Mouth-watering words: Articulatory inductions of eating-like mouth movements increase perceived food palatability

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We explored the impact of consonantal articulation direction of names for foods on expected palatability for these foods (total N = 256). Dishes (Experiments 1–2) and food items (Experiment 3) were labeled with names whose consonants either wandered from the front to the back of the mouth (inward, e.g., PASOK) or from the back to the front of the mouth (outward; e.g., KASOPI). Because inward (outward) wandering consonant sequences trigger eating-like (expectoration-like) mouth movements, dishes and foods were rated higher in palatability when they bore an inward compared to an outward wandering name. This effect occurred already under silent reading and for hungry and satiated participants alike. As a boundary condition, this articulation effect did occur when also additional visual information on the product was given (Experiment 3), but vanished when this visual information was too vivid and rich in competing palatability cues (Experiment 2). Future marketing can exploit this effect by increasing the appeal of food products by using inward wandering brand names, that is, names that start with the lips and end in the throat.

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The preference for food is determined by various psychological factors. Already before consumption, exteroceptive cues such as color, variety, shape and surface area influence how likeable and palatable we expect a food to be (for a recent comprehensive review, see Wadhera & Capaldi-Phillips, 2014). The visual appearance of a meal influences our expectations about its taste quality, flavor, and palatability (Hurling & Shepherd, 2003). Its color influences food choice and taste expectations (Koch & Koch, 2003; Walsh, Toma, Tuveson, & Sondhi, 1990), as well as its shape does (Olsen, Ritz, Kramer, & Möller, 2012). But also exteroceptive cues that do not directly stem from the food itself influence preference, such as contextual lighting (Cho et al., 2015; Hasenbeck et al., 2014), the color of the plate the food is served on (Piqueras-Fizman, Alcaide, Roura, & Spence, 2012), or the packaging (Deng & Kahn, 2009; Gmuer, Siegrist, & Dohle, 2015; Madzharov & Block, 2010; Siegrist, Leins-Hess, & Keller, 2015). Furthermore, also an appealing presentation of food increases preference and consumption (Jansen, Mulkins, & Jansen, 2010; Zampollo, Kniffin, Wansink, & Shimizu, 2012; Zellner, Lankford, Ambrose, & Locher, 2010; Zellner, Loss, Zearfoss, & Remolina, 2014; Zellner et al., 2011). These exteroceptive cues can also influence taste ratings (Piqueras-Fizman & Spence, 2015; Spence, Levitan, Shankar, & Zampini, 2010; see Siegrist & Cousin, 2009; for the difference between taste ratings and the taste experience itself) and can increase the desire to eat it (Marcelino, Adam, Couronne, Koster, & Seiffertmann, 2001). Moreover, there were demonstrations that the verbal label a food is given can influence the attitudes towards this food (e.g., Gmuer et al., 2015; Gmuer, Siegrist et al., 2015; Miller & Kahn, 2005). For instance, in their classic study Wolfson and Oshinsky (1966) labeled a drink as either ‘Space food’ or as ‘Unknown’, with the former increasing preference compared to the latter label. Also, matching of the sounds in the brand name with certain product features increases preference (Spence, 2012).

Besides these exteroceptive cues, of course interoceptive cues such as taste, odor, and mouthfeel most heavily influence our attitudes towards food, with taste being the key determinant (Birch, McPhee, Shoba, Pirok, & Steinberg, 1987; Bobroff & Kissileff, 1986; Duffy, 2007; Glanz, Basel, Malbach, Goldberg, & Snyder, 1998). Finally, higher psychological factors influence food palatability, such as familiarity of the food (Birch & Marlin, 1982; Pliner, 1982) or the nutritional status of the consumer (Drobes et al., 2001). In this vein, it was shown that food deprived individuals evaluate food stimuli more positively than satiated individuals (Brendl, Markman, & Messner, 2003; Seibt, Häfner, & Deutsch, 2007), consume more of
it (Bellisle, Lucas, Amrani, & Le Maguen, 1984; Hill, 1974) and show lower disgust responses towards unpalatable food (Hoefling et al., 2009).

We demonstrate a route to increase food palatability not yet considered, namely an articulatory induction of eating movements that increase the expected palatability of food. The basic logic behind this approach is that triggering bodily movements that are related to a certain need increases the need-related attractiveness of that object. Regarding food and eating, the simplest (and surely trivial) instantiation of such an induction would be to confront individuals with food and to let them imagine or pantomime eating it. Such a simulation of eating behavior would likely increase the perceived palatability of that food (cf., for an eating imagery task, see Morewedge, Huh, & Vosgerau, 2010). In this vein, although without a presentation of an actual object, Topolinski and Türk Pereira (2012) found that food-deprived participants reported higher hunger when they had chewed a tasteless and calorie-free chewing gum (eating-related movements) than when they had kneaded a ball (non-eating related control behavior) for a few minutes.

The present approach introduces a way to induce such eating-like movements without participants’ awareness via articulatory means, as is developed in the following.

1. An articulatory induction of eating-like mouth movements

The intake of food, such as during sucking, drinking, slurping and simply eating, is realized by muscular movements of the mouth, involving the lips, the tongue, and the pharyngeal muscles in the throat (Duffy, 2007; Hejnol & Martindale, 2008; Rosenthal, 1999; Rozin, 1996). The specific muscular pattern to propel food and liquid from the entrance of the mouth through the oral cavity into the pharynx and the esophagus is a sequence of muscle contractions starting in the front of the mouth—the lips—, over the front of the tongue to the rear of the tongue and further on to the pharyngeal muscles, not unlike peristalsis of the esophagus (Goyal & Mashimo, 2006). In contrast, the expectoration of harmful or inedible substances, such as during spitting or vomiting, is realized by muscular constrictions wandering from the rear of the mouth, the throat, over the tongue to the lips (Rozin, 1999), similar to an outward peristalsis (Goyal & Mashimo, 2006). Thus, food intake requires an inward going peristalsis, and food expectoration requires an outward going muscular peristalsis.

The mouth, however, does not only serve the function of ingestion, but also the evolutionarily more recent function of language, namely via articulation (Rozin, 1999; Steklis & Harnad, 1976). This behavior is a complex muscular activity of the lips and the tongue (Inoue, Ono, Honda, & Kurabayashidid, 2007; Ladefoged & Maddieson, 1996). Basically, articulating a phoneme (that is, a speech sound) works by generating a certain well-defined muscular pattern to propel food from the entrance of the mouth through the oral cavity into the pharynx and the esophagus (Goyal & Mashimo, 2006). In contrast, the expectoration of harmful or unwanted substances, such as during spitting or vomiting, is realized by muscular constrictions wandering from the rear of the mouth, the throat, over the tongue to the lips (Rozin, 1999), similar to an outward peristalsis (Goyal & Mashimo, 2006). Thus, food intake requires an inward going peristalsis, and food expectoration requires an outward going muscular peristalsis.

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While the vowels (the Os) in this words are neutral, the consonants clearly wander from the lips (B) over the tip of the tongue (D) to the rear of the mouth (K), which makes this an inward going word. Now consider the reversed sequence, KODOB, featuring consonantal articulation spots that start in the rear of the mouth (K) over the middle (D) to the front (B), which makes this an outward going word.

On a mere muscular level, the mouth activities during the articulation of inward words resemble the inward peristalsis during ingestion, and articulation of outward words resembles the outward peristalsis during expectoration. Thus, merely uttering an inward word such as BODOK simulates food intake in an abstract fashion, and uttering an outward word like KODOB simulates expelling food. This method of articulatory induction of inward and outward mouth movements has recently been applied to the induction of approach and avoidance states (Topolinski, Maschmann, Pecher, & Winkielman, 2014). Approach states are motivational states realizing a decrease in distance, and avoidance states realize an increase in distance toward an attitude object (Higgins, 1997). Approach signals positive attitudes and likeability, whereas avoidance signals negative attitudes and withdrawals.

As a consequence, it was hypothesized that inward (outward) words would induce approach (avoidance) states and accordingly more positive (negative) attitudes. Showing this, it was found in various set-ups that individuals being unaware of the articulation manipulation preferred inward over outward words and also liked persons and products more when those were labeled with inward than with outward names (Godinho & Garrido, 2015; Kronod, Lowrey, & Ackerman, 2015; Topolinski & Bakhtiar, 2015; Topolinski, Boecker, Erle, Bakhtiar, & Pecher, 2015; Topolinski, Maschmann, et al., 2014; Topolinski, Zürn, & Schneider, 2015). Thus far, this effect was found for English, German, and Portuguese articulation and even occurred when participants read the words silently. While this seems surprising at first, it is well in line with previous research on subvocal vocalizations (Topolinski, 2012; Topolinski et al., 2014; Topolinski & Strack, 2009, 2010). During reading the brain automatically simulates the motor movements required to produce speech, which can even be mapped with electromyography in the laryngeal motor periphery; but these motor simulations are covert, not overt movements, so usually they are much too subtle to be felt by the reader or to overtly observed (Hardyck, Petrino, & Ellsworth, 1966). There are also many other demonstrations of the affective consequences of such covert simulations in other muscle systems (e.g., Körner, Topolinski, & Strack, 2013; Leder, Bar, & Topolinski, 2013; Sparenberg, Topolinski, Springer, & Prinz, 2012; Topolinski, 2010). One possible alternative explanation of this effect might the fluency with which inward and outward words are processed (cf., Topolinski, 2013, 2014; Topolinski, Erle, & Bakhtiar, 2016; Topolinski et al., 2015; Topolinski, Likowski, Weyers, & Strack, 2009; Topolinski & Reber, 2010). For instance, it could be the case that inward words are simply read more easily than outward words, which would feel more comfortably and thereby increase positivity (cf., Dohle, 2014; Gmuer et al., 2015). However, in an independent line of research we have shown that, although reading fluency does play a role in the in-out effect, it does not completely mediate this effect (Bakhtiar, Körner, & Topolinski, 2016).

This oral approach-avoidance induction might be highly relevant for the perception of food, because food itself is approach-related (Bradley, Codispoti, Cuthbert, & Lang, 2001; Chen &
Bargh, 1999; Selb et al., 2007). In this vein, Förster (2003) showed that bodily movements of approach vs. avoidance can change attitudes toward foods. Arm extension, an expression of avoidance behavior, leads to smaller food intake than arm flexion, an expression of approach behavior (see also Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011). However, these were movements of the limbs and not of the mouth; and the oral approach-avoidance manipulation by Topolinski, Maschmann et al. (2014) has not been applied to attitudes towards foods, such as palatability ratings. The present experiments tested the straightforward prediction that reading inward (outward) words, because their subvocal articulation simulations induce ingestion-like (expectoration-like) mouth movements, would increase (decrease) expected palatability of food items that are labeled with these inward and outward words. Moreover, we systematically tested a boundary condition of this effect to also inform future applied realizations. However, it should also be mentioned that the link between oral inward and outward movements on the side and approach-avoidance tendencies on the other side have not yet been shown directly but are simply assumed theoretically (Topolinski Maschmann et al., 2014).

1.1. Power analysis for required sample sizes and stopping rule

We used the effect size obtained in Experiment 5 in Topolinski, Maschmann et al. (2014, p. 888) which addressed German speaking participants like the current experiments did. The effect size obtained there was \( d_z = 0.77 \) (Cohen, 1988). Using G’Power (Faul, Erdfelder, Lang, & Buchner, 2007) the required sample size to replicate this effect two-sided with a power of 0.95 is \( N = 24 \). Arbitrarily, we massively over-powered all of the present experiments. Statistical analyses were ran after the full sample was collected. We report all IVs and DVs and data exclusions.

1.1.1. Experiment 1

In this first experiment we wanted to demonstrate the basic effect that inward-outward words can increase palatability of food named with these words. Thus, we presented such words to participants and told them that these were names of dishes. In the present experiments we only used consonantal inward and outward wanderings, because consonants require more precise and well-defined motor movements in articulation and thereby induce stronger effects than vowels (Topolinski & Boecker, 2016).

2. Method

2.1. Participants

\[ N = 82 \] non-psychology students from the University of Cologne (49 female; mean age 22, \( SD = 4 \)) were approached on the campus and invited to take part in the 5 min task for a candy reward (that was given to them after the task, of course).

2.2. Materials

We used the stimulus pool of 60 inward and 60 outward words designed for German phonation by Topolinski, Maschmann et al., (2014, Experiment 5). The original stimulus pool can be retrieved at http://dx.doi.org/10.1037/a0036477.supp. For this pool, consonants were sampled from three distinct phonational spots in the mouth according to German phonation (IPA, 1999); namely front (labial: B, M, P, W), middle (alveolar: D, L, N, S, T), and rear (velar-uvular: G, K, R). Words were created by randomly sampling one consonant from each of these spots, either in the sequence front-middle-rear (for inward wandering words) or rear-middle-front (for outward wandering words) and inserting random vowels in between the consonants. This way, words like PASOKI (inward) or KASOPI (outward) were generated. We slightly modified that published pool to avoid syllables that are food- or disgust-related. For instance, the stimulus KOTEM (meaning feces in German language) and was altered to KITEMA. The resulting pool can be found in the appendix.

Regarding vowels, an important comment is to be added. Although the present manipulations, as all earlier inout-manipulations (e.g., Topolinski, Maschmann, et al., 2014) only involve consonantal front and back wanderings, linguistics also conceptualizes front and back vowels. And indeed, various previous studies have shown meaningful psychological consequences of reading front vs. back vowels (e.g., Baxter & Lowrey, 2014; Maglio, Rabaglia, Feder, Krehm, & Trope, 2014; Rummer, Schweppe, Schielegelmilch, & Grice, 2014; Shrum, Lowrey, Luna, Lerman, & Liu, 2011; Yorkston & Menon, 2004). However, none except one of these previous accounts have tested an inward vs. outward sequence of vowels (this is, front-to-back vs. back-to-front-vowels). The exception is the yet unpublished study by Kronrod et al. (2015).

In a series of also yet unpublished highly powered experiments we also realized a vocal inward-outward wandering and did not find a reliable impact of vocal wandering on preference ratings (Topolinski & Boecker, 2016). As we had already mentioned, we think this is due to the fact that vowels do not have such distinct, well-localized motor patterns, but rather involve larger orofacial muscle systems (see Rummer et al., 2014).

2.3. Procedure

Participants were informed that this was a rating for possible names for dishes presented on the computer screen. They were asked to read each presented name carefully, imagine that this was a name for a dish, and then spontaneously rate the palatability of such a dish by typing in a number from 0 (not at all palatable) to 10 (very palatable). They received 30 inward and 30 outward words randomly sampled from the stimulus pool and appearing in randomized order. After the task they were asked for demographics, self-reported hunger (1 not at all hungry to 10 very hungry) and time since their last meal (only just, half an hour ago, 1 h ago, 2 h ago, 3 h ago, 4 or more hours ago). The task took around 5 min.

2.4. Food deprivation

On the scale from 1 to 10, participants reported a hunger of \( M = 4.99, SD = 2.70 \), ranging from 1 to 10. Regarding time since last meal, participants reported an average of 2.20 h (\( SD = 1.45 \)). These two variables were positively related to each other, \( r(82) = 0.50, p < .001 \).

2.5. Debriefing

After the experiment participants were asked for any conspi-cuity in the experimental task and whether they had discovered regularities in the words. No participant reported a speculation that hinted to the present actual manipulation.

3. Results

In 4 (<1%) of the trials participants mistyped their response (they either falsely typed in a letter or a number exceeding the provided scale). These responses were discarded from the analysis. Dish names with inward wandering words were rated as being more palatable (\( M = 4.77, SE = 0.12 \)) than dish names with outward wandering words (\( M = 4.57, SE = 0.13 \)), \( r(81) = 2.88, p = .005, 95\% \) Cl difference \( 0.06, 0.32 \), \( d_z = 0.32 \). This effect did not correlate with
self-reported hunger or time since last meal, nor did the mean average of all palatability ratings per participant, rs < 0.01.

4. Discussion

The present experiment yields a first demonstration that simply naming a dish with a word that features inward consonantal articulation spots increases the expected palatability of that dish. The effect size obtained, $d_z = 0.32$, is in the range of previously found effect sizes (Topolinski, Boecker, et al., 2015). Interestingly, this effect was not influenced by participants’ hunger. We found this in all of the present experiments and will discuss this in more detail in the General Discussion. The next experiment tested a boundary condition of this effect, namely the competition with visual information.

4.1. Experiment 2

The information on the dishes given in Experiment 1 was highly impoverished, participants only received the names of the dishes. Note, however, that in practical conduct dish names and maybe some mentions of the ingredients are the only information provided on restaurant menus (e.g., Kozup, Creyer, & Burton, 2003; Roberto, Larsen, Agnew, Baik, & Brownell, 2010). In this experiment we tested whether providing additional information on the dishes would change the impact of dish names’ articulation direction on palatability. The most important predictor of expected palatability are visual cues, as reviewed in the introduction (e.g., Hurling & Shepherd, 2003; Koch & Koch, 2003; Walsh et al., 1990). Likewise, some restaurants feature depictions of their dishes along with the dish names in their menus. Because this visual information is so strong, we predicted that the impact of articulation manipulation would be strongly reduced. This prediction is also supported by the well-known picture superiority effect in psychology (Paivio, 1990, 2013; Paivio & Csapo, 1973; in the consumer domain, see Russell, 2002). In this domain it has been shown that pictorial information likely rules out verbal information. Thus, we predicted that pictorial information on palatability, that is, whether a dish looks more or less palatable, would override the verbal information of the dishes’ names; and along with that verbal information the articulatory manipulation of inward and outward wanderings. For the sake of completeness, in this study we also implemented control words with no particular articulation direction. One previous study has shown that such words elicit preferences falling in between inward and outward words (Topolinski, Machsmann et al., 2014; Experiment 5).

5. Method

5.1. Participants

$N = 89$ non-psychology students from the University of Cologne (58 female; mean age 23, $SD = 4$) were again approached on the campus and invited to take part in the 5 min task for a candy reward.

5.2. Materials

We again used the inward and outward words from Experiment 1. In addition, we also used a third category of words that had no particular but rather mixed consonantal transition directions. We used these stimuli from a baseline experiment in Topolinski, Machsmann et al., (2014, Experiment 5). These control stimuli with mixed consonantal wanderings can be found in the appendix.

As dish images, we collected 60 images of various dishes from various internet resources. The images were cropped in size, so that they appeared with around 5–8 cm in vertical and 3–6 cm in horizontal length on the center of the screen. Also, the color of the images was reduced by saving them as 24-bit bitmaps instead of 256-bit bitmaps in the program Paint to reduce required storage and processing facilities of the experimental running software DirectRT. In a pilot study on $N = 67$ volunteers (42 female, 25 male, mean age 25, $SD = 9$) we let participants rate these images in palatability on a scale from 0 (not at all palatable) to 10 (very palatable). According to the averaged ratings per image, we divided the images (using a median split) into the 30 more (average rating $M = 7.70$, $SD = 0.44$) and 30 less (average rating $M = 5.22$, $SD = 0.49$) palatably looking images (examples see Fig. 1). Note, however, that all the images were rather palatably looking and not disgusting (cf., Hoefling et al., 2009).

5.3. Procedure

Participants were instructed to rate the palatability of dishes and their names for future research. They were explicitly instructed to take into account both the name and the image of the dish when assessing palatability. In every trial first the ostensible name of the dish was presented for 1000 ms. This name was either an inward, outward, or mixed word (completely randomized). After 1000 ms the image of the dish was presented in addition to the name (the name stayed presented on the screen) for additional 1000 ms. This image was either the image of a more or a less palatably looking dish. Then both name and image disappeared and a box was presented in which participants should type in their palatability rating ranging from 0 (not at all palatable) to 10 (very palatable). Participants received 60 trials in total, the 30 less and the 30 more palatably looking images, and, orthogonally to image palatability, 20 inward, 20 outward, and 20 mixed names. Pictures and target words were sampled randomly for each participant. The task took 5 min. Then, demographics and food deprivation were assessed.

5.4. Food deprivation

On the scale from 1 to 10, participants reported a hunger of $M = 4.91$, $SD = 3.02$, ranging from 1 to 10. Regarding time since last meal, participants reported an average of 2.01 h ($SD = 1.45$). These two variables were positively related to each other, $r(89) = 0.60$, $p < .001$.

5.5. Debriefing

Again, no participant expressed awareness of the present articulation manipulation.

6. Results

In 7 (<1%) of the trials participants mistyped their response (these trials were discarded). Over the averaged ratings, we conducted a 3 (Consonantal articulation direction: inward, mixed, outward) × 2 (Image palatability: high, low) Analysis of Variance (ANOVA), which only detected a main effect of image palatability, $F(1, 88) = 192.15, p < .001$, $\eta^2_p = 0.69$. No other effect was significant ($F$s $< 1.2, ps > 0.30$). As can be seen in Fig. 2, dishes with palatable images ($M = 6.29$, $SE = 0.11$) were generally rated more palatable than dishes with less palatably looking images ($M = 5.45$, $SE = 0.12$), while the articulation direction of the dish name had no systematic impact.

Neither the impact of image palatability nor of articulation direction was related to the nutrition-state variables self-reported hunger or time since last meal, all $rs < 0.10$, n.s.
7. Discussion

Providing pictorial information of a dish in addition to the mere name of the dish completely eliminated any impact of consonantal articulation direction of dish names on expected palatability of these dishes. Thus, one boundary condition of an articulatory effect on palatability is the competition with strong visual information on palatability, which is a strong determinant of attitudes towards foods (e.g., Hurling & Shepherd, 2003; Koch & Koch, 2003) and has generally more impact on mental processes than verbal information (e.g., de Vries et al., 2005; Hirschman, 1986; Shepard, 1967). We will discuss applied implications of this effect in the General Discussion. The final experiment should, however, demonstrate a case in which articulation direction would still impact expected palatability despite the presence of pictorial information.

7.1. Experiment 3

In this experiment we sought a condition under which the verbal information of food names along with its articulation direction would exert an impact in addition to pictorial information, namely when the pictorial information is not that informative for the palatability judgment anymore, because it is informationally impoverished (e.g., Dolan et al., 1997) or simply undiagnostic due to little variance (Skowronski & Carlston, 1987).

The first case of impoverished pictorial information is realized under situations in which pictorial information indeed is given for a certain foot item, but is providing little sensory information about the food itself. Imagine, for instance, standing in front of a row of wine bottles in the grocery store, where all the greenglass bottles fairly look alike (despite minor variations in bottle size and shape), and you automatically turn over to the verbal information printed on the bottles' tags. In this situation, the pictorial information is impoverished, because the color, let alone the taste, of the wine is not accessible. The second case of little diagnosticity due to little variance is realized when the pictorial information is simply not strongly varying across items. Imagine, for instance, a vegetable store with different sorts of the same vegetable, for instance, several boxes with different sorts of green beans. This vegetable is not varying much in visual appearance; and although you receive the full visual information on how the different sorts look like, this little varying information is rather undiagnostic to discriminate the different sorts, because it seems to be the same for each of the sorts. In Experiment 2, the images of the dishes strongly varied in their visual information, and thereby participants more likely used this highly varying information to build their judgments (Skowronski & Carlston, 1987).

Thus, we realized a set-up in which participants received the names and images of various sorts of the same foods, namely of green beans, cheese, orange juice, and wine. Although the images fully depicted the product, and each image was different from the others, the different sorts did not vary much within one product category (beans, cheese, juice) or simply did not convey much sensory information of the product (wine, which comes in bottles). We predicted that under these circumstances the articulation effect would still occur. We did not actively manipulate the visual palatability of the foods to render an articulation effect more likely.

8. Method

8.1. Participants

N = 85 non-psychology students from the University of Cologne (48 female; mean age 24, SD = 4) were again approached on the campus and invited to take part in the 5 min task for a candy reward.

8.2. Materials and procedure

We used again the inward and outward words from Experiment 1. Because we had only ten images per product category available,
we omitted the mixed wanderings control words (implemented in Experiment 2) to ensure an appropriate number of trials for each cell of the experimental design. Conceptually, the control items would not add very much to the present investigation (they have been found to elicit neutral attitudes lying in between more positive attitudes for inward and more negative attitudes for outward words, Topolinski, Maschmann et al., 2014; Experiment 5). We collected images of green beans, cheese, orange juice, and wine bottles from various internet resources with the constraints that the products would be depicted without any additional stimuli or objects (no tags, plates, bowls and the like) and in front of a white background. The tag on the wine bottles did not depict any verbal material. We ended up with 10 images per category, exemplary images can be found in Fig. 3.

Participants were informed that this was a pre-rating for possible brand names for several product categories. Similar to Experiment 2, in each trial first the name of the sort was presented for 1000 ms. This name was either an inward or an outward name. After 1000 ms, also the image of the product was presented in addition to the name, for additional 1000 ms. Then both stimuli disappeared and a box to type in the palatability rating was provided. Participants received the four different product categories in four separate blocks (e.g., beans, cheese, juice, wine; the sequence of products counter-balanced across participants), with five of the names within a product category being a randomly chosen inward and five of the names being a randomly chosen outward word. Thus, participants received 40 trials altogether. After the task, participants provided again demographics and hunger estimates. The task took less than 5 min.

8.3. Food deprivation

On the scale from 1 to 10, participants reported a hunger of $M = 4.69, SD = 2.76$ on average, ranging from 1 to 10. Regarding time since last meal, participants reported an average of 2.29 h ($SD = 1.34$). Hunger and time since last meal correlated with $r(85) = 0.52, p < .001$.

8.4. Debriefing

As in the previous experiments, no participant expressed awareness of the present articulation manipulation.

9. Results

Six (<1%) trials were discarded due to mistyped responses. Over the averaged ratings, we conducted a 2 (Consonantal articulation direction: inward, outward) $\times 4$ (Product: beans, cheese, juice, wine) ANOVA. We found a main effect of consonantal articulation direction, $F(1, 82) = 8.99, p = .004$, $r^2_p = 0.10$. No other effect was significant ($F$s < 2, $p$s > 0.13). Collapsed over all products, products with inward going names ($M = 5.30, SD = 0.92$) were rated as being more palatable than products with outward going names, ($M = 5.18, SD = 0.97$), $t(84) = 3.00, p = .004$, 95% CI$_{difference}[0.04, 0.20]$, $d_z = 0.33$. The conditional means are shown in Fig. 4. Although the missing interaction between the in-out manipulation and product type does not support single comparisons within each category, descriptively it is obvious that the in-out manipulation worked for all but one product category (juice, see Fig. 4). Although the study was sufficiently powered, we deem this lacking impact on juice as object category to be a normally occurring statistical fluctuation (Pashler & Harris, 2012).

The in–out effect did not correlate with self-reported hunger or time since last meal, both $|r|s < 0.06$, $ps > 0.50$.

10. Discussion

Realizing a condition in which visual information on food palatability is provided but this information is of minor diagnostic value because it does not vary much across stimuli we found that the articulation direction of food names indeed influenced expected palatability. The effect size was similar as in Experiment 1 where no pictorial information was provided.

10.1. General discussion

We show that the mere consonantal articulation direction of names for dishes and foods can influence expected palatability of that dishes and foods. Names that featured inward wandering consonant sequences, triggering eating-like mouth movements, provoked higher palatability ratings than names with outward wandering consonant sequences, triggering expectoration-like mouth movements. We show this effect in Experiment 1 where only a name of a dish is given. In Experiment 2, we demonstrate the boundary condition that this effect cannot be detected when

### Fig. 4. Palatability ratings in Experiment 3 as a function of consonantal articulation direction for each of the products used (error bars are SEMs). The scale was cropped for visual clarity; it was originally from 0 to 10.
additional visual information on the food is provided that signals palatability. Finally, we show in Experiment 3 that articulation direction can still impact expected palatability when the visual palatability information is rendered relatively undiagnostic for the judgment. This effect occurred for silent reading and for hungry and satiated participants alike.

These experiments introduce a novel determinant of food preferences that has not yet been considered in the literature. Of course, there have been earlier excellent demonstrations that labels or names of foods can affect palatability or attractiveness (Gmuer, Nuessli, et al., 2015; Gmuer, Siegrist et al., 2015; Miller & Kahn, 2005; Spence, 2012; Wolfson & Oshinsky, 1966), but these inductions worked either via the semantic meaning of the names (e.g., “space food”, Wolfson & Oshinsky, 1966; adding the word “fruit” to the label sugar, Sütterlin & Siegrist, 2015), via the articulation ease of the names (e.g., Gmuer, Nuessli, et al., 2015; see Dohle & Siegrist, 2014, for medical drug names), or the sounds contained in the names (Spence, 2012). The present induction works completely outside semantic routes, articulation ease, or onomatopoeia (when words sound similar to what they denote, like “cuckoo”), by using meaningless odd-sounding words that trigger oral ingestion or expectoration movements without participants being aware of this. Rather, the present route (visuomotoric induction outside of semantic information processing. Also, it has been shown that approach-related body movements can increase food take ( Förster, 2003), but this was constrained to limb movements.

In the present experiments we also assessed the nutritional state of the participants (although we did not manipulate it actively). In none of the present experiments we found a correlation between self-reported hunger or the elapsed time since participants had had their last meal and any of the palatability ratings. From theoretical grounds, one would have at least expected that the mean palatability rating per participant, collapsed over the articulation or visual manipulations, would increase with increasing subjective hunger (cf., Brendt et al., 2003; Hoefling et al., 2009; Seibt et al., 2007). However, this was not the case. A missing variation of hunger can hardly be the cause, since a significant proportion of participants reported food-deprivation of more than 3 h, which is usually the laboratory manipulation of hunger (Hoefling et al., 2009; Topolinski & Türk Pereira, 2012). Although we do not have an ultimate theoretically derived interpretation of this, we suspect that the present food images were not vivid enough to be modulated by the deprivation state, or the fact that participants took part for a candy reward after the task might have somehow interfered with the basic hunger-palatability link.

11. Limitations

The present studies have several limitations that should briefly be discussed. First of all, numerically, the present effects are small, for instance in Experiments 1 and 3 we only found a difference of 0.2 points on a 10 points rating scale. This limits the applied implications, for instance, for the retailing and marketing sector. However, statistically, the effects were robust. Also, in retailing marketing campaigns, many a little makes a mickle, due to the amount of products sold: The value of 0.2 on a 10 point scale amounts to 2%. Translated into possible willingness-to-pay tendencies (cf., Topolinski et al., 2015), this would, for instance amount to a profit gain of 2000$ for every 100,000$ items sold. Furthermore, more research is needed on how perceivers take into account competitive cues other than the presently explored (visual appearance), such as price. Also, we must acknowledge that the products in Experiment 3 were all unpacked products and looked very similar, so the question remains how robust the present labeling effect is for packed products and in the presence of additional competing cues.

12. Applied implications and speculations for future research

These are interesting applied implications of this effect. Marketing agencies and product developers can use the articulation direction of food products to increase expected palatability of their products already in the shelf. Restaurant owners can exploit this effect on their menus, but should avoid also placing images of the foods along with the names, because this would erase the articulation impact (see Experiment 2). For shop displays where there are many homogenous specimen for a given category (e.g., many different sorts of wines) the articulation effect is also likely to work. It is also likely that individuals would spend more money on foods or dishes with inward-names (cf., Topolinski et al., 2015).

Finally, there are diverse possible applications that should be tested in future research, for instance in the realm of medication adherence, dietary conduct, and the self-regulation of eating behavior (Herman & Polivy, 2004; Muraven & Baumeister, 2000). For instance, the intake of medication by patients with swallowing issues, which often comes with oral discomfort (Bardow, Nyvad, & Nauntofte, 2001), might profit from articulatorily induced inward mouth movements (Linn et al., 2012). For instance, it is possible that repeatedly uttering an inward word before swallowing a pill might prepare the oral muscle system for swallowing and thus render pill intake more convenient.

Furthermore, just as Wiers et al. (2011) trained avoidance arm movements in alcoholics to decrease alcohol consumption, repeated articulation of outward words might activate an oral avoidance state that might help decrease food intake or voracious appetite. Also, training oral inward movements by articulation might reduce anorectic states or disgust. All these possible applications shall be explored in future work.

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Appendix

Word stimuli used in the present experiments.

Inward wandering words

BIDAGO, BADIKU, BEDURA, BALUGO, BILOKE, BULARO, BENIGA, BONUKE, BANURO, BESIGA, BUSOKI, BOSIRE, BETUGA, BATIKU, BETIKA, MOSAGE, MUDeki, MADeRO, MILEGO, MULEKA, MOLARU, MANGOE, MENOKU, MUNORA, MOSIGE, MESAKU, MISARO, MATEGI, MOTEKA, MUITARI, PEDAGO, PUDOKA, PIDERU, PELUGO, PULIKA, PALERU, PUNOCGE, PENUKA, PONIRA, PASEGO, PASOKI, PUSIRE, PUTAGI, POTIKE, PATURO, WODEGA, WIDAKU, WADURE, WULIGO, WILUKA, WOLURI, WENOGU, WANKO, WONURI, WASOGE, WESUKA, WOSIRU, WITUGE, WITARO, WITUGE, WITARO.

Words with mixed wanderings

DIGABO, KABIDU, DERUBA, GABULO, LIKOBIE, RUBALO, NIGIBA, KOBUNE, NARUBO, GEBISA, SUKOKI, ROBISE, TEGUBA, KABITU, TIREBA, GOMADE, DUKEME, RAMODU, LIGEMO, KUMELA, LORAMU, GAMONE, NEKOMU, RUMONA, SOGIME, KEMASU, SIRAMO, GAMETI, TOKEMA, RUIJMATI, DEGAPO, KUPUDA, DIREPUI, CEPULO, LUKIPA, RAPELLI, NUGOPE, KEPUNA, NORIPA, GIPESU, SAKOPE,


