through providing the first evidence that a pictorial nudge influences children's fruit consumption. These results also demonstrate for the first time, that the portion size of a pictorial nudge may be key to whether pictorial nudges on tableware

influence children's eating behaviour.

The results of study 2 are consistent with the portion size literature (Hetherington & Blundell-Birtill, 2018; Small, Lane, Melnyk, & McBurnett, 2013) and indicate that the pictorial nudges in these studies may have influenced children's vegetable consumption through the portion size effect. The portion size effect has been suggested to occur due to the portion acting as a cue or social norm about the appropriate amount to eat (Versluis & Papies, 2016). Thus, in study 2 the large portion pictorial nudge may have indicated that eating a large amount of vegetables was appropriate. The results of study 1 may also be explained by the portion size effect. Although we did not measure the impact of different portion size nudges on children's fruit consumption in study 1, the pictorial fruit nudge constituted a large portion and may have communicated that the appropriate course of action was to eat a large amount of grapes. In study 2, the small portion pictorial nudge did not increase children's vegetable consumption relative to the control condition, which may be due to the small portion nudge producing a ceiling effect. According to the normative model of social influence (Herman & Polivy, 2005), people look to cues in the environment to determine the appropriate amount to eat without eating excessively. Therefore, the small portion pictorial nudge may have set the limit for the appropriate amount to eat and the children may have felt that they should not eat more than this. A related explanation is that eating 3–4 carrot batons (approximately 30 g) is the norm for children, as demonstrated by children in the control condition eating this amount. The small portion nudge, which weighed 27 g and constituted 3 carrot batons, may have reinforced this norm and guided children's behaviour. However, we did not measure normative perceptions regarding children's beliefs about the amount of vegetables eaten by other children, or what they perceived to be the appropriate amount to eat. This would be a valuable addition in future studies and would allow for the investigation of whether the nudge communicates normative information. Furthermore, in these studies we only examined large or small pictorial portion size nudges, therefore, it would be valuable to understand how nudges which depict the recommended portion size influence children's fruit and vegetable consumption.

The results of these studies may also be explained by how visually appealing the pictorial nudges were. Research has shown that visually appealing food promotes consumption (Jansen, Mulkens, & Jansen, 2010; Van Kleef, Vrijhof, Polet, Vingerhoeds, & de Wijk, 2014). For example, van Kleef et al (2014) found that presenting whole wheat rolls in a fun shape almost doubled consumption of whole wheat bread, while Jansen et al. (2010) showed that children ate more fruit when it was presented in a visually appealing way (e.g. a variety of fruit on cocktails sticks stuck in a melon, vs. the same fruit on a plain plate). Thus, in the present studies the fruit nudge in study 1 may have been more appealing than the control condition (no image), and the large portion nudge in study 2 may have been more appealing than the small portion nudge and control. However, this explanation is speculative since we did not collect any information about whether children found one of the plates more visually appealing than the other, and future studies are needed to address this.

Due to the novelty of this approach it is important to gain a deeper understanding of how pictorial nudges influence children's eating behaviour. In the present studies the pictorial nudge presented to the children was the same as the food on offer and children were only offered one food option. Therefore, it is not clear whether these nudges may influence children's food choice, encouraging children to select the food depicted in the nudge over options of varying healthfulness. It is also not clear whether an image of fruit or vegetables may generalise and influence children's consumption of other types of fruit and vegetables (for example, whether an image of carrots may influence consumption of broccoli or is specific to carrot consumption). In the present studies, children participated alone, however, in a real-world setting such as the home environment, it is likely that parents would be present. Therefore, examining the impact of pictorial nudges with present parents would be an important avenue for future research. Furthermore, since the research to date has only examined the influence of pictorial nudges on one occasion, examining the longer-term impact of this type of nudge would be of value. Understanding these factors would enable a greater understanding of how and when pictorial nudges influence children's eating behaviour, and would be informative for interventions using the nudge approach.

In conclusion, the results of these studies provide the first evidence that pictorial nudges influence children's fruit consumption, and indicate that the portion size of the pictorial nudge may be key to whether children are influenced. Future research investigating whether pictorial nudges communicate normative information, whether they influence children's food choice or are specific to the image depicted, and whether the influence of pictorial nudges persist over time, would be of value.

Conflicts of interest

On behalf of all authors, the corresponding author states that there is no conflict of interest.

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Appendix A. Supplementary data

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