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Prompting vegetable purchases in the supermarket by an affordance nudge: Examining effectiveness and appreciation in a set of field experiments

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ABSTRACT

The supermarket is a promising location for stimulating healthier food choices by nudging interventions. However, nudging healthy food choices in the supermarket has shown weak effects to date. The present research introduces a new nudge based on the concept of affordances – i.e., an animated character – that invites interaction with healthy food products and examines its effectiveness and appreciation in a supermarket context. We present findings of a series of three studies. In Study 1, evaluations of the new nudge were collected, revealing that the nudge was appreciated. In Studies 2 and 3, field experiments were conducted to test the nudge's effect on vegetable purchases in a real-life supermarket. Study 3 demonstrated that vegetable purchases increased significantly (up to 17%) when the affordance nudge was placed on the vegetable shelves. Furthermore, customers appreciated the nudge and its potential for implementation. Taken together, this set of studies presents compelling findings illustrating the potential of the affordance nudge for increasing healthy choices in the supermarket.

1. Introduction

Numerous scientists and policy makers aim to tackle the pressing question of how to support people in making healthier food choices without intruding on their freedom of choice. More than a decade ago, the concept of nudging was introduced to address this matter (Thaler & Sunstein, 2008). Nudges modify the choice architecture so that the environment favours the desired option by making it the convenient and attractive choice without using financial incentives (Service et al., 2014). Nudges have shown to be a promising, easy to implement, and cost-effective tool for improving decisions about health and well-being (Benartzi et al., 2017). Since the concept of nudging was introduced, a large variety of nudge interventions has been applied to promote healthy food choices, including easy access to a more desirable option, such as when healthier food choices are positioned at the front counter (Adjoian et al., 2017; Bucher et al., 2016; Cheung et al., 2019; Kroese et al., 2016). Other nudges aim to increase the salience or visibility of a more desirable option, for example by making the vegetarian option on a menu stand out (Bacon & Krpan, 2018). Nudges can also involve decreased effort in selecting a more desirable option, for instance by presenting healthier choices as the default (Friis et al., 2017; Van Gestel et al., 2020). Overall, meta-analyses suggest promising effects of nudges to promote healthy food choices (Arno & Thomas, 2016; Broers et al., 2017; Hollands et al., 2013; Hummel & Maedche, 2019). However, in the supermarket setting, one of the core food choice locations, nudging effects are modest (Cadario & Chandon, 2019). This may be because food choice in the supermarket involves selecting from a huge variety of tempting options, with variety mitigating the nudge effect (Seymour et al., 2004).

In the present study, we aim to test a novel type of nudge that may be effective in promoting healthy food choices in the supermarket by explicitly *inviting* customers to consider a healthy option (i.e., vegetables), based on the notion of affordances. Affordances relate to opportunities for action that stimuli or objects present (Gibson, 1977). As such, affordances provide a unique avenue for nudge design as they may generate nudges that help people in choosing the more favourable option by making this option more relevant in the midst of a noisy environment such as the supermarket context. The gist of affordances is illustrated by the automatic activation of the motor system when people observe an object that affords action, such as when someone sees an object that can be grasped - like a mug with a handle pointed towards one's dominant hand (McNair et al., 2017). Several studies suggest that small changes in the environment can indeed afford action toward the nudged food. For instance, observing proximal foods was found to

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activate consumption-related information as compared to foods at a distance (Hunter et al., 2018; Junghans et al., 2013; Maas et al., 2012; Wansink et al., 2006). These findings suggest that presenting healthy food choices in a way that activates interaction with them could be used to nudge the healthy option.

Importantly, objects that afford action have been reported to trigger precisely the type of responses that nudges aim to achieve with respect to the more desirable option. Specifically, they have been shown to capture visual attention, to be liked more as reflected in higher ratings on attractiveness and preference, and to lead to increased purchase intentions (Eelen et al., 2013; Elder & Krishna, 2012; Handy et al., 2003). More in general, affordances are regarded to bring about a natural response to interact with the object of interest. While some existing nudges may already draw attention to the affording properties of the nudged option, the concept of affordances has so far not explicitly been employed for developing nudge interventions.

In the present research, we aim to provide proof of concept for a novel affordance nudge by examining its impact on healthy food choices in a series of studies. Despite the fact that many people aim to eat healthily (De Ridder et al., 2014), they often do not succeed in making healthy food choices in daily life (De Ridder et al., 2017), as illustrated by the alarmingly high overweight statistics (WHO Factsheet,). Nudging healthy food options may resolve the difficulty that people experience in following up on their healthy eating intentions. Our research is driven by the notion that an affordance nudge invites people to interact with the desirable option. We do so by employing gaze cueing (directing the gaze towards a stimulus) to draw attention to the affording properties of healthy food (Bach & Schenke, 2017). Gaze cueing has been found to increase preference for the stimulus towards which the gaze is directed (Van der Weiden et al., 2010), and bring about faster responses to the stimuli to which the gaze is directed (Frischen et al., 2007). The novel nudge consists of an animated interactive character on a monitor inviting people to choose the desirable option by leaning and gazing towards this option when people approach the display (see Fig. 1). A small camera attached to the monitor detects whether a person approaches and reaches for the preferred option. The animated character provides positive feedback when the person takes the nudged product by smiling and raising its thumb. When the customer does not reach for the nudged product, the character returns to its default setting of looking ahead with a neutral expression.

We investigated the novel nudge in three studies. In Study 1, we evaluated whether the nudge was perceived as an invitation to make the preferred choice, so as to provide evidence that it affords the preferred choice. In Study 2, we examined the nudge's effectiveness in stimulating healthy choices (i.e., vegetable purchases) as well the feasibility of implementing it in a supermarket setting. Study 3 entailed a longitudinal experimental field study, with the goal of examining the effectivity and robustness of the affordance nudge in stimulating vegetable purchases in the supermarket. The latter study was conducted in two supermarkets, employing an AB-AB-AB design (6 weeks in total) with three experimental weeks alternating with control weeks. This design allowed for replicating the findings from Study 2 in a more stringent longitudinal design (Bucher et al., 2016).

We expected that the affordance nudge would be effective as indicated by increased sales numbers of the nudged vegetables (primary outcome). Furthermore, we explored the appreciation of the customers of the product setup with the affordance nudge (secondary outcome). The studies were approved by the Ethics Review Board of the Faculty of Social and Behavioral Sciences at Utrecht University, filed under number FETC19-032. All studies were part of the Supreme Nudge project that examines the effects of nudging and pricing strategies in supermarkets (Van Lakerveld et al., 2018).

2. Study 1: Invitingness of the affordance nudge

2.1. Method

2.1.1. Design of the affordance nudge

The nudge design consisted of five steps. First, the concept of affordances was employed to create an animated figure that would invite customers to consider the purchase of vegetables. This concept was subsequently transformed into a nudge that could be implemented in a supermarket setting by an industrial designer. Next, we examined whether the nudge was considered feasible for implementation in a supermarket setting by the cooperative affairs manager of the Dutch supermarket chain in which the experimental field study would be conducted. Subsequently, a graphic designer animated the gender-neutral character presented on the monitor, after which the nudge was further developed technically by the Beta Lab of Science at Utrecht University. In this fifth and final step, the connection between the camera that would register movement was established and as such could inform the program whether and when the display of the animation should be adjusted. By doing so, the animation could respond accurately when the camera would detect someone walking by and reaching for the nudged product.

The animation video of the figure was designed to loop through three different stages (see Fig. 1), depending on people's actions detected through a non-hidden camera.

In Stage 1 the animated character was looking straight ahead. When a person approached the nudged products, stage 2 started with the character leaning forward and gazing towards the left or right products, depending on from which side the person approached. Third, if the person reached for the nudged product, the character looked up again, smiled and raised its thumb. Subsequently, or when the person did not reach for the nudged product, the monitor returned to the default setting.

2.1.2. Study design and procedure

Participants were academic professionals from multiple disciplines who were invited to evaluate a novel vegetable display. After signing the informed consent form, they were instructed to choose some vegetables from the display and to fill out a pen-and-paper questionnaire afterwards. The vegetable display (see Fig. 2) consisted of a table with two baskets filled with snack sized vegetables, with the monitor displaying the affordance nudge placed behind the baskets. The animation video of the nudge would loop through the three different stages described earlier.

2.1.3. Participants

The sample comprised 66 participants (40 females) with ages ranging from 23 to 59 years ($M = 35.83 \pm 9.87$ years). They were not reimbursed for their participation.

Fig. 1. The affordance nudge in (a): the default setting, (b): when participants approach the vegetable display, and (c): after participants have picked a vegetable.

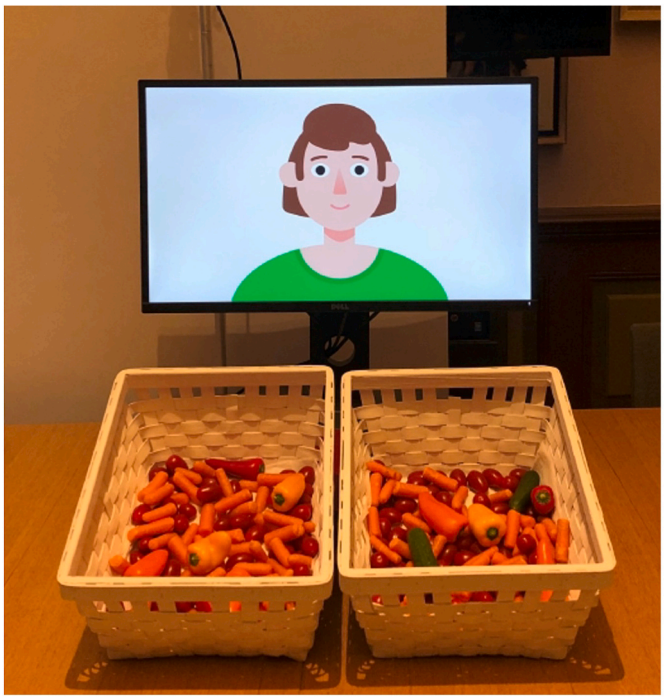

Fig. 2. The affordance nudge setup from Study 1, with the character in default setting.

2.1.4. Measures

We used several questions tapping into characteristics that are typically associated with affording stimuli: ease and pleasantness of accessibility of the vegetables; and attractiveness, invitingness, and salience of the vegetable display. We also measured the possible presence of concerns by asking whether participants felt patronized, directed, being watched and taken seriously. All responses were rated on a scale ranging from strongly disagree (1) to strongly agree (7). To assess feasibility of supermarket implementation, participants were asked "How would you feel if the vegetables in your supermarket would be presented in this manner?", using a scale ranging from very negative (1) to very positive (7). Finally, to assess how people evaluated the animation displayed on the monitor, participants responded to the statements "I like the animation" and "I identified with the animation" using a scale ranging from strongly disagree (1) to strongly agree (7).

2.2. Results and discussion

The vegetable display was overall evaluated positively (see Table 1 for an overview). Participants (academic professionals) agreed that taking the vegetables from the display was easy and pleasant. They also agreed that the vegetable display was rather attractive, inviting, and salient. Furthermore, they felt somewhat encouraged to choose one of the vegetables because they indicated not to feel patronized or directed. Participants did report to feel watched to some extent as well as to be taken seriously. In response to the question about implementation potential in their own supermarket, participants responded neutrally. Regarding the evaluation of the animation, participants did not identify themselves with the animation and did not particularly like or dislike the animation.

Table 1
Evaluation of the nudge (animated character vegetable display) on a 1–7 scale in study 1.

	M (*SD*)
Easy taking of vegetables	6.17 ± 1.34
Pleasant	5.28 ± 1.33
Attractive	4.67 ± 1.35
Inviting	4.92 ± 1.35
Salient	5.00 ± 1.24
Encouraging	4.50 ± 1.38
Patronizing	2.91 ± 1.40
Directing	3.86 ± 1.90
Being watched by animated character	4.41 ± 1.90
Taken seriously	4.21 ± 1.27
Implementation potential	4.00 ± 1.67
Identification with animated character	2.75 ± 1.46
General liking of the animated character	3.94 ± 1.57

Together, the results of Study 1 indicate that participants were positive about the nudge, particularly with regard to items that relate to affording properties of the nudge, i.e., inviting, attractive, salient, and accessible. These findings suggest that the nudge setup is indeed perceived as affording the choice of vegetables. In Study 1, we did not examine whether the nudge was effective in stimulating desirable choices, in particular in an ecologically valid setting, nor did we compare it to a control condition. We therefore conducted an experimental field study in a supermarket, complemented by interviews with customers and supermarket staff.

3. Study 2: Implementation of the affordance nudge in a supermarket setting

3.1. Method

3.1.1. Study design and procedure

Employing an A-B design (Kratochwill, 2013), Study 2 introduced the affordance nudge for promoting vegetable sales in a real-life supermarket in a large city in the Netherlands. We pre-registered that an increase of 5–10% in sold nudged vegetables would count as an effective nudge (Hoenink et al., 2020). The field experiment was conducted over a two-week course: week 1 served as the control condition with no nudge present and week 2 was the experimental condition during which the nudge was present. The same nudge setup was used as described in Study 1. The screen displaying the affordance nudge was placed behind one of the vegetable shelves (see Fig. 3).

Whereas our main outcome measure of vegetable purchases was derived from electronic cash registrations (see Measures section), we aimed to determine whether customer characteristics were similar over the control and the experimental week by asking a subsample of customers (at least 18 years old and regardless of whether or not they had bought vegetables) about their gender, age, and education level when exiting the supermarket after having paid for their purchases. Averaged

Fig. 3. The affordance nudge set-up in the supermarket from Study 2, with the character in default setting.

over both conditions, the sample ($N = 151$) consisted of 66% female customers with a mean age of 49.57 ± 17.37 years. Attained education equivalent to levels 1–2 of the European Qualifications Framework were classified as low (23% of participants), levels 3–5 were classified as middle (24%), and levels 6–8 were classified as high levels of education (53%).

3.1.2. Measures

We employed electronic cash registration of purchased vegetables that were placed in the vegetables aisle as a measure to determine nudge effectiveness. If the vegetables were sold packaged in a box or a bag, the number of packages was registered.

3.2. Results and discussion

3.2.1. Randomization check

A comparison of the characteristics of customers in the control week ($N = 60$) with those in the experimental week ($N = 91$) revealed no differences regarding age, $t(148) = 0.921$, $p = .359$; gender, Fischer's exact test, $p = .081$; or education, Cramer's V = 0.20, $p = .413$).

3.2.2. Nudge effectiveness

During the nudge week, one of the nudged vegetables was on sale. We therefore excluded this product from the analyses. A *t*-test comparing the number of sold vegetables revealed a non-significant 13% increase for nudged vegetables sales in the experimental nudge week (191 vegetables sold; $M = 27.29 \pm 5.79$ per day) compared to the baseline week (169 vegetables sold; $M = 24.14 \pm 4.88$), $t(12) = 1.135$, $p = .279$ (two-sided). Because an increase of 5–10% was predetermined as the cut off value for an effective nudge, an increase of 13% may be considered promising with respect to the novel nudge's potential in stimulating healthy food choices.

Additionally, for explorative purposes we examined nudge effectiveness based on the proximity of the customer to the vegetables of interest, so as to provide preliminary evidence for the affording properties of the nudge. Breaking down vegetable sales according to their proximity to the customer (either within reach or further away) suggests that vegetable that were proximate to the customer were more often chosen in the presence of the animated character (129 vegetables sold) than without its presence (99 vegetables sold). Vegetables that were further away from the customer showed a smaller difference in sales between the control week and the experimental week, depending on whether vegetables on sale were included (119 during the control week and 144 during the experimental week) or excluded (during the control week and 62 during the experimental week).

4. Study 3: A longitudinal field study examining the effectiveness of the affordance nudge

4.1. Method

4.1.1. Study design and procedure

Employing an AB-AB-AB design, the affordance nudge was implemented to stimulate the sales of vegetables in two supermarkets in the Netherlands, both located in neighbourhoods with a below average SES (based on postal code SES scores of The Netherlands Institute for Social Research, SCP, 2018). Health effects of unhealthy diets tend to cluster in people with a lower SES (Mackenbach, 2012) and health inequalities based on SES may be amplified as educational health interventions do not always sufficiently reach people with lower SES (McGill et al., 2015). Nudges could prove beneficial because adjustments within the choice environment may reach all individuals, including those with a lower SES (Marteau et al., 2012; McGill et al., 2015). The experiment started with a control (A) condition lasting one week, followed by a nudge (B) condition lasting one week (i.e., cycle one = week 1 and 2, cycle two = week 3 and 4, cycle three = week 5 and 6). In the control weeks, no nudge was present. In the nudge weeks, the monitor displaying the affordance nudge was placed behind one of the vegetable displays (see Fig. 4).

Our primary outcome was the sales of the nudged products. In addition to sales data, we examined customer evaluation of the nudge by questionnaires in each supermarket on one day per week in each of the six weeks. On that day, one of the researchers would stand near the vegetable display. If a customer walked near the vegetable display, it was explained that we were interested in their opinion of the novel display. All questionnaires were administered after vegetable selection, so that asking for evaluations would not interfere with nudge effects. If customers were willing to fill out the questionnaire, they signed the informed consent form and were given the pen-and-paper questionnaire to fill out. After completion of the questionnaire, the customer was thanked, shortly debriefed, and was given a supermarket coupon of 5 euros as compensation for their participation.

To estimate the required sample size, we performed an a priori power analysis in G*Power 3.1 ($\alpha = 0.05$, power = 80%). Based on a meta-analysis examining the effect of nudging on fruit and vegetable intake (Broers et al., 2017) we estimated a moderate effect size of $d = 0.03$. This power analysis revealed that a total of 352 participants (176 per condition) should be sufficient. A total of 361 customers participated. Participants' age ranged from 18 to 86 years ($M = 53.45 \pm 16.26$). The majority (76%) of participants was female. Attained education equivalent to levels 1–2 of the European Qualifications Framework were classified as low (32% of participants), levels 3–5 were classified as middle (40%), and levels 6–8 were classified as high levels of education (28%).

4.1.2. Measures

Sales numbers. Sales numbers of the nudged vegetables (i.e., those that were placed below the monitor displaying the affordance nudge) were electronically registered for each supermarket. If the vegetables were sold packaged in a box or a bag, the number of packages was registered. Additionally, we had access to the total number of sales for all product categories for each supermarket. We calculated nudged products sold as percentage of total sales of relevant product categories (i.e., excluding all non-food categories, alcoholic beverages, and baby food) as the main outcome measure for nudge effectiveness, so as to provide a more conservative test of effectiveness rather than comparing the number of sold vegetables across conditions. This measure was calculated per day by dividing the total number of nudged products sold by the total sales of relevant product categories, multiplied by 100 (where sales data for each day constituted one data point, in line with Van Gestel et al., 2018). Because the affordance nudge was either placed (in nudge weeks) or removed (in control weeks) on Monday during the day, we did not include Mondays in the sales data and analyses.

Questionnaires. Eight questions assessed participants' appreciation of the vegetable shelf. The first four questions were introduced with the statement "*The following questions are about the way the vegetables are presented on this vegetable shelf.*". This was followed by "*Do you find this [arrangement] attractive?*" (attractiveness), "*Do you find this inviting?*" (invitingness), "*Do you find this salient?*" (salience), and "*Do you think it is easy to pick up vegetables from this shelf?*" (ease). The following four questions were introduced with the statement "*The following questions are about how you would feel if you were to pick vegetables from this shelf.*". This was followed by "*Would you feel encouraged?*" (encouraged), "*Would you feel patronized?*" (patronized), "*Would you feel directed?*" (directed), and "*Would you feel taken seriously?*" (taken seriously). To control for hunger during the experiment, participants were asked "*How hungry are you right now*?". To measure whether participants considered healthy eating important, we asked "Do you find it important to eat healthily?". For all of these questions, we employed answering scales with three options ('yes', 'a bit', 'no/not at all') to facilitate people with low health literacy to understand and complete the questionnaire, based on recommendations of the Dutch Centre of Expertise on Health Disparities

Fig. 4. The affordance nudge set-up in the supermarket from Study 3. The figure shows the vegetable shelf in supermarket 2 in: (a) control condition, and (b) in the experimental condition, with the monitor displaying the character in default setting.

(Pharos, 2021). To assess whether participants were shopping at their usual supermarket, they were asked "*Do you usually do your shopping in this supermarket?*" to be answered with *yes* or *no*. To assess nudge awareness, we asked "*Does anything stand out to you on this vegetable shelf?*". When participants responded with yes, they could fill out what they noticed, and what their opinion of it was.

4.1.3. Analytic strategy

4.1.3.1. Sales data. We first conducted a factorial ANOVA (in line with Van Gestel et al., 2018) with percentage of nudged product sales per day as dependent variable, and experimental condition, cycle, and location as independent variables. Second, a sensitivity analysis (factorial ANOVA) was conducted with the percentage of healthy, non-nudged product sales as outcome measure, in order to examine whether a possible increase in nudged vegetable sales was not at the expense of sales of other healthy products. In addition to frequentist statistical tests, we performed Bayesian analyses in JASP (JASP Team, 2022) to quantifying the evidence for the hypotheses (Hoijtink et al., 2019).

4.1.3.2. Customer data. We first examined whether randomization across experimental conditions was successful by comparing the control measures of participants in the two different conditions and the two different supermarket locations. Next, we examined whether appreciation of the vegetable shelf differed between experimental conditions by conducting Mann Whitney U-tests for the full sample as well as per location (supermarket 1 and supermarket 2), with experimental condition (control vs. nudge) as the independent variable. Bonferroni correction was applied to account for multiple hypothesis testing, resulting in an adjusted p-value of .002 (0.05/24).

4.2. Results

4.2.1. Sales data

4.2.1.1. Nudged product sales. A factorial ANOVA with experimental condition (control vs. nudge), cycle (one vs. two vs. three) and location (supermarket 1 vs. 2) as independent variables, and the number of nudged product sales as a percentage of all relevant supermarket sales (i.e., excluding all non-foods, alcohol, and baby food) per day as dependent variable was performed to assess nudge effectiveness. Importantly, this analysis revealed a main effect of experimental condition, $F(1,60) = 6.48$, $p = .014$, with a medium to large effect size (Cohen, 1988) of $\eta_p^2 = 0.10$. The number of nudged products (as the percentage of all relevant supermarket sales) sold per day was significantly larger in the nudge vs. the control condition (Mean difference of 0.08, 95% CI [0.02, 0.15]), as was also indicated by an increase of 17% in nudged product sales from control to nudge condition (see Table 2). It should be noted that a nudge effect of this size is remarkable, given the reported low effectiveness of nudges in supermarkets (Cadario & Chandon, 2019).

There was no main effect of cycle ($F(2,60) = 0.59$, $p = .560$, $\eta_p^2 = 0.02$), nor an interaction between condition and cycle ($F(2,60) = 2.20$, $p = .120$, $\eta_p^2 = 0.07$). There was also no main effect of location ($F(1,60) = 1.47$, $p = .230$, $\eta_p^2 = 0.02$), no interaction between location and cycle ($F(2,60) = 0.05$, $p = .955$, $\eta_p^2 = 0.00$), no interaction between location and condition ($F(1,60) = 0.71$, $p = .404$, $\eta_p^2 = 0.01$), nor an interaction between location, cycle, and condition ($F(2,60) = 0.74$, $p = .481$, $\eta_p^2 = 0.02$). Together, these results indicate a robust effect of the nudge across time and location. Conducting the same analysis while excluding four outliers did not change the significance nor direction of these results. A Bayesian analysis of variance indicated that the model including only the main effect of experimental condition was most likely given the data. The data were 10.33 times more likely to be observed under this model, compared to the other models ($BF_M = 10.33$) and 3.77 times more likely to be observed under this model than under the null model ($BF_{10} = 3.77$).

4.2.1.2. Sensitivity analysis: percentage of healthy, non-nudged product sales. To examine whether the increase in nudges healthy products affected sales of other healthy, non-nudged products, a factorial ANOVA

Table 2
Percentage of Nudged Product Sales from all relevant sales in the Control and the Nudge Condition in Study 3.

		Full sample *M* (*SD*)	Supermarket 1 *M* (*SD*)	Supermarket 2 *M* (*SD*)
Overall	Control	0.49 (0.12)	0.52 (0.12)	0.45 (0.12)
	Nudge	0.57 (0.15)	0.57 (0.19)	0.56 (0.12)
	Overall	0.53 (0.14)	0.55 (0.16)	0.51 (0.13)
	Change (in %)	17.14	10.73	24.50
Cycle 1	Control (week 1)	0.51 (0.13)	0.52 (0.11)	0.49 (0.12)
	Nudge (week 2)	0.51 (0.11)	0.54 (0.13)	0.47 (0.09)
	Overall (week 1–2)	0.51 (0.12)	0.53 (0.13)	0.48 (0.10)
	Change (in %)	−0.45	3.74	−4.86
Cycle 2	Control (week 3)	0.48 (0.12)	0.53 (0.11)	0.43 (0.13)
	Nudge (week 4)	0.57 (0.12)	0.54 (0.15)	0.59 (0.09)
	Overall (week 3–4)	0.52 (0.13)	0.54 (0.12)	0.51 (0.14)
	Change (in %)	17.96	2.01	37.67
Cycle 3	Control (week 5)	0.47 (0.12)	0.50 (0.13)	0.43 (0.11)
	Nudge (week 6)	0.63 (0.20)	0.64 (0.27)	0.63 (0.12)
	Overall (week 5–6)	0.55 (0.18)	0.57 (0.21)	0.53 (0.15)
	Change (in %)	35.39	27.21	44.94

Note. The reported numbers represent nudged product sales as percentage of total relevant (i.e., excluding all non-food categories, alcoholic beverages, and baby food) product sales.

with experimental condition (control vs. nudge), cycle (one vs. two vs. three) and location (supermarket 1 vs. 2) as independent variables, and the number of healthy, non-nudged product sales (as a percentage of all relevant products) per day as dependent variable was performed. Importantly, no effects of condition showed in this analysis (Mean difference = 0.25, 95% CI [−0.37, 0.86], indicating that the increase in nudged product sales observed in the current study, did not induce a decrease in sales of other healthy products.

There was no main effect of experimental condition ($F(1,60) = 0.68$, $p = .413$, $\eta_p^2 = 0.01$), no interaction between condition and cycle ($F(2,60) = 1.83$, $p = .169$, $\eta_p^2 = 0.06$), no interaction between condition and location ($F(1,60) = 0.51$, $p = .479$, $\eta_p^2 = 0.01$), nor an interaction between condition, cycle, and location ($F(2,60) = 0.13$, $p = .878$, $\eta_p^2 = 0.00$). Furthermore, there was no main effect of cycle ($F(2,60) = 1.31$, $p = .278$, $\eta_p^2 = 0.04$), and no interaction between location and cycle ($F(2,60) = 0.09$, $p = .918$, $\eta_p^2 = 0.00$). A main effect of location did show ($F(1,60) = 8.42$ $p = .005$, $\eta_p^2 = 0.12$), indicating that a larger percentage of healthy, non-nudged products were sold overall in supermarket 1 ($M = 8.98 \pm 1.33$), compared to supermarket 2 ($M = 8.11 \pm 1.14$). A Bayesian analysis of variance indicated that the model including only the main effect of location was most likely given the data. The data were 13.07 times more likely to be observed under this model compared to the other models ($BF_M = 13.07$) and 8.94 time more likely to be observed under this model than under the null model ($BF_{10} = 8.94$).

4.2.2. Questionnaire data

4.2.2.1. Randomization checks. Separate two-way ANOVAs with experimental condition (control vs. nudge) and location (supermarket 1 vs. 2) as between subject factors, showed that there were no differences in participants' age (all $ps \geq .261$), healthy eating importance (all $ps \geq .196$), and hunger (all $ps \geq .633$). With respect to education level, there was no main effect of condition ($p = .136$), nor an interaction effect ($p = .997$). Education level was significantly higher in supermarket 2 ($M = 2.08 \pm 0.77$) compared to supermarket 1 ($M = 1.83 \pm 0.76$), $F(1,355) = 10.00$, $p = .002$, $\eta_p^2 = 0.03$. Fisher's exact tests for sex ($ps \geq .236$), and for regular supermarket ($ps \geq .265$) showed no differences across conditions and locations. Besides a small difference in education level between the two supermarkets, these results thus indicate successful randomization. See Table 3 for sample descriptives.

Table 3
Descriptives of the full sample and the sample per supermarket in study 3.

		Full sample	Supermarket 1	Supermarket 2
N		361	180	181
Age				
	M	53.45 ± 16.26	52.58 ± 17.37	54.32 ± 15.08
	Range	18–86	18–86	18–86
Sex				
	Male	87 (24%)	31 (17%)	46 (26%)
	Female	274 (76%)	149 (83%)	125 (69%)
Education level				
	Low	116 (32%)	70 (39%)	46 (25%)
	Middle	143 (40%)	70 (39%)	73 (41%)
	High	100 (28%)	39 (22%)	61 (34%)
Healthy eating importance				
	Yes	348 (97%)	173 (97%)	175 (97%)
	Somewhat	11 (3%)	6 (3%)	5 (3%)
Hunger				
	A lot	31 (9%)	18 (10%)	13 (7%)
	Somewhat	137 (38%)	64 (36%)	73 (41%)
	None	192 (53%)	98 (54%)	94 (52%)
Regular supermarket				
	Yes	261 (73%)	138 (78%)	123 (68%)
	No	98 (27%)	40 (22%)	58 (32%)

4.2.2.2. Nudge evaluation. We conducted Mann Whitney U-tests for the full sample as well as per location (supermarket 1 and supermarket 2) with experimental condition (control vs. nudge) as the independent variable and the score per questionnaire item concerning the vegetable shelf as dependent variables. As can be seen in Table 4, there were no differences in appreciation of the vegetable display across conditions given the Bonferroni adjusted *p*-value of .002. Hence, implementing the affordance nudge did not reveal any differences in the evaluations of the vegetable shelf compared to when it was not implemented. It should be noted that we used a 3-point nominal scale to assess customer evaluations to accommodate low levels of health literacy, which may be considered a limitation of these assessments.

5. General discussion

In the present research, the concept of affordances was introduced as a way to develop a new kind of nudge that would be effective in a supermarket setting. Nudging is generally regarded as a promising and effective policy tool to stimulate desirable choices, including healthy food choices (Benartzi et al., 2017). In view of nudges' overall modest efficacy in supermarket settings (Cadario & Chandon, 2019), a new type of nudge is much needed. As such, proof of concept of the effectiveness of the novel affordance nudge was examined in three studies in which healthy food choices were nudged. Study 1 consisted of people's evaluation of the nudge with respect to whether it indeed was perceived as inviting and affording action. Study 2 consisted of an experimental field study in a supermarket examining the nudge's efficacy in increasing healthy food choices, and the feasibility of real-life implementation of the novel nudge. Study 3 entailed a six-week longitudinal experimental field study to test robustness of the nudge effectiveness over time.

Several results stand out. First, participants perceived the affordance

Table 4
Appreciation on a 1–3 scale of the Vegetable Shelf in the Control and the Nudge Condition in Study 3.

Item		Control *M* (*SD*)	Nudge *M* (*SD*)	*W*	*p*
1	Overall	1.35 ± 0.52	1.35 ± 0.58	16671	.635
	Supermarket 1	1.21 ± 0.44	1.14 ± 0.38	4317	.238
	Supermarket 2	1.49 ± 0.57	1.55 ± 0.67	3993	.743
2	Overall	1.43 ± 0.62	1.44 ± 0.66	16494	.808
	Supermarket 1	1.28 ± 0.54	1.21 ± 0.47	4276	.360
	Supermarket 2	1.59 ± 0.65	1.66 ± 0.73	3942	.632
3	Overall	1.78 ± 0.80	1.74 ± 0.80	16670	.608
	Supermarket 1	1.68 ± 0.79	1.62 ± 0.79	4216	.601
	Supermarket 2	1.89 ± 0.80	1.86 ± 0.80	4132	.803
4	Overall	1.16 ± 0.45	1.11 ± 0.36	16858	.293
	Supermarket 1	1.17 ± 0.46	1.07 ± 0.29	4367	.075
	Supermarket 2	1.16 ± 0.45	1.15 ± 0.42	4063	.875
5	Overall	1.84 ± 0.80	1.70 ± 0.78	17959	.070
	Supermarket 1	1.74 ± 0.80	1.46 ± 0.71	4857	.010
	Supermarket 2	1.94 ± 0.78	1.93 ± 0.77	4123	.935
6	Overall	2.84 ± 0.48	2.86 ± 0.42	16248	.940
	Supermarket 1	2.87 ± 0.40	2.77 ± 0.54	4329	.192
	Supermarket 2	2.81 ± 0.54	2.95 ± 0.23	3805	.095
7	Overall	2.67 ± 0.63	2.69 ± 0.61	16060	.756
	Supermarket 1	2.70 ± 0.63	2.64 ± 0.66	4224	.503
	Supermarket 2	2.63 ± 0.64	2.74 ± 0.55	3799	.263
8	Overall	1.39 ± 0.67	1.25 ± 0.57	17712	.028
	Supermarket 1	1.33 ± 0.65	1.17 ± 0.48	4508	.049
	Supermarket 2	1.44 ± 0.69	1.33 ± 0.64	4340	.226

Note. Item 1 = Attractiveness; Item 2 = Invitingness; Item 3 = Salience; Item 4 = Ease; Item 5 = Encouraged; Item 6 = Patronized; Item 7 = Directed; Item 8 = Taken seriously. Mann Whitney U-tests were performed because the 1–3 scale was not adequate for parametric analysis. The critical *p*-value was .002 (after Bonferroni correction).

nudge as inviting and attractive, while they felt only mildly patronized or directed in Study 1. These findings suggest that the novel nudge was successful in affording action as intended. Second, the first experimental field study (Study 2) showed the nudge to be effective in stimulating vegetable purchases in the supermarket. The number of nudged vegetable sales per week increased by as much as 13% (albeit not significant) from the control to the nudge condition when vegetables on sale were left out; a percentage that is rarely found in any intervention aimed at increasing healthy food purchases regardless of whether it concerns nudging or other approaches to change food choices (Adjoian et al., 2017; Broers et al., 2017; Yi et al., 2022). Considering the predetermined threshold for a meaningful effect being 5–10%, this increase is promising with respect to the novel nudge's effectiveness. The finding that the nudge was more effective in encouraging vegetable purchases that were close to the customer as compared with vegetables that were further away provides suggestive evidence that it wat not mere salience of the nudge display that increased vegetable sales in the experimental condition but rather the affording properties of vegetables that were within reach of the customer; and which were made prominent by the presence of the nudge display. These results speak even more when considering the fact that nudges are generally less effective in stimulating healthy food choices than they are at reducing unhealthy food choices (Cadario & Chandon, 2019), indicating that this first test of the nudge's effectiveness is a rather strict one.

Finally, the longitudinal field study (Study 3) provided clear and statistically significant evidence that the affordance nudge effectively stimulated healthy food choices (i.e., vegetable purchases) in the supermarket. Over the course of six weeks, we implemented the affordance nudge in two different supermarkets with three nudge weeks alternating with control weeks. Nudged vegetable sales increased with 17% from control to nudge condition. Within the reported set of studies, we extended our first results by use of a more robust longitudinal design in two supermarket settings as well as by testing effectiveness in the most conservative manner by accounting for all other supermarket purchases by customers. As highlighted earlier, it is of importance to replicate nudge studies (Arno & Thomas, 2016), as well as to examine nudge effectiveness over longer periods of time (Bucher et al., 2016). Additionally, repeating control and experimental weeks had the benefit of controlling for unknown potential other influences.

Examining customers evaluations of nudge implementations is important as it provides empirical evidence for the discussion on the legitimacy of nudging, which to date remains somewhat restricted to hypothetical situations (De Ridder et al., 2022; Wachner et al., 2020). There were no differences between customer evaluations of the control and experimental condition in the longitudinal Study 3, indicating that the vegetable shelf with and without the affordance nudge were appreciated equally. In view of continuing debate on the legitimacy of nudges as a potentially manipulative way of influencing choices (e.g., Grüne-Yanoff, 2012), these findings are promising, suggesting that customers did not experience the affordance nudge as overly intrusive and/or patronizing. It should be noted that customer evaluations were measured on a three-point answer scale. This set-up allowed people of different health literacy levels to understand the questionnaire, but it may also have prevented detection of smaller differences in appreciation.

Taken together, findings from the present research suggest that the novel nudge is indeed impactful in stimulating healthy choices despite the absence of a statistically significant effect in Study 2. Interestingly, including the vegetables on sale in the analysis of Study 2 increased the sales of nudged vegetables from 13% to 25% (data not shown). This suggests that a combined nudging and pricing strategy could be even more effective than a nudging only strategy (Stuber et al., 2021; Van der Molen et al., 2021). Nevertheless, pricing strategies might not always be preferred by the retail industry, possibly reducing the applicability of such a combined approach in real-life settings. It is therefore encouraging that the nudge's effectiveness in stimulating desirable choices clearly exceeded the predetermined threshold of 5–10% in the longitudinal field study.

On a more theoretical note, our findings show that the concept of affordances can be beneficial in the development of nudge concepts that are acceptable to the target audience. Having a clear theoretical conceptual framework provides guidance to develop effective nudges in a more systematic way, while at the same time contributing to understanding how nudging works. Based on the current study's findings, it would be useful for future studies to examine whether the efficacy of nudges might be enhanced by emphasizing the affording properties of the nudged options. This could be done by utilizing measures that have been shown to be successful in determining the affording properties of objects, such as by measuring the attractiveness and the preference for the nudged options (Eelen et al., 2013) or whether the nudged options capture visual attention (Handy et al., 2003).

The potential of the concept of affordances for the development of nudges is also of high relevance with respect to the ongoing discussion about the legitimacy of nudging. Based on the current study, we propose that nudges need not be inherently manipulative as has been suggested and that nudges that are based on inviting people to make more desirable choices can indeed be effective. This notion concurs with studies suggesting that nudges may in fact enhance choice autonomy through facilitation of choices that individuals would prefer to make (de Ridder et al., 2022). Viewed from this perspective, nudges may facilitate making healthy food choices, which is relevant for people encountering difficulty in complying with their goal to eat healthily (de Ridder et al., 2017).

A question that remains relates to the fact that the affordance nudge was designed such that it provided an individual with positive feedback (i.e., a smile and thumbs up) when a nudged product was chosen. The effect of this feedback was not explicitly examined in the current studies. Because this feedback is given post-decision, it can be assumed that it does not influence momentary choices. It would however be relevant to test whether receiving positive reinforcement after making a more desirable choice that is being nudged affects people's follow-up choices and as such eventually maybe even their habits. If such longer-term effects of positive feedback after being nudged emerge, this would be highly beneficial for public health. For instance, the use of positive feedback could then be implemented more deliberately in nudging to stimulate the development of healthier food habits. Stimulating the development of healthier food choice habits is particularly pertinent given the current alarming obesity rates combined with the fact that many people often do not succeed in making healthy food choices despite their goal to eat healthily (De Ridder et al., 2017; WHO Fact-sheet,).

5.1. Conclusion

The present set of studies suggests that developing and testing novel nudge implementations based on the concept of affordances is a fruitful approach in the field of nudging. The findings show that the nudge was perceived as inviting, and that it stimulates desirable choices in a real-life setting in a highly effective manner. Though future research should replicate and extend the findings of the current set of studies, the results are promising with respect to the robust effectivity as well as the feasibility of implementation of the novel nudge.

Author contributions

MG, SB, FdB and DDR were involved in developing the nudge. MG, FdB, and DDR designed Study 1. MG, SB, and DDR designed Study 2 and Study 3. FdB and SB performed data analyses under supervision of MG and DDR. MG, SB, and DDR were involved in drafting the manuscript.

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Ethics statement

Ethical approval for the studies was obtained from the Ethics Committee of Utrecht University's Faculty of Social and Behavioural Sciences, filed under number FETC19-032.

Declaration of competing interest

The authors report no conflict of interest.

Data availability

Data will be made available on request.

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