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How head and visual movements affect evaluations of food products

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Abstract

Many studies suggest that specific movements or postures with shared social meaning can influence mainly verbal stimuli evaluation. On the other hand, several visuospatial biases can interact with this influence. Thus, we tested whether both head and stimuli movements can influence individual attitude towards food pictures. In two experiments, we used images of common foods with a weak positive valence in association with two kinds of movements. In Experiment 1, head movement was induced by presenting food pictures with a vertical or horizontal continuous movement on a computer screen. Conversely, Experiment 2 was conducted to test the effects of participants' own head movements with respect to the same food pictures presented in a fixed position. In neither case did head movements influence product evaluation. However, Experiment 1 revealed that the continuous movement left-right-left in the horizontal condition improved the desire to buy and eat, as well as the willingness to pay for the product shown. Two further experiments, the Experiments 3 and 4 demonstrated, respectively, that this effect disappears if the stimulus does not make the return direction, and that it does not depend on the starting or final placement of the images on the screen. These findings are discussed in the context of embodied cognition and visuospatial bias theories.

Keywords Decision making · Embodied perception · Visual perception

Introduction

In traditional economic theory, consumer behavior implies a rational decision aimed at maximizing personal gain and utility (Samuelson, 1938). It is a well-accepted idea that utility is a driving force for some human behavior, especially consumer behavior (Ariely & Norton, 2008). This means that the decision to purchase a product would be determined from the estimated advantages that the purchased item provides to the consumer. So, the choice, the preference, and the judgement of a certain product could be the result of this rational estimation that the consumer makes before any purchase (e.g., Lutz & Bettman, 1977; Tom et al., 1991). However, many studies suggest that some aspects of consumer behavior can be affected by certain bodily factors, like specific movements or postures. These findings were demonstrated in the embodied cognition research, in which the manipulation of specific body regions affected some behavioral aspects.

In 1988, a famous experiment carried out by Strack and colleagues showed that by manipulating the facial expression of participants using a simple pen, it was possible to influence their stimuli response and preferences. In this experiment (Strack et al., 1988), participants held a pen with their lips, so as to simulate a pursed (i.e., negative) expression, or with their teeth, so as to simulate a smiling (i.e., positive) expression, before evaluating some funny cartoons. The results showed that if a smiling expression was induced, the cartoon was evaluated in a more positive way compared with the induced pursed expression (Strack et al., 1988). These results have been replicated more recently (e.g., Paredes et al., 2013).

In addition, the manipulation of arm movements can also influence attitudes. In particular, arm extension or flexion conveys approach and avoidance, desirability and

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refusal (Solarz, 1960). For example, in Förster (Förster, 2003) the arm flexion condition led participants to consume more food and drink compared to the arm extension condition. In a more recent study (Van Den Bergh et al., 2011), these types of movements were used in a series of experiments in order to evaluate their influence on purchase behavior, product preferences, and economic decisions. It was shown that approach behavior can increase the purchase of products that offer immediate benefits. In some of the other experiments carried out by the authors, the arm extension was able to influence more generally the preferences in intertemporal choice towards immediate benefits over delayed ones.

Influence of head nodding and head shaking on product evaluation

The possibility of manipulating agreement or disagreement judgments have also been tested using head movements. Particularly, head nodding and shaking are able to influence the agreement or disagreement to a novel/unknown persuasive message (Wells & Petty, 1980) and the specific attitude towards products (Tom et al., 1991). Briñol and Petty (2003) suggest that these gestures can influence our attitudes according to the self-validation theory: head nodding would confirm the validity of a thought, whereas head shaking would suggest that a thought is wrong, reducing its validity. Particularly, in the case of the Wells and Petty work (Wells & Petty, 1980), when participants' thoughts were favorable, head nodding increased persuasion (and confidence), and head shaking reduced it (conveying disapproval). On the other hand, Förster (Förster, 2004) manipulated the movement of the written name of some well-known food products, on a giant screen, inducing head shaking and nodding in their participants in order to investigate whether such body feedback affects the liking and the desire to buy those products. The experiment demonstrated that participants showed a greater liking and a greater desire to buy the pleasant products when the stimulus displayed induced a vertical head movement (nodding), whereas a horizontal head movement (denying) decreased liking and desiring of unpleasant products. Such an effect was in line with the conceptual-motor compatibility model (Förster & Strack, 1996): when the stimulus valence and the body gesture valence are compatible and occur together (e.g., positive stimuli and head nodding), the stimuli processing is facilitated and its preference is improved, and vice versa. For example, in the case of Strack and colleagues' experiment (Strack et al., 1988), even if it is certainly possible to smile when we are unhappy or to nod when we disagree with a message, the execution of emotionally incongruent behaviors requires more effort (Moretti & Greco, 2018).

Influence of other visuospatial biases on product evaluation

The relationship between body feedback and affective evaluation is a central concept in embodied cognition. However, such a relationship is complex and multifaceted, and other visuospatial biases implicated in nodding and shaking head movements could have played a role in the aforementioned effects. For example, other studies, inspired by Rudolph Arnheim's work (Arnheim, 1965), have provided evidence for a spatial compatibility effect (Moretti & Greco, 2018, 2020) according to which the placing of a product on a vertical or horizontal dimension can play a role in its evaluation. For example, in the vertical dimension, the higher location is often associated with good things while the lower location with negative things, due to a metaphorical association (Lakoff & Johnson, 1980). In addition, the vertical spatial dimension also shows some embodiment effects due to the mental simulation process (Barsalou, 1999; Schubert, 2005). For example, Valenzuela and co-workers (2013) have shown on different consumer product categories that the more expensive items were associated with the top shelves. Deng and Kahn (2009) demonstrated that the position of a product image on a package can also influence consumers' perception of its heaviness, with the "heavier" items identified on the bottom-right, versus the top-left for “lighter” items. Sundar and Noseworthy (2014) have found greater purchase intention for the brand that has the logo placed in the higher rather than the lower position.

Regarding the horizontal dimension, the body-specificity hypothesis of Casasanto and colleagues (Casasanto, 2009; Casasanto & Chrysikou, 2011; Casasanto & Jasmin, 2010) states that right-handers tend to associate positive content with their right side and negative content with their left side (the opposite occurs with left-handed people). But a left-to-right bias has also been observed (Chae & Hoegg, 2013; Monahan & Romero, 2020), according to which individuals tend to have a preference for the reading/writing direction of their native language (left to right for Western society) when they have to represent visual stimuli in space (Chatterjee, 2001; Maass & Russo, 2003; Santiago et al., 2007). So, also this effect can be reconducted to an embodied phenomenon, due to the fact that this would be the result of the simulation of the oriented actions involved in writing and reading activities (Schubert & Maass, 2011; Suitner & Giacomantonio, 2012). Particularly, Cian and co-workers (Cian et al., 2014) showed that logo orientation (from left-to-right or from right-to-left) paired and matched with the innovation or the traditionality of the company (consumers' representation of time, past-left, future-right) leads to more favorable attitudes towards the company. Monahan and Romero (2020) observed that when consumers see an ad featuring an object (e.g., a car or an airplane) facing the left-to-right direction (rather than right-to-left), its brand trust perceptions are improved. In these cases, it has been demonstrated that the implied motion of the products can have an effect on the engagement, attention, and preferences of the consumer (Cian et al., 2014; Monahan & Romero, 2020; Suitner & Maas, 2016). But implicit movement is not the sole influence on the consumer's judgment. Even real movements following a specific trajectory are able to change the perception of the brand (e.g., company logos that move across the screens of mobile devices; Guido et al., 2016).

Research objectives

The decision-making variables and some aspects of consumer behavior seem to be affected by specific body factors and automatic impression, and not only by utility maximization (Camerer et al., 2005). Recently, a growing number of studies are investigating the numerous processes involved in decision-making in order to understand the way in which consumers make choices and decisions in real environments, through the analysis of specific actions and spatial biases, highlighting the importance of the somatic component of attitude (Connors & Rende, 2018). The embodied cognition approach supports the bidirectional influence between motor system and cognition. For example, Lepora and Pezzulo (2015) stated that specific body movement or images conveying movement or directionality (e.g., head movements) are able to influence attitudes (Barsalou, 2003). What has been lacking in this domain is evidence that body feedback can influence individuals' judgments of known picture stimuli. On the other hand, regarding the spatial biases, research has been limited to verbal stimuli (e.g., Chasteen et al., 2010; Dudschig et al., 2013; Lakoff & Johnson, 1980), or, if pictures have been used, they were static images conveying a sense of directionality instead of showing real movements (e.g., Chae & Hoegg, 2013; Cian et al., 2014; Kohli et al., 2002; Monahan & Romero, 2020).

Thus, we tested whether actual head-nodding and head-shaking movements have an influence on product preference and on the willingness to buy it. Particularly in our study, in contrast to previous ones (e.g., Förster, 2004; Wells & Petty, 1980), we present pictures of familiar foods with a weak positive valence. We use such stimuli since food selection and evaluation are mainly guided by visual factors (Linné et al., 2002; Padulo et al., 2018), and since in brand advertising the use of images is more effective than simple verbal communication (Mitchell & Olson, 1981; Monahan & Romero, 2020; Rossiter & Percy, 1978). On the other hand, the use of food pictures allows us to extend the knowledge about the embodiment cognition effects. In fact, while the conceptual-motor compatibility effect (Förster & Strack, 1996) explains well the effect of head nodding and shaking on strongly valenced words, the self-validation theory (Briñol & Petty, 2003) describes the effect that body feedbacks have on novel verbal message evaluations. In particular, Förster (2004) hypothesizes that head movements should not influence the evaluation of neutral and well-known stimuli (like our products), thus we predict that head shaking and head nodding do not influence evaluation of familiar food pictures with a weak positive valence.

Further, we intend to explore whether the place in which the image is presented or the trajectory of its movement can affect the attitude towards the products presented. In fact, both head gestures can be divided into more simple movements, like the trajectory left-to-right and vice versa (in the denying condition) or the last placement in which stimuli are displayed (e.g., the top or the bottom of the screen in the nodding condition). Most of the studies using pictures focused on the implied motion conveyed by the stimulus (i.e., directionality) instead of investigating the effect of real movement on participant attitudes. Hence, we wish to verify if some spatial compatibility effects (Moretti & Greco, 2018, 2020) can influence the evaluation of food pictures. Here we explore this effect in a context in which several spatial theories have been proposed both on the horizontal dimension (e.g., the body-specificity hypothesis of Casasanto, 2009 and the left-to-right bias of Suitner & Maas, 2016) and on the vertical one (e.g., higher-good and lower-bad hypothesis of Lakoff & Johnson, 1980, and the upper-light vs. lower-heavy arrangement of Deng & Kahn, 2009).

Experiment 1

In our first experiment, we replicate study 1 carried out by Förster (2004) using food picture products with a weak positive valence as stimuli, instead of showing just the name of negative and positive products; the images were shown on a computer screen moving vertically (i.e., nodding), horizontally (i.e., denying), or remaining motionless in the control condition. In order to extend the investigation, we added two further features, namely the willingness to pay and the desire to eat it. As in Förster's (Förster, 2004) research, the starting point of the stimuli was balanced, in order to control whether the movement direction (e.g., from the right to the left and backward vs. from the left to the right and backward in the nodding condition) influenced the product's evaluation.

Our aim was to test if the attitude towards food pictures is influenced mainly by the head nodding/shaking (e.g., motor-compatibility effect) or by spatial-attentional bias (left-to-right bias).

Materials and methods

Participants

Using G*Power 3.1 (University of Kiel, Germany), we computed the required sample size to test our hypotheses based on the effect sizes of previous similarly designed research (Monahan & Romero, 2020). Consequently, we recruited 40 participants for the three equally designed experiments (1, 3, and 4), which led to an effect size f = 0.20 with 80% power according to the sensitivity analysis.

Four participants were excluded because of being left-handed or reporting eating disorders, nutritional restrictions, allergies, or food intolerances. Thus, the analyzed sample consisted of 36 right-handed young adults (12 male, *M* age = 28.73 years, *SD* = 11.64) with normal weight (body mass index (BMI) 18.5 to < 25 kg/m^2) and no food-related issues. All participants had normal or corrected-to-normal sight and were healthy and unaware of the specific purpose of the study. They also gave written informed consent before beginning the experiments and were rewarded with university course credits for their participation.

Stimuli

We selected 16 colored images (544 × 364 pixels; see Online Supplementary Material (OSM) for a full list of the selected images) of food products from Full4Health Image Collection (University Medical Center Utrecht, the Netherlands; Charbonnier et al., 2016), a food picture database validated in different European countries. We selected products balanced for liking, perceived healthiness, and calories (see Table 1). All the stimuli were presented on a white background.

Table 1 Mean real calorie (Kcal * 100g), liking, perceived calories, and healthiness (ranging from 1 to 9) and standard deviation of food pictures extracted from the validated Full4Health database (Charbonnier et al., 2016)

	Mean	Standard deviation
Real calorie (Kcal * 100g)	219.91	178.62
Liking	6.21	1.18
Perceived Calories	5.24	2.15
Perceived Healthiness	4.83	2.52

Procedures

Upon arrival, participants were seated on a chair at about 57 cm from the computer monitor, which measured 34 × 27 cm (15.4 in.). Each participant was instructed to assume and maintain a relaxed position for the entire duration of the test. Before starting, we administered a questionnaire (through Qualtrics Survey Software; Provo, UT, USA) in which we asked participants to enter their age, weight, height, and sex information and to answer specific questions regarding their psycho-physiological state.

Subsequently, participants began the experiment that consisted of a within-subject evaluation task: they were instructed to watch each presented stimulus (N = 16) and to follow it with their head during the displayed time (20 s) before evaluating it. In particular, each trial consisted of a stimulus (i.e., the image of a food product) placed on the center of the screen or moving vertically or horizontally for 20 s. Then, during the interstimulus interval, the participants rated the liking, the desire to eat, the desire to buy, and the willingness to pay for the viewed food product (see Table 2) by marking with the pencil a point on four different 100-mm visual analogue scales (VASs) placed in each booklet page (one page per trial). After that, the page of the booklet was turned by the experimenter before moving to the next trial.

In particular, stimuli were pseudo-randomly assigned to three conditions presented in an intermixed order: six images were presented without any movement at the center of the screen (control condition, CE), five images moved vertically (to simulate nodding movement, YES) and five moved horizontally (to simulate a denial movement, NO). In order to induce a movement of the head that was as natural as possible, each image movement (e.g., from top to bottom and backward) had a duration of 5 s and was repeated four times, so that each product movement had a total duration of 20 s. In the CE, the image appeared at the center of the screen for 20 s (Fig. 1). In addition, the experimenter always remained in the room in order to verify that the participants made congruent movements, while not explicitly telling them to nod or deny. The order of the shown stimuli, of their movement, and of the four VASs presented in each page of the booklets were pseudo-randomized between participants.

With regard to the NO and YES conditions when the stimulus started moving from left to right, its last movement was from right to left and vice versa; similarly, the stimulus that started with a top-down movement finished with a bottom-up movement, and vice versa. Thus, the movement pattern of the stimuli was also counterbalanced between participants in order to have a comparable number of food products that began moving from the right or from the left side (for the NO condition), and from the top or from the bottom (for the YES condition). Since there were five stimuli for each movement condition (YES, NO), when a participant

Table 2 Questions (translated from Italian) to which participants had to respond after each picture display. Responses to each question were given by marking with a pencil the four correspondent 100-mm visual analogue scales presented on each page of the provided booklet (one for each stimulus)

Like: How much do you like the product shown in the picture? (from 0 = "not at all" to 100 = "very much")
Eat: How much would you like to eat the product shown in the picture? (from 0 = "not at all" to 100 = "very much")
Buy: How much would you like to buy the product shown in the picture? (from 0 = "not at all" to 100 = "very much")
Pay: How much would you pay to buy the product shown in the picture? (from 0 = "less than € 1" to 100 = "more than € 10")

was shown three stimuli moving in a right-left-right pattern and two with a left-right-left pattern, the next participant was shown three stimuli moving in a left-right-left pattern and two with a right-left-right pattern (the same occurred with the YES condition).

At the end of the experiment, two other questionnaires were filled out by the participants (through Google Forms), namely the Edinburgh Handedness Inventory (Oldfield, 1971) and the Dutch Eating Behavior Questionnaire (DEBQ; Van Strien et al., 1986).

Results and discussion

Data analysis was performed using Statistica 8.0 software (StatSoft). Each response (Like, Eat, Buy, Pay) was converted into a score from 0 to 100. The dependent variables were the average scores of each questionnaire item for each participant. For each question, a one-way analysis of variance (ANOVA) was performed, using the movement condition as a within factor (YES, CE, NO). We did not find any significant effect of the movement condition (see Table 3).

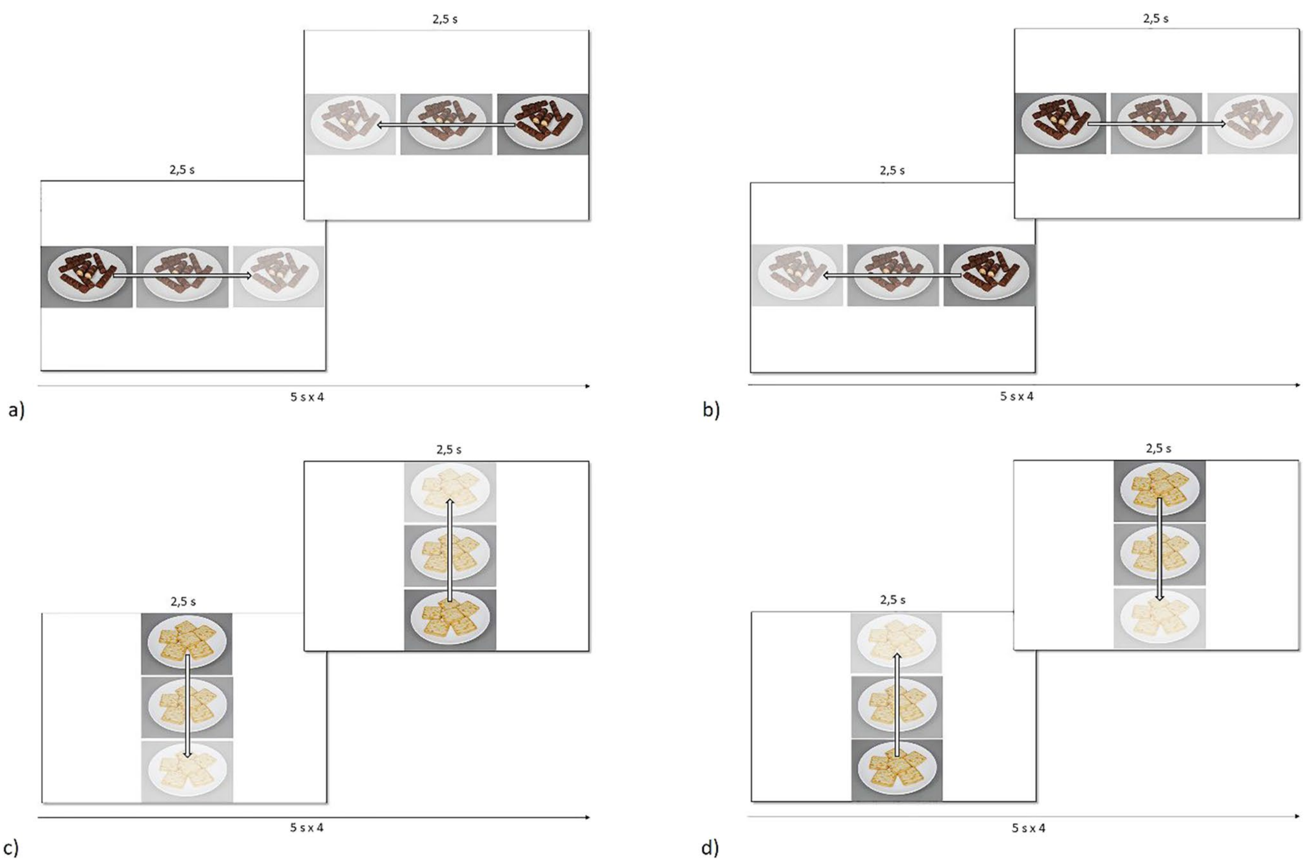

Fig. 1 Example of trials in Experiment 1. The fading pictures represent the shift of the picture in the direction described by the arrows. Above are the NO conditions: (**a**) Left-Right-Left condition and (**b**) Right-Left-Right condition. Below are the YES conditions: (**c**) Top-Bottom-Top and (**d**) Bottom-Top-Bottom. Each movement had a duration of 5 s repeated four times, thus each product was displayed for a total of 20 s. In the control condition (CE) the picture was displayed at the center of the screen for 20 s (see Fig. 5b). After 20 s they had to respond on the four visual analogue scales

Table 3 Experiment 1: Mean, standard error of the mean, and *p* values for the ANOVAS carried out on each question score (Like, Eat, Buy, and Pay) with movement condition as within factor (NO, CE, YES)

	NO		CE		YES		*p*
	Mean	SEM	Mean	SEM	Mean	SEM	
Like	51.16	2.08	53.07	2.67	53.27	2.41	.705
Eat	38.71	2.92	39.84	2.42	38.97	2.47	.896
Buy	35.15	2.60	37.56	2.06	37.04	2.07	.599
Pay	23.39	2.67	25.99	2.07	25.28	7.67	.269

Subsequently, for each question, we carried out two other one-way ANOVAs in order to test if the movement pattern could influence the evaluation compared with the CE (all the data are reported in OSM Tables 1 and 2). Hence, for the YES condition the within factors were the movement patterns Bottom-Top-Bottom, Central, Top-Bottom-Top. In the case of the YES condition, the movement pattern did not influence the judgments of the participants. For the NO condition the within factors were the movement patterns Left-Right-Left, Central, Right-Left-Right. We found a significant effect of the movement pattern for the desire-to-eat score ($F_{2.70} = 5.208$, $p = .008$, $\eta^2_p = .129$, 1-β= .814). In particular, Duncan's post hoc showed a greater desire to eat the product when the movement pattern was left to right and backward compared with the opposite pattern ($p = .003$) or to the motionless central condition ($p = .03$; Fig. 2).

A significant effect of the movement pattern was also found for the desire to buy the product ($F_{2.70} = 4.669$, $p = .012$, $\eta^2_p = .118$, 1-β= .767). Duncan's post hoc test showed a greater desire to buy the product when the movement pattern was left to right and backwards compared to the opposite movement ($p = .004$; Fig. 3).

Another significant effect of the movement pattern was found for the question related to the willingness to pay ($F_{2.70} = 6.117$, $p = .004$, $\eta^2_p = .149$, 1-β= .875). Duncan's post hoc test showed that the willingness to pay for the product was lower when the movement pattern was right to left and backwards compared with the opposite movement ($p = .002$) and to the motionless central condition ($p = .020$; Fig. 4).

No significant effect of the movement starting point was found instead for the liking question ($F_{2.70} = 0.758$, $p = .472$, $\eta^2_p = .019$).

Thus, neither the movement simulating nodding (YES) nor that simulating denying (NO) influenced the product evaluation. Instead, when the food picture moved from left to right and finished with the opposite movement, the desire to buy and eat it, as well as the willingness to pay for it, increased compared with the opposite movement (i.e., started from right to left and finished from the left to the right). Maybe product movements were not large enough to induce adequate head feedback (i.e., denying or nodding) able to influence its perception. On the other hand, the attentional-visual biases should be accounted to explain our findings.

Experiment 2

Based on the results of Experiment 1 in which we indirectly induced head gestures through movement of the stimuli, we carried out a second experiment where we

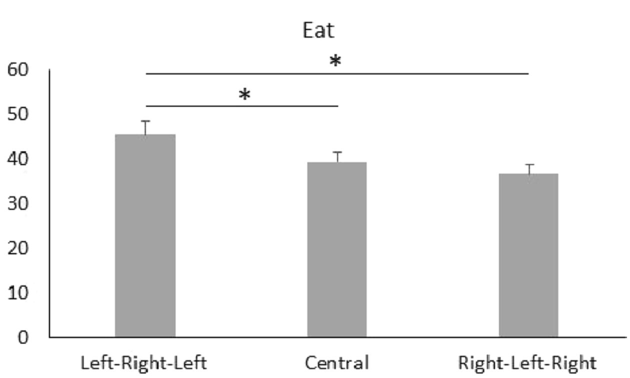

Fig. 2 Means and standard errors for the "Eat" visual analogue score. The bars indicate the three movement pattern conditions. The asterisks indicate significant comparisons ($p < 0.05$)

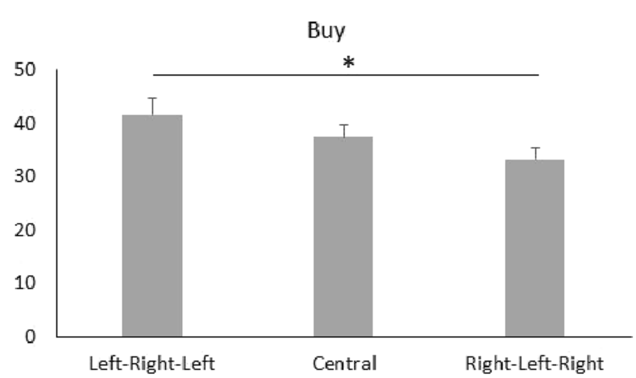

Fig. 3 Means and standard errors of the "Buy" visual analogue score. The bars indicate the three movement pattern conditions. The asterisk indicates significant comparisons ($p < 0.05$)

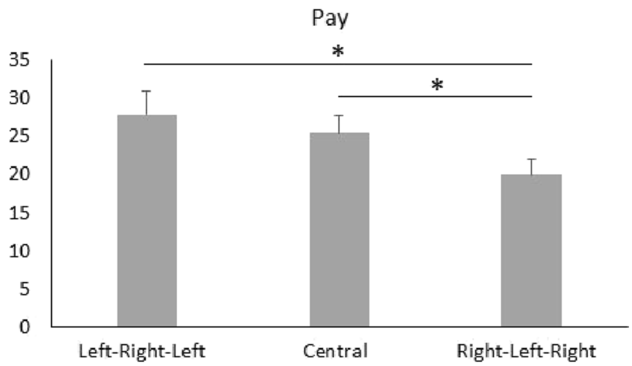

Fig. 4 Means and standard errors for the questionnaire item related to "Pay" in the NO condition with respect go the direction of the movement

directly manipulated the body movements of our participants. In Förster (Förster, 2004) the displaying of the items on a giant screen induced a wider head movement in their participants compared with that achieved by moving the stimulus on a classic PC monitor. Hence, in our Experiment 2, we showed all the products at the center of the screen, and participants were invited to make no head movement (control condition) or to move their head horizontally (deny) or vertically (nod) during the display of the food, before evaluating it, as already done by other researchers (e.g., Tom et al., 1991; Wells & Petty, 1980). In this way we intend to enhance the head movements, in order to confirm that this body feedback is not able to influence our stimuli evaluation.

Materials and methods

Participants

Using G*Power 3.1 (University of Kiel, Germany), we computed the required sample size to test our hypotheses based on the effect sizes of previous similarly designed research (Moretti & Greco, 2018). Consequently, we planned to recruit 39 participants (13 for each condition) for Experiment 2, which led to an effect size of f = 0.38 with 80% power according to the sensitivity analysis. Two participants were excluded because they were either left-handed or reported eating disorders, nutritional restrictions, allergies, or food intolerances. Thus, the analyzed sample consisted of 37 right-handed young adults (12 male, *M* age = 21.49 years, *SD* = 2.36) with normal weight and no food-related issues. All of them had normal or corrected-to-normal sight. All participants were healthy and unaware of the specific purpose of the study. They also gave written informed consent before beginning the experiments and were rewarded with university course credits for their participation.

Procedures

The procedures adopted for Experiment 2 are similar to those for Experiment 1, but in this case we used a between-subjects design as carried out in similar studies (e.g., Wells & Petty, 1980). Specifically, we divided our sample into three groups depending on the movement requested: each group of participants was instructed alternatively to move the head vertically (YES, N = 13), horizontally (NO, N = 12), or to keep the head motionless (CE, N = 12) while observing the foods displayed at the center of the screen (Fig. 5). Hence, each participant performed the same head movement/no-movement for all the 16 products in order to hide as much as possible the experiment aim.

Thus, in each trial (N = 16) a stimulus (i.e., the image of a food product) was shown at the center of the screen for 20 s while participants moved their head horizontally (group NO), vertically (group YES), or kept their head motionless (group CE). Then, during the interstimulus interval, participants evaluated the shown product by marking with a pencil a point on the four 100-mm VASs presented on each booklet page. The evaluation was carried out after the presentation of each single stimulus, and the pages of the questionnaire were turned by the experimenter whenever participants moved to the next trial.

Results and discussion

Data analysis was performed using Statistica 8.0 software (StatSoft). Each participant's response was converted into a score from 0 to 100. The examined variables were the average scores of each participant in the items of the questionnaire (Like, Eat, Buy, Pay). For each item a one-way analysis of variance (ANOVA) was performed, using the group as between factors (YES, CE, NO).

We found no significant effects of the type of movement in the subsequent judgments expressed by our participants (see Table 4).

By increasing vertical head movements (denying) and horizontal head movements (nodding), we did not find any effect on food preference/willingness to buy. Experiments 1 and 2 showed that Förster's findings (Förster, 2004), as predicted, are not replicable using known product pictures with a non-polarized valence, instead of the written name of valenced products. The importance of a polarized valence for the motor-compatibility effect has been already mentioned by Förster (2004). Our food, instead, did not have a strong positive valence, although it was generally evaluated as mildly positive. Also, the self-validation theory could not influence our stimuli, since their focus was on unknown stimuli whereas we used well-known food products (Wells &

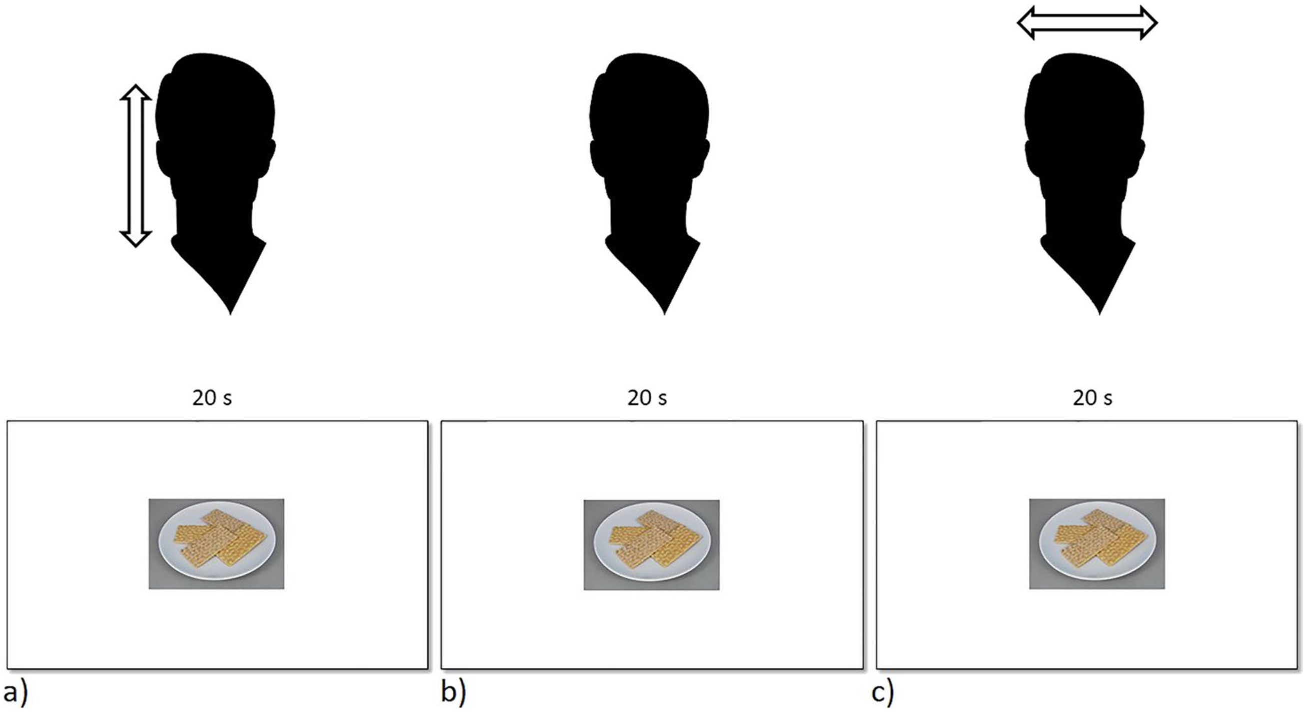

Fig. 5 Example of trials in Experiment 2. In this case pictures were always placed at the center of the screen and we asked our participants to: (**a**) move their head vertically; (**b**) not move their head; (**c**) move their head horizontally. After 20 s participants had to respond on the four visual analogue scales

Petty, 1980). Finally, we supposed that the sight of a product, more than its name, determines a more stable and shared mental representation, probably less influenced by body feedback. Indeed, food pictures always assume a neutral to positive valence (e.g., Padulo et al., 2017; Padulo et al., 2018), unless they are rotten or judged by an individual with an eating restriction (e.g., Blechert et al., 2014; Foroni et al., 2013). On the other hand, Experiment 1 leaves an unsolved question: What visual-attention pattern caused the increase in the willingness to eat, buy, and pay for products that initially moved from left to right?

Experiment 3

In order to investigate the significant results of Experiment 1 we carried out two further experiments. Specifically, in Experiment 1 we found an increase in the desire to eat, willingness to buy, and willingness to pay for all the products shown that moved horizontally starting from left to right and finishing from right to left. The cause of such an effect could be the entire movement, the initial (i.e., left-to-right) or the final movement (i.e., right-to-left) or the side in which products are seen at the beginning and at the end of the experiment (i.e., left). Thus, in Experiment 3 we arranged a new set of trials in which food pictures moved continuously

Table 4 Experiment 2: Mean, standard error of the mean, and *p* values for the ANOVAS carried out on each question score (Like, Eat, Buy, and Pay) with movement condition as between factor (NO, CE, YES)

	NO		CE		YES		*p*
	Mean	SEM	Mean	SEM	Mean	SEM	
Like	52.82	3.09	57.75	3.05	53.74	3.15	.532
Eat	42.04	3.18	43.99	2.58	43.68	3.04	.976
Buy	36.73	2.16	40.50	3.61	41.96	2.60	.663
Pay	23.02	3.67	28.31	2.71	25.90	2.23	.391

in one single direction to test whether single trajectories can affect product evaluation.

Materials and methods

Participants

Initially, accordingly with the sample size and the sensitivity analyses reported for Experiment 1, 40 participants were involved in the experiment; three of them were excluded because of being left-handed or reporting eating disorders, nutritional restrictions, allergies, or food intolerances. Thus, the analyzed sample consisted of 37 right-handed young adults (18 male, *M* age = 24.28 years, *SD* = 2.15) with normal weight and no food-related issues. All had normal or corrected-to-normal sight. All participants were healthy and unaware of the specific purpose of the study. They all gave written informed consent before beginning the experiment and were rewarded with university course credits for their participation.

Procedures

The procedures for the third experiment were the same as those for Experiment 1. In this within-subjects design procedure, each participant evaluated 16 stimuli shown for 20 s on the center of the screen or moving vertically or horizontally by marking with a pencil four 100-mm VASs presented on each page of a booklet composed of 16 pages. The evaluation was carried out after the presentation of each single item, and the pages of the questionnaire were turned by the experimenter before moving to the next trial. Specifically, the stimuli were pseudo-randomly assigned to three conditions presented in an intermixed order: six images were presented without any movement at the center of the screen (control condition, CE), five images moved vertically and five moved horizontally. However, in this case the non-CE stimuli moved in one single direction with a continuous movement (i.e., from right to left, from left to right, from top to bottom, or from bottom to top; Fig. 6). As for Experiment 1, the stimuli movement directions were

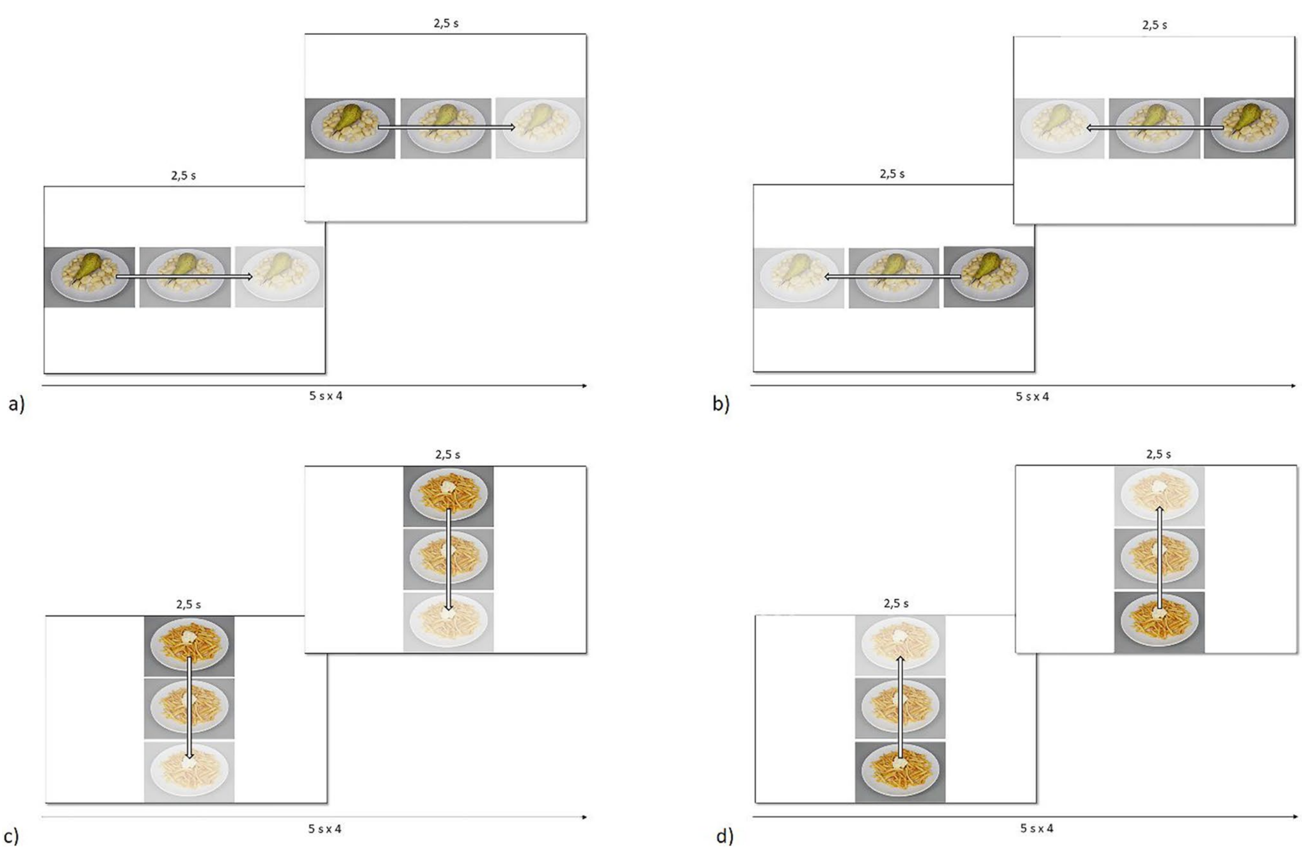

Fig. 6 Example of trials in Experiment 3. The arrows indicate the shift direction of the pictures. Above are the horizontal movement conditions: (**a**) Left-Right direction and (**b**) Right-Left direction. Below are the vertical movement conditions: (**c**) Top-Down direction and (**d**) Bottom-Up direction. Each movement had a duration of 5 s repeated four times, thus each product was displayed for a total of 20 s. In the control condition (CE) the picture was displayed at the center of the screen for 20 s (see Fig. 5b). After 20 s participants had to respond on the four visual analogue scales

counterbalanced between participants in order to have a comparable number of stimuli moving continuously from the right or from the left side (for the horizontal movement), and from the top or from the bottom (for the vertical movement): when a participant was shown three stimuli moving in a right-left direction and two with a left-right direction, the next participant was shown three stimuli moving in a left-right direction and two with a right-left direction (the same occurred with the vertical condition).

Results and discussion

Data analysis was performed using Statistica 8.0 software (StatSoft). Each participant's response was converted into a score from 0 to 100. The examined variables were the average scores of each participant in the items of the questionnaire (Like, Eat, Buy, Pay). For each item of the questionnaire, two one-way ANOVAs were performed. In the first one, we investigated the effect of horizontal movement, using the stimulus directions (Left-Right, Central, Right-Left) as within factors. In the second one, we investigated the effect of vertical movement, using the stimulus direction (Bottom-Up, Central, Top-Down) as within factors. We did not find any significant effect of the movement directions in the subsequent judgments expressed by our participants (see OSM, Tables 3 and 4).

Experiment 3 showed no significant results, suggesting that movement in a single direction does not determine the effects found in Experiment 1. The last variable to investigate was the food placement on the screen. In fact, it could be that the place in which food appears at the beginning of each trial or disappears at the end of them plays a role in these findings. In fact, whereas in Experiment 3 each picture appeared at the beginning on one side and finished the movement on the opposite side, in Experiment 1 the initial and final placements were the same.

Experiment 4

In order to clarify the effect of food placement on participant evaluations, we carried out Experiment 4. In Experiment 1, products started and ended their movements on the same side, hence the effects found could be determined by a visual attentional bias for the processing of food products. Thus, in this last experiment, stimuli were placed in a fixed position on one side of the screen (i.e., left, right, top, or bottom) in order to determine the existence of a displaying bias or to confirm the results found in Experiment 1.

Materials and methods

Participants

Initially, in accordance with the sample size and the sensitivity analyses reported for Experiment 1, 40 participants were involved in the experiment; three of them were excluded because of being left-handed or reporting eating disorders, nutritional restrictions, allergies, or food intolerances. Thus, the analyzed sample consisted of 37 right-handed young adults (10 male, M age = 23.37 years, SD = 6.55) with normal weight and no food-related issues. All participants had normal or corrected-to-normal sight and were healthy and unaware of the specific purpose of the study. They also gave written informed consent before beginning the experiments and were rewarded with university course credits for their participation.

Procedures

The procedures for Experiment 4 were similar to those of the previous experiments; however, in this instance the product was placed in a fixed position of the computer screen (i.e., top, bottom, right, left, or central; Fig. 7) counterbalanced between participants. Each participant evaluated 16 stimuli shown for 20 s on the center of the screen or on one of the four sides of the screen (Left, Right, Top, Bottom), by marking with a pencil four 100-mm VASs presented on each page of a booklet composed of 16 pages. The evaluation was carried out after the presentation of each single item, and the pages of the questionnaire were turned by the experimenter before moving to the next trial. Hence, Experiment 4 was a within-subject design: the stimuli were pseudo-randomly assigned to five positions presented in an intermixed order. Specifically, six images were presented on the center of the screen (Central), five images on the Top or on the Bottom side of the screen, and five images on the Left or on the Right side of the screen. When a participant was shown three stimuli on the right side of the pattern and two on the left side, the next participant was shown three stimuli on the left side of the screen and two on the right side (the same occurred with the Top/Bottom condition).

Results and discussion

Data analysis was performed using Statistica 8.0 software (StatSoft). Each participant's response was converted into a score from 0 to 100. The examined variables were the average scores of each participant in the items of the questionnaire (Like, Eat, Buy, Pay). For each item of the

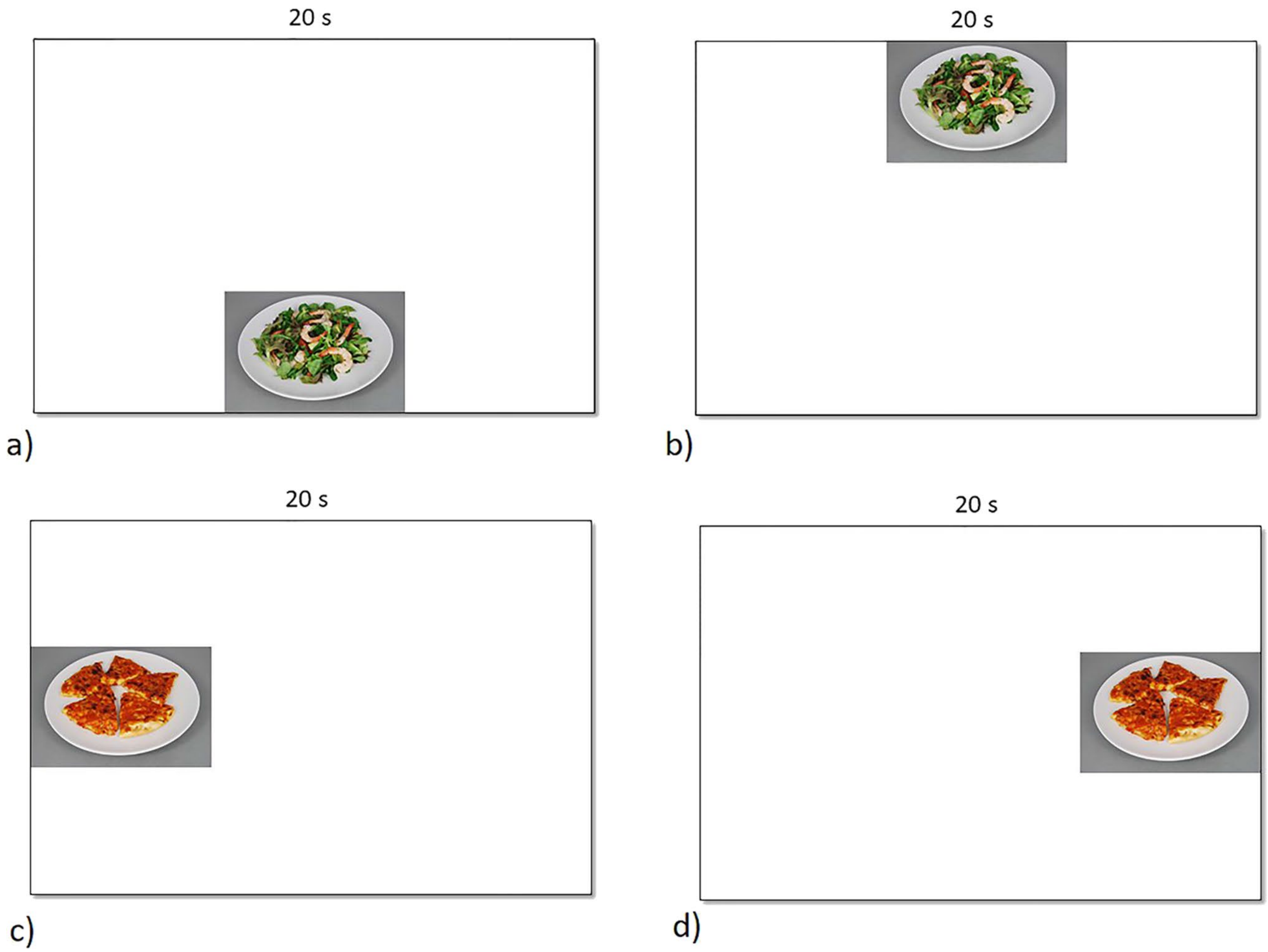

Fig. 7 Example of trials in Experiment 4. In this case pictures were placed for 20 s (**a**) on the bottom; (**b**) on the top; (**c**) on the left; (**d**) on the right side or on the center of the screen. After 20 s participants had to respond on the four visual analogue scales

questionnaire, two one-way ANOVAs were performed. In the first one we investigated the effect of horizontal arrangement, using the stimulus position (Left, Central, Right) as within factors. In the second one we investigated the effect of vertical arrangement, using the stimulus position (Bottom, Central, Top) as within factors. We did not find any significant effect of the stimulus position in the subsequent judgments expressed by our participants (see OSM, Tables 5 and 6).

As for Experiment 3, we did not find significant results determined by the display of food pictures. Although some studies have reported side biases in food preference and perception, such research describes differences between different categories of food, such as healthy and unhealthy products (e.g., Manippa et al., 2020; Romero & Biswas, 2016) or heavy and light products (Deng & Kahn, 2009). Thus, we suggest that neither the display placement nor the single movement direction was the cause of the effect found in Experiment 1.

General discussion

Previous studies have demonstrated the potential of body gestures and spatial biases in influencing attitudes to verbal stimuli. While Wells and Petty (1980) found that nodding and shaking the head while listening to a novel persuasive message can respectively confirm the positive and the negative thoughts about the massage, Förster (Förster, 2004) has shown that the written name of positive foods are more preferred when participants were induced to move their hand vertically, whereas unpleasant products were less liked after a horizontal head movement. Despite that, other evaluation biases can be induced by specific horizontal or vertical movement of images, or by the (static) place in which they are displayed (e.g., in the package covering). We tested whether such embodiment effects influenced the evaluation of food pictures. Our results demonstrate that shaking and nodding head movements (conveying respectively disagreement and agreement) do not influence food picture attitudes, neither if the head gestures were induced by picture movements (Experiment 1), nor if participants were explicitly asked to move their head vertically and horizontally (Experiment 2). On the other hand, Experiment 1 showed the specific effect of the left-right-left movement pattern in improving the desire of the product but not the liking score. The subsequent Experiments 3 and 4, in which we manipulated the stream of the stimuli trajectories or the place in which foods were shown on a screen, did not show further results regarding this. These findings are in line with both the hypothesis of Förster stating that body feedback did not influence weak-valenced stimuli and with the left-to-right bias hypothesis (Spalek & Hammad, 2005; Suitner & Maass, 2016).

Our findings suggest that the kind of stimuli we used have been responsible for the lack of gesture embodiment. In fact, the *conceptual-motor compatibility model* seems to work mainly with verbal stimuli with strong positive and negative valences: when the gestures (motor) and the stimulus valence (concept) are congruent, the latter was further enhanced. In particular, an agreement gesture (e.g., head nodding) increased positive attitude to pleasant stimuli, while a disagreement gesture (e.g., head shaking) decreased negative attitudes to unpleasant stimuli (Förster, 2004). This model is also applicable to unknown stimuli with a neutral valence (e.g., Chinese ideograms for non-Chinese speakersCacioppo et al., 1993), whereby the subsequently induced movement can represent the only information to categorize them as positively or negatively valenced (e.g., Neumann & Strack, 2000). Also, in the case of extreme valenced and novel stimuli (e.g., attractive or unattractive faces of strangers), a compatibility effect between the valence of the stimuli and the movement was found (Förster, 1998). On the other hand, the influence of body feedback on unknown stimuli has been investigated by Briñol and Petty (2003): their *self-validation theory* postulates that head movements either enhance (nodding) or undermine (denying) confidence in one's thoughts. For example, when the message arguments were strong, nodding produced more persuasion than shaking. When the arguments were weak, the reverse occurred.

We took a step forward, compared to these studies, by asking our participants to judge food pictures with a general mild positive valence; with these particular items we did not find any effect of nodding and shaking head gestures on food evaluation, either when they were induced with a subtle method (i.e., using picture movements on the screen Experiment 1) or when inducing head movement in a more explicit way (i.e., Experiment 2). Our stimuli were extracted from a validated database in which there were no negative valenced products (Charbonnier et al., 2016) since foods are biological survival-related stimuli and the only visually regrettable foods are rotten or dangerous ones (e.g., Foroni et al., 2013; Toet et al., 2019). Although there is a high degree of subjectivity for food picture evaluations depending on food features, interindividual differences, eating restrictions, or psychophysiological state (e.g., Padulo et al., 2017, 2018), reading the name of a product involved a further increase of subjectivity caused by the lack of an objective visual stimulus to process. For example, it is presumed that the word "Beef lung" determines a very different thought compared to the picture of a ready-to-eat (e.g., cooked, spiced) dish of beef lung.

Thus, since most of the previous findings (Förster & Strack, 1996; Förster, 2004; Wells & Petty, 1980) are related to the compatibility effect between verbal stimulus valence and head movements (i.e., head nodding increases positive evaluation of positive stimuli, whereas head shaking increases negative evaluation of negative stimuli), our results might have been attenuated by the particular kind of stimuli that we used, food pictures with a weak positive valence. In agreement with this, Dru and Cretenet (2008) have shown that the evaluation of weak-valenced visual stimuli was not influenced by motor behavior. In their study, in one case facial expressions with six different categories of valence were presented, whereas in another experiment, valenced pictures were taken from the International Affective Picture System (IAPS; Lang et al., 1997). They demonstrated that neutral or weak-valenced pictures are not able to trigger the compatibility mechanisms. Our results extend these findings to weak positively valenced food images and using head movement instead of arm movements. We do, however, stress that foods are salient stimuli, very different to neutral stimuli such as Chinese ideograms (for a non-Chinese sample; Cacioppo, Priester, & Berntson, 1993) with which the motor-conceptual compatibility effect has been demonstrated.

Moreover, the analyses of Experiment 1 showed visual-spatial effects with regard to the horizontal movement of our stimuli. Specifically, when the image began with a left-to-right movement and ended with a right-to-left movement, participants expressed more positive judgments compared with the opposite pattern and the control condition (i.e., motionless stimulus). Experiments 3 and 4 were conducted in order to clarify the findings of Experiment 1 and to identify if the single movements of the pictures affected the evaluation of the products or if it was the side in which they began/finished the movements that influenced their judgments. Specifically, with Experiment 3 we found that food evaluation was not affected by the continuous movement of the stimulus in one single direction, whereas the results of Experiment 4 disconfirm the existence of a left attentional bias for food-product attitudes. Thus, we can assert that neither the continuous shift in a single direction nor the side in which the product was observed (at the beginning or at the end of the display) influenced food-picture preference. In particular, it was the specific left-to-right and backward movement that determined an increase of either the desire to buy and eat the product, or the willingness to pay more for the product.

The horizontal and vertical movements of the head (and the movement of the stimulus on the monitor) could be subjected to some spatial (vertical or horizontal) bias and/or to further directionality biases that these trajectories imply. In the marketing and advertising field, in fact, several studies have documented that visual objects operate within a system based on conventions, such that consumers have expectations regarding how visual elements should be organized (Scott, 1994). As a result, advertising effectiveness has been shown to be influenced by a variety of factors in relation to spatial orientation, including horizontal and vertical position and direction (Chae & Hoegg, 2013; Deng & Kahn, 2009). For example, previous literature has documented the tendency to see actions evolving in a trajectory according to which motion and agency would be mapped onto the direction in which native language is written and read (Suitner & Maass, 2016). This specific literature is related to the *left-to-right bias* (e.g., Spalek & Hammad, 2005; Suitner & Maass, 2016). Also, this research was conducted within the *embodied cognition* field, because the bias would be the result of the simulation of the oriented actions involved in writing and reading activities (Suitner & Giacomantonio, 2012). Monahan and Romero (2020) manipulated the direction of the implied motion in some advertising pictures, and found that when this direction was from left-to-right the trust related to the featured brand increased. Also, Chokron and De Agostini (2000) have shown that reading habits can influence the aesthetic preferences (i.e., left-to-right readers showing a preference for stimuli with a rightward directionality). In these studies, the stimuli used by the authors were specific images implying motion and directionality, but neither of these performed real movements. In Guido and co-workers (Guido et al., 2016), however, we can observe that a real trajectory followed by a brand logo was also effective in influencing the preferences toward it.

Although our food stimuli did not convey any motion or directionality, they followed a real trajectory moving on the screen; the findings of Experiment 1 demonstrated that the continuous left-right-left stream improves the general desire for a food and particularly the desire to eat it, to buy it and the willingness to pay for it. Liking was, however, not influenced by any movement pattern. This latter variable described the general disposition towards a specific food may be less influenceable by actual external/environmental cues (like a specific stimulus movement pattern) compared with more context-driven variables such as the desire to eat or to buy a product (e.g., Berridge, 2004; Manippa et al., 2020). In fact, the incentive-sensitization theory posits that it is possible to amplify the "wanting" of a specific food by means of cues, without necessarily amplifying its "liking" (Berridge, 2009; Finlayson et al., 2007). We assumed that the higher desirability of a product moving in a specific horizontal pattern should be related to a visual attentional bias. In particular, individuals from Western society scan their environment following the writing/reading script direction (i.e., from left-to-right; Suitner & Giacomantonio, 2012) and backwards (right-to-left) before restarting visual scanning. Therefore, if the classical visual-attention pattern is oriented consistently with the object movement, this should facilitate the tracking of the object itself (Spalek & Hammad, 2005). Hence, the continuous movement from left to right and backwards of Experiment 1 may reflect the regularity with which participants normally move their attention while scanning the environments, enhancing their positive attitudes to the products. This could also explain why the single direction movements (e.g., the continuous stream left-right) used in Experiment 3 had no effect.

Lastly, no effects were found either for the vertical movement or for the fixed placements. Regarding the former, assuming that the Western script visual-attentional pattern was responsible for the effects, we point out that any vertical movement was reported to influence item preferences. To our knowledge, the only study investigating the influence of vertical trajectory of some items, is the one by Guido and co-workers (2016), who found in their sample a preference for logos moving upward over those moving downward. Different studies, instead, have explored the influence of food placement on its preference/perception; such research has shown, for example, that healthy food was preferred when shown on the right side compared with unhealthy food (e.g., Manippa et al., 2020; Manippa et al., 2021; Romero & Biswas, 2016). Also, Deng and Kahn (2009) showed that the location of the product image on a package facade influences consumers' perception of its heaviness, with the "heavier" location identified in the bottom-right and the "lighter" in the top left. Regarding vertical placement, Valenzuela and co-workers (2013) have found that individuals associate the top shelves with more expensive products. Despite that, these findings were always linked to a(n) (in)congruence between specific food categories and a respective placement, while we were not interested in the interaction between different product categories and specific head/stimulus movement or display.

Practical implications, limitations, and future research

Our findings confirm that various motor and environmental factors can influence individuals' food judgments, and this evidence could be taken into consideration for online marketing purposes. Our study could have concrete applications in various fields such as the construction of websites or for social media advisors. These marketing strategies are picture-centered, and the use of culturally congruent visual patterns could have a great impact acting as nudges (Suitner & Maass, 2016). Also, given the need to attract the user's attention in increasingly effective ways, especially with regard to mobile devices, a moving image that is congruent with the consumer's reading habits could be a strategic and functional method to engage positive feelings towards the product (i.e., Guido et al., 2016).

However, some limitations should be considered. First of all, we used a very peculiar kind of image, namely food pictures with a weak positive valence, in contrast with Förster (Förster, 2004), who used the written name of products with a negative or a positive valence. As in our study, Dru and Cretenet (2008) have shown that the evaluation of weak-valenced visual stimuli was not influenced by body feedback, but they did not enhance the influence of visuospatial patterns. As said, rated food images are very different to rated words: the former are generally perceived as positive whereas only rotten food pictures assume strong negative valence. For these reasons future studies should replicate our experiments using other images assuming positive or negative valence, to disambiguate whether the valence or the type of stimuli influenced our findings.

Whereas Förster (2004) displayed his items on a giant screen (370 × 175 cm) with participants seated about 180 cm from it, we used a desktop screen with participants seated about 57 cm from it. The different visual angles covered by the stimuli movements on the screen could have weakened the body feedback effects. Although head movements were not measured either in our study or in the previous ones, in Experiment 2 we enhanced them, explicitly asking our participants to perform vertical, horizontal, or no-head movement while looking at the items before judging them, and also in this latter case we found no significant influence. Future studies should consider filming/tracking the participants' movement in order to check if a minimum of head movement is required to obtain a body feedback effect.

Curiously, the left-right-left condition influenced the Pay, Eat, and Buy scores but not the Like scores, although a slight enhancement was also observed for this score (see OSM). We point out that in the field of food perception the "liking" (food pleasantness) and the "wanting" (food desire) are dissociable concepts (e.g., Berridge, 2009; Finlayson et al., 2007) and environmental manipulations are not always able to influence both of them (Papies et al., 2014; Seo, 2020). Thus, we encourage further research to replicate our findings with larger samples and/or to consider other factors, for example using different kinds of products or clinical samples, to get more comprehensive results. Moreover, it would be interesting if these experiments were replicated in a different culture where the writing/reading habits were different (i.e., right to left for the Arabic population).

Conclusions

In conclusion, according to Förster and Strack (1996), a congruence between the valence of the judged stimulus and motor gesture (in this case nodding and shaking the head) seems necessary to influence the stimulus evaluation, perhaps thanks to the embodiment of the motor feedback. Using food pictures with a mild positive valence, the body feedback did not affect their evaluation. Secondly, we found that the movement pattern of our stimuli influences the attitudes toward them: when the items moved from left to right and backwards, participants were more willing to eat, pay for, and buy them compared with the opposite movement pattern. The left-to-right-to-left trajectory can improve food desire and could be successfully used in online and mobile advertising and for marketing purposes in general.

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Author contributions SF and VM conceived and designed the experiment, and collected, analyzed, and interpreted the data. SF wrote the manuscript and VM, AB, and DP provided critical revisions and contributed to the final version of the manuscript by reviewing and critically revising text. All authors approved the final version for submission and agreed to be accountable to for all aspects of the work.

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Declaration

Competing Interest We have no conflicts of interest to disclose.

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Open Practices Statement

The data and materials for all experiments are available from the corresponding author upon request. None of the experiments were pre-registered.