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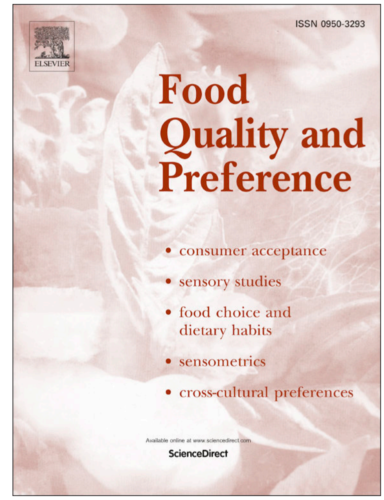

Short Communication

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Sound symbolism overrides articulation dynamics in the taste continuum

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1. Introduction

In a seminal paper, Topolinski and colleagues reported a psycholinguistic phenomenon referred to as the "in/out" effect which shows that people exhibit a preference for words that have an inwards (IW) [vs. outwards (OW)] articulatory pattern (Topolinski et al., 2014). For example, the word /padak/ involves consonants /p/ (originating from the front of the oral cavity), /d/ (originating from the middle of the oral cavity) and /k/ (originating from the back of the oral cavity). In contrast, the word /kadap/ has an entirely reversed articulatory pattern. It is believed that IW words involve the same muscles that are responsible for deglutition (the action or process of swallowing) whereas OW words involve those underlying the regurgitation movement. These orally ingestive and expulsive movements are perceived as positive and negative respectively, representing the rewarding effects of consumption and the negative associations of vomiting and other expulsive actions (Topolinski et al., 2014). Recently, researchers have also offered alternative explanations (e.g., fluency, pronounceability) behind the phenomenon (e.g., Bakhtiari, Körner & Topolinski, 2016). Similarly, Maschmann and colleagues have argued that other explanations are behind the in-out effect and people generally prefer front consonants to back consonants and the oral kinematics alone might not be the only mechanism governing the effect (Maschmann et al., 2020).

Since Topolinski et al.'s original finding, over twenty further papers have been published in a wide variety of journals demonstrating the robustness of the in/out effect. A preference for IW (vs. OW) words has been shown to extend to brand names, product appeal, a willingness to pay more and the approach-avoidance dichotomy (see Topolinski, 2017 for a review). IW (vs. OW) words have also been found to influence perception of food products. Objects and dishes having IW (vs. OW) names are expected to be more edible, more palatable, appealing and have been shown to increase food intake amongst respondents (e.g., Rossi, Pantoja, Borges & Werle, 2017; Topolinski & Boecker, 2016). Given the robustness and relatedness of the in/out effect with ingestion and food products, it seems plausible that an OW sounding name i.e. a non-likeable, non-palatable and non-appealing name, would also be associated with expectations of an unpleasant taste. Indeed, it might also be hypothesized based solely on the in/out effect that IW names would lead to expectations of a pleasant (e.g. sweet) taste whereas OW names would lead to expectations of a discordant (e.g. bitter) taste.

However, in the current paper, we present evidence that contradicts this seemingly logical hypothesis. Our argument is based on the existence of other well-known sound symbolic associations from the phonemic sounds contained within these IW or OW words. For example, although the word /ralam/ has an OW structure, it also contains three soft, mellifluous phonemes (/r/, /l/, /m/) and it is therefore unlikely that it would be construed as connoting taste bitterness (i.e. unpleasant) when compared to /badak/ which, although an IW word, is composed of more discordant phonemes than soft liquid and nasal sounds. The aim of the current paper is not to challenge the in/out effect but rather to demonstrate that at least in the taste dimension, this effect can be overridden by the other sound symbolic associations (e.g., soft and bilabial sounds associated with roundedness, pleasantness and sweet tastes) (e.g., Whissell, 2000).

2. Theoretical background

Sounds contained within words have been shown to affect their meanings, especially in novel and unknown words (e.g., Whissell, 2000). This is referred to as sound symbolism. Specific to taste, both vowels and consonants have been linked to the pleasant-discordant taste continuum (e.g., sweet-bitter) (e.g., Pathak, Calvert & Motoki, 2020; Motoki et al., 2020). In the current paper, two phenomena in the sound symbolic literature are of particular interest to us. These are onomatopoeia and phonesthesia. Onomatopoeia is the poetic construction of a word such that when pronounced, the sound resembles the object or concept it refers to (e.g. /tick tock/ mimics the sound of a clock). To wit, a large body of research has demonstrated that people often use soft sounds for pleasant concepts such as sweet tastes and harsh sounds for discordant or unpleasant concepts such as bitter tastes (e.g., Motoki et al., 2020; Whissell, 2000).

Phonesthemes suggest that word endings play an important role in words. Phonesthemes are particular sounds (or collection of sounds) that convey certain concepts and are especially found in word-beginnings or -endings. For example, in the English language /gl/ at the start of certain words (e.g., glimmer, glitter, glisten) conveys the concept of shininess, whereas /ash/ at the end of a word can connote an impact (e.g., smash, crash, bash, slash, gnash, splash (e.g., Mobbs, 2015). Phonesthemes, which are present across many languages (Mobbs, 2015), have also been shown to influence perception in the taste dimension [e.g. /ng/ endings normally refers to something 'that hangs' (cling, hang) and /tang/ refers to a 'strong taste that hangs in the mouth' (Allan, 2009)]. Typically, in phonesthesia, the word endings have been given more importance, and a phonesthetic change in a word ending often changes the meaning of the word or concept. For example, for a word with the root /ski/, /skid/ (i.e. with a hard /d/ sound) suggests an impact, whereas /skim/ (with a soft /m/ sound) suggests a motion with little friction, and /ski/ (with a soft vowel ending) represents unimpeded motion (like /fly/, also a word with a soft vowel ending) (Allan, 2009). Word endings convey much about a word's meaning, especially in the case of novel words (e.g., words ending with /oon/ tend to be nouns whereas those ending with /erge/ are generally verbs, and people can often infer a word's meaning based on its ending (even if it is unfamiliar), based on their past experience of that language (Kemp, Nilsson, & Arciuli, 2009). Although both word-beginnings and word-endings have been shown to be important in lexical processing, there is evidence to suggest that word-endings play a more important role than word-beginnings (Arciuli & Monaghan, 2006), especially in the novel word learning (e.g., brand names, non-words) (Slobin, 1973).

Word ending in bilabial sounds are likely to be linked to lip-gestures that evoke pleasant tastes (e.g., sweetness). Historically, languages evolved from a series of vocal and hand movements (e.g. hand gestures, lip smacking) and in accordance with the mouth-gesture hypothesis, while speaking, humans often unintentionally match their mouth movements with those of their hands (Paget, 1930). For example, the word /capture/, when communicated using hands involves opening the wrist and closing it with a force. In the speech equivalent of /capture/, the articulation of phoneme /k/ (from the back of the mouth), goes to bilabial sounds (from the front of the mouth), ending with an explosive /p/ sound, which vocally imitates the hand gesture of the word /capture/ (Swadesh, 1971). This link suggests that often speech and lip gestures imitate those of the hands (Hawhee, 2006). Since early evolution, humans and primates have used lip smacking as a means of communication to convey pleasant concepts (e.g. taste, mating calls). On this basis, the theory would suggest that words ending in lip smacking sounds (or bilabials) are akin to lip-gestures that evoke pleasant tastes (e.g., sweetness). Lip smacking in response to pleasant tastes is in fact common in both monkeys and infants.

If imitating muscle actions of deglutition (vs. regurgitation) movements can change the palatability expectations in food, then by the same logic, a word-ending in a lip-smacking, bilabial sound (vs. discordant word-endings) and words containing soft (vs. harsh) sounds should be associated with a pleasant taste, irrespective of the articulatory muscular movement (as both are induced by past associations of pleasant=positive and unpleasant=negative). This is what we aim to demonstrate in the current paper.

3. Method and overview of studies

Forty-five IW/OW word pairs (see Appendix 1) were created in a bi-syllabic format (CV-CVC; consonant-vowel-consonant) using three front/bilabial consonants (/b/, /m/, /p/)[1], five central consonants (/d/, /l/, /n/, /s/, /t/) and three back consonants (/g/, /k/, /r/) (Topolinski et al., 2014). Only the central vowel /ʌ/ (as in /h**u**t/) was used in both the vowel positions [e.g. /balar/ (IPA notation: /bʌlʌr/) (IW) and /ralab/ (IPA notation: /rʌlʌb/) (OW)][2]. For the analysis, we segregated bilabials (/b/, /m/, /p/), liquids (/l/, /r/) and nasals (/m/, /n/) as soft sounds, as these have often been associated with pleasant concepts (e.g. softness, child-like) (Kawahara, 2019; Pathak, Calvert, & Velasco, 2017; Maschmann et al., 2020; Sakamoto & Watanabe, 2018). Studies were designed on the Inquisit 6 platform (Millisecond.com) and participants were native English speakers recruited from the USA through Amazon Mechanical Turk; all participants took part in only one of the studies. In both studies, participants were asked to guess the purpose of the experiment; none of the participants could make a correct guess and all data was thereby retained. In both studies, the stimuli were presented visually in the Arial font and participants were familiarized with the experimental procedure in a few practice trials.

In Study 1, participants were shown an IW/OW word pair and were asked to drag and drop the names in two categories (sweet vs. bitter) shown on top. Study 2 aimed to test the association of IW/OW words with roundedness vs. angularity. Since sweet (vs. bitter) tastes have been shown to be associated with roundedness (vs. spikiness) (see Velasco, Woods, Petit, Cheok, & Spence, 2016 for a review), Study 2 used the indirect shape-sound paradigm to demonstrate the results.

4. Study 1

4.1. Participants

Sixty participants between the ages of 21 to 73 years completed the study, $M_{Age} = 43.33$ yrs., $SD = 12.46$, *Males* = 29, *Females* = 31) (data of one participant with values outside +/- 3SD was excluded). All participants were native English speakers and were fluent in English (in addition, two participants also knew Japanese and one each knew Persian, Spanish, Cantonese, Russian and Turkish).

4.2. Procedure and design

Participants were told that a company was launching two new brands of chocolates (one sweet and the other bitter) in a non-English speaking market and was looking for suitable brand names. Each participant was then presented with twenty IW/OW word pairs on the screen (word pairs were randomized and counterbalanced within-participants) and they had to drag the names to an appropriate taste category (sweet vs. bitter; categories were counterbalanced between-participants) shown on top of the screen. We hypothesized that words/names containing soft sounds (liquids, nasals and bilabials) would be more associated with sweet tastes, irrespective of a names' articulatory pattern (IW or OW).

4.3. Results

A repeated measures ANOVA[3] showed that participants associated more OW (vs. IW) words with sweet (vs. bitter) taste, $F\ (1, 58) = 6.05$, $p = 0.017$, $n_{p2} = 0.094$; $M_{Outwards\ words\ with\ sweet} = 0.55$, $M_{Outwards\ words\ with\ bitter} = 0.45$, $SD = 0.16$. Subsequent segregation of the words by the number of soft sounds (/b/, /p/, /m/, /l/, /r/, /n/) present in the words (i.e. one vs. two vs. three soft sounds) revealed an effect of the soft sounds on taste expectations.

4.3.1. Effect of the number of soft sounds (OW words)

As the number of soft sounds in a word increases, so does the expectation of a sweet taste; one soft sound: $M_{Outwards\ words\ with\ sweet} = 0.52$, $M_{Outwards\ words\ with\ bitter} = 0.48$, $SD = 0.22$, $t\ (58) < 1$, $p > 0.4$; two soft sounds: $M_{Outwards\ words\ with\ sweet} = 0.56$, $M_{Outwards\ words\ with\ bitter} = 0.44$, $SD = 0.22$, $t\ (58) = 2.06$, $p = 0.044$, $d = 0.27$; three soft sounds: $M_{Outwards\ words\ with\ sweet} = 0.59$, $M_{Outwards\ words\ with\ bitter} = 0.40$, $SD = 0.33$, $t\ (58) = 2.21$, $p = 0.031$, $d = 0.29$ (Figure 1a). The in/out effect rests mainly on the positions of front and back consonants (since central consonants remain at the same position in both set of IW or OW stimuli), and the central consonants do not play any role. However, we find that the soft central phonemes (e.g., /l/, /n/) significantly add to the expectation of sweetness, which supports our argument in favor of a coexisting sound symbolic effect along with the in/out effect, which best explains these results.

Insert Figure 1 about here

4.3.2. Effect of the number of soft sounds (IW words)

A repeated measures ANOVA (Greenhouse–Geisser corrected) with number of sounds (one, two, three) and taste expectation (sweet, bitter) as factors showed significantly different results, $F\ (1.45, 83.97) = 10.73$, $p < 0.001$, $n_{p2} = 0.16$. Results suggest that as the number of soft sounds in a word increase, so does the expectation of the sweet taste; one soft sound: $M_{Inwards\ words\ with\ sweet} = 0.40$, $M_{Inwards\ words\ with\ bitter} = 0.60$, $SD = 0.21$, $t\ (58) = 3.49$, $p = 0.001$, $d = 0.51$; two soft sounds: $M_{Inwards\ words\ with\ sweet} = 0.45$, $M_{Inwards\ words\ with\ bitter} = 0.55$, $SD = 0.19$, $t\ (58) = 2.06$, $p = 0.04$, $d = 0.27$; three soft sounds: $M_{Inwards\ words\ with\ sweet} = 0.56$, $M_{Inwards\ words\ with\ bitter} = 0.39$ $SD = 0.36$, $t\ (58) = 2.01$, $p = 0.049$, $d = 0.26$ (Figure 1b).

4.3.3. Effect of the last letter ending (IW words)

To analyze the effect of the last letter (harsh vs. soft sounds) on the results, we further analyzed the results based on the last letter endings (i.e. IW words ending in /k/ vs. /g/ vs. /r/). A repeated measures ANOVA (Greenhouse–Geisser corrected) showed marginal differences, $F\ (1.80, 104.65) = 2.92$, $p = 0.06$. However, /r/ and /k/ endings were found to be significantly different from each other ($t\ (58) = 2.31$, $p = 0.02$, $d = 0.31$), but not with the other letters (i.e., not in r/ with /g/, ($t\ (58) = 1.76$, $p = 0.08$) or /g/ with /k/, ($t\ (58) = 0.84$, $p = 0.40$) ($M_{Word\ ending\ /r/} = 0.49$, $SD = 0.23$; $M_{Word\ ending\ /k/} = 0.40$, $SD = 0.28$; $M_{Word\ ending\ /g/} = 0.44$, $SD = 0.21$). This suggests that when the IW word ends in a soft sound (/r/) the expectation of sweetness increases considerably more than when it ends with /g/ or /k/ sounds) (Figure 1c). On comparison of /g/ & /k/ endings with the /r/ endings [i.e. harsh (/g/ & /k/) vs. soft (/r/)], a significant difference emerges between harsh (vs. soft) word-endings, $F\ (1, 58) = 6.46$, $p = 0.014$, $n_{p2} = 0.10$; ($M_{Word\ ending\ /g/\ and\ /k/} = 0.42$, $SD = 0.18$; $M_{Word\ ending\ /r/} = 0.49$, $SD = 0.23$. This pattern suggests the effect of harsh vs. soft sounds in the word endings and shows that most of the association of IW words with expected bitter taste is actually due to the /g/ and /k/ word-endings, and not due to the soft /r/ sound endings.

4.3.4. Effect of the last letter ending (OW words)

A repeated measures ANOVA showed no differences in the last letter endings (/b/, /m/, /p/) for the OW words, $F\ (2, 116) < 1$, $p > 0.40$. None of the paired contrasts (/b/, /p/, /m/) showed any differences, $M_{Word\ ending\ /b/} = 0.53$, $SD = 0.24$; $M_{Word\ ending\ /m/} = 0.58$, $SD = 0.23$; $M_{Word\ ending\ /p/} = 0.54$, $SD = 0.22$ (Figure 1c). Words ending in /b/, /m/, /p/ were also compared with the /r/ endings (IW words) and no differences were found, $F\ (2.40, 139.64) < 1$, $p > 0.30$. None of the paired contrasts (/b/, /p/, /m/, /r/ endings) showed any difference ($M_{Word\ ending\ /b/} = 0.53$, $SD = 0.24$; $M_{Word\ ending\ /m/} = 0.58$, $SD = 0.23$; $M_{Word\ ending\ /p/} = 0.54$, $SD = 0.22$; $M_{Word\ ending\ /r/} = 0.49$, $SD = 0.23$). This further supports the argument that soft (vs. harsh) sounds can override any other coexisting effect (e.g., in/out).

4.3.5. Orthographic angularity of /k/

One potential confound that can affect the results is the orthographic angularity of the letter /k/. When compared to other letters used in the stimuli, the letter /k/ is the only orthographically angular letter. However, /k/ is also phonemically angular (or harsh) at the same time and it is not possible to dissociate its orthographic (vs. phonemic) angularity from the current data set. In order to rule out any undue dominance of the orthographic angularity in the results, we only compared trials where IW/OW words with letter /k/ were presented together (i.e. OW words with /k/ initial vs. IW words with /k/ ending, e.g., /balak/ vs. /kalam/). If orthographic angularity were responsible for the results, then we would expect to find similar association of taste with the IW/OW words in such trials. However, the results show that in majority of such trials (67% vs. 33%) participants chose words ending with the letter /k/ (i.e. IW words) as bitter (vs. word initial /k/ presentation i.e. OW words) ($M_{Inwards\ word\ ending\ /k/}$ = 0.67, $M_{Outwards\ word\ initial\ /k/}$ = 0.33, SD = 0.33, Z = 3.41, p = 0.001, r = 0.46; Figure 1d).

5. Study 2

Research suggests that people often associate pleasant (vs. unpleasant) concepts (e.g., sweet vs. bitter taste) with roundedness (vs. angularity). Study 2 aimed to use this indirect shape-sound paradigm to test our findings. Study 1 demonstrated the association of OW words (vs. IW words) and words with softer sounds more with the expectation of sweetness (vs. bitterness). In Study 2, we expect the OW words (i.e. bilabial word-endings) and words with higher number of soft sounds to be more associated with roundedness (than the IW words and words with fewer numbers of soft sounds, which will be associated more with angularity).

5.1. Participants

Sixty participants between the ages of 23 to 74 years completed the study, M_{Age} = 41.65 yrs., SD = 11.60, *Males* = 31, *Females* = 29) (data of two participants with values outside +/- 3SD was excluded). All participants were native English speakers and were fluent in English (in addition, two participants knew Spanish, one each knew French, Tamil, Korean and German and one was multilingual knowing French and Spanish). The participants in Study 2 were different from those in Study 1.

5.2. Procedure and design

Participants were told that on each trial they would see a word presented on the computer screen and were asked to read it aloud and match it to one of two shapes (rounded vs. spiky) presented beneath the word. The shapes (rounded vs. spiky) were anchored to an eleven point scale (1= very angular and 11=very rounded; the anchors were counterbalanced between-participants).

5.3. Results

A repeated measures ANOVA showed that participants associated the OW (vs. IW) words significantly more with roundedness (vs. angularity), $F\ (1, 57) = 5.20$, $p = 0.026$, $n_{p2} = 0.08$; $M_{Outwards} = 6.13$, $SD = 1.26$, $M_{Inwards} = 5.72$, $SD = 1.16$.

5.3.1. Effect of the number of soft sounds

A repeated measures ANOVA with the type of word (IW vs. OW) and number of soft sounds (one vs. two vs. three) as factors revealed a significant main effect of soft sounds ($F\ (1.65, 65.99) = 35.06$, $p < 0.001$, $n_{p2} = 0.47$) and a significant interaction ($F\ (1.84, 73.78) = 10.13$, $p < 0.001$, $n_{p2} = 0.20$) (IW words: one soft sound, $M = 4.91$, $SD = 1.33$; two soft sounds, $M = 5.94$, $SD = 1.41$; three soft sounds, $M = 7.59$, $SD = 1.92$; OW words: one soft sound, $M = 5.87$, $SD = 1.50$; two soft sounds, $M = 6.40$, $SD = 1.33$: three soft sounds, $M = 7.06$, $SD = 1.99$). As the number of soft sounds in the word increases, so does its association with roundedness (vs. angularity), irrespective of its articulatory nature (i.e. IW vs. OW) (Figure 2a). To unpack the interaction, two one-way ANOVAs (one each for IW and OW words) were conducted with one, two and three soft sounds as factors. Both ANOVAs showed a significant effect of the soft sounds on a words' association with roundedness (vs. angularity) (IW words: $F\ (1.71, 82) = 56.99$, $p < 0.001$, $n_{p2} = 0.54$; OW words: $F\ (1.74, 83.64) = 7.58$, $p = 0.001$, $n_{p2} = 0.14$).

Insert Figure 2 about here

5.3.2. Effect of the last letter ending

To analyze the effect of the last letter, the data was segregated as per the letter ending (i.e. words ending in /b/, /p/, /m/, /k/, /g/, and /r/). A repeated measures ANOVA showed significant differences, $F\ (5, 275) = 22.98$, $p < 0.001$, $n_{p2} = 0.29$) ($M_{Word\ ending\ /b/} = 6.13$, $SD = 1.84$; $M_{Word\ ending\ /g/} = 5.78$, $SD = 1.96$; $M_{Word\ ending\ /k/} = 4.34$, $SD = 1.49$; $M_{Word\ ending\ /m/} = 6.73$, $SD = 1.44$; $M_{Word\ ending\ /p/} = 5.81$, $SD = 1.67$; $M_{Word\ ending\ /r/} = 7.06$, $SD = 1.75$) (Figure 2b). Specifically, we were interested in the OW words ending in /g/ and/k/ compared to /r/ endings. If all OW words are perceived as similar then there should be no difference in these letter endings. However, significant differences were observed, /g/ vs. /r/ ($t\ (56) = 4.35$, $p < 0.001$, $d = 0.57$), /k/ vs. /r/ ($t\ (57) = 9.69$, $p < 0.001$, $d = 1.26$) and /g/ vs. /k/ ($t\ (56) = 5.22$, $p < 0.001$, $d = 0.68$). OW words with /r/ endings were significantly rated as rounded, whereas OW words with /g/, and /k/ endings were rated as angular (/k/ endings were rated significantly more angular than the /g/ endings). To examine the effect of the sharp vs. soft sounds in the word-endings, /b/, /p/, /m/, and /r/ endings were compared with only /k/, /g/ endings, which increased the statistical difference and exhibited a higher effect size, demonstrating the importance of soft vs. sharp word endings irrespective of the articulation type (i.e. IW vs. OW), $F\ (1, 57) = 48.57$, $p < 0.001$, $n_{p2} = 0.46$) ($M_{Sharp\ word\ ending} = 5.04$, $SD = 1.36$; $M_{Soft\ word\ ending} = 6.42$, $SD = 1.18$) (Figure 2c). Word initial letters seemed to have no effect on the results (word initial (/g/, /k/) vs. word initial (/b/, /m/, /p/, /r/), $F\ (1, 57) < 1$, $p > 0.60$) ($M_{Sharp\ word\ initial} = 5.89$, $SD = 1.39$; $M_{Soft\ word\ initial} = 5.98$, $SD = 1.02$).

6. General discussion

This paper builds on and explores the alternative explanations of the well established in/out effect as described by Topolinski et al. (2014) in the taste dimension. The in/out effect has so far been demonstrated to influence the perception of various food related attributes namely, palatability, edibility, willingness-to-pay, likeability and even to increase the consumption of foods named with IW (vs. OW) sounding words (see Topolinski, 2017 for a review). Though oro-kinematics (articulatory muscle action of pronouncing words akin to swallowing vs. vomiting) was originally proposed as the mechanism behind the in/out effect, recent evidence suggests alternative explanations (e.g. pronounceability, fluency, greater preference for first consonants) (Maschmann et al., 2020; Topolinski et al. 2014). For example, one alternative explanation is that in natural languages, words with sounds originating from the front of the mouth (e.g., /m/) are more abundant than words with sounds originating from the back of the mouth. This natural phenomenon leads the speakers of such languages to be more familiar with such words and patterns (i.e. frontal preference of sounds). Words imitating front to back movements are thus believed to be processed more fluently, spoken with ease and seem more familiar (than words imitating back to front movement). These explanations have been recently offered as reasons behind the in/out effect and are said to lead some words (e.g. those imitating inwards articulatory movement) towards certain preference judgements (e.g., approach vs. avoidance) (Ingendahl et. al, 2020). Adding further weight to these explanations, the in/out effect has also been shown to weaken when participants are aware that the word/name refers to a food (vs) non-food brand or even reversed with some training or familiarity with the pseudo-words (Körner et al., 2019). Together, this suggests that there may be other simultaneous mechanisms affecting (and/or coexisting) with the in/out effect, and may at times override it.

To ascertain the generalizability of our findings, we checked the articulatory pattern of the existing food brands. There are forty-nine food brands listed in the Brand Finance’s top 500 list of American brands (https://brandirectory.com, 2018), and barring just three brands (Pepsi, Fanta, Wendy’s), which have an IW articulatory pattern, rest forty-six brands have either OW or inconclusive articulatory pattern (i.e. no specific IW or OW pattern) (see Appendix 2). Similarly, even the articulatory pattern of the taste words in the English language shows similar findings. Among the taste words, ironically the word 'bitter' has a clear IW pattern (which is contradictory to the in/out effect), whereas the other taste words have no specific articulatory pattern (i.e. the words 'sweet' (inconclusive pattern or partially OW), 'salty' (inconclusive pattern) and 'umami' (inconclusive pattern).

We propose that the findings reported here can be more accurately explained by sound symbolism and suggest that because spoken words consist of a variety of phonemic sounds (consonants and vowels) and prosodic features (e.g., stress, pauses, length of a vowel), which can affect the words' final meaning. Specifically, we demonstrate that OW words having soft sounds (i.e. liquids, nasals, bilabials) and bilabial word-endings (akin to lip smacking sounds) evoke expectations of sweetness (when compared against IW words without these inclusions). Bilabials and nasals (i.e. typical word-endings in the OW words) have been linked to softness whereas /k/ and /g/ (i.e. typical word-endings in the IW words) with harshness (Sakamoto & Watanabe, 2018). Similarly, one of the most researched sub-fields within the sound symbolic literature is the shape-sound correspondence. Research has shown the association of certain speech sounds (e.g. harsh vs. soft) with certain shapes (e.g., angular vs. round) and bilabial consonants have been regularly shown to be associated with smoothness and roundedness (e.g., Sakamoto & Watanabe, 2018). Using shape-sound paradigm, we demonstrate that the OW (vs. IW) words are more associated with roundedness (vs. angularity), which indirectly supports the findings of Study1 [since sweet (v. bitter) tastes have also been shown to be linked with roundedness (vs. angularity) (Velasco et al., 2016)].

Sound symbolism has shown that people often link sounds with concepts. For example, since children learn bilabials (/b/, /m/, /p/) first and bilabials are often found in their utterances (e.g., mama, baba) (Pathak, Calvert, & Velasco, 2017) people often associate these sounds to childlike concepts (e.g., innocence) (Kawahara, 2019). To illustrate, research suggests that companies incorporate more bilabials when naming brands catering to children's needs (e.g. diapers) rather than with e.g., adult cosmetic brands. This stream of research also shows that since bilabials are associated with innocence and children, when creating names for villains, respondents tend to avoid using bilabials (Kawahara, 2019). Such examples and prior research suggest a link between early communication (e.g., bilabials, front consonants which appear early in life) with concepts (e.g., pleasantness, likability) (Maschmann et al., 2020). Similarly, languages have developed from both manual and lip gestures- the earliest forms of communication. Since people often smack lips in response to pleasant taste (akin to bilabial phoneme) it is likely that a word-ending phoneme is construed as a pleasant taste due to this onamato-kinetic link (pleasant taste=lip smack). Lip smacking has been seen in many primates and infants as a mean of communication in pleasant interactions or situations (e.g. sweet taste, mating, mother-infant interactions) (MacNeilage, 1998).

In fact, we are not disputing the in/out effect and rather take support from it. In/out effect suggests that the articulatory muscular movement (IW vs. OW) can change the palatability and likeability ratings of food. We suggest a similar explanation for our findings. The utterances of bilabials (i.e. front of the oral cavity and lips) involve the same articulatory apparatus which is involved in assessing sweet tastes (i.e. sweet tastes are linked to the front portions of the tongue and front phonemes; back portion of the tongue has been linked to bitter tastes and back phonemes) (Motoki et al., 2020; Whissell, 2000). The current research does not claim that the in/out effect is absent in the taste dimension, instead it demonstrates the coexistence of other well-known mechanisms (e.g., sound symbolism, softness of liquid consonants and vowels) which cannot be ignored and may themselves be adding/attenuating the results. More research is needed to reaffirm these findings in other product dimensions (e.g., healthiness, size/portions).

To conclude, this study explores the link between sound symbolism and the in/out effect in the taste continuum. Our results suggest that sound symbolism appears to override the in/out effect in sound-taste and sound-shape associations. Contrary to the in/out hypothesis [which would have suggested that words with inwards (vs. outwards) articulatory movement would be expected as sweet and rounded (vs. bitter and sharp)], our results instead show that words with an outwards (vs. inwards) articulatory pattern are expected as sweet and round (vs. bitter and sharp). Further research should be needed to confirm these findings and to explore whether sound symbolism overrides the in/out effect in other research streams related to sensory and consumer science (e.g., tastiness, smell).

Footnotes

Footnote 1 – Topolinski et al. (2014) also used /w/ and /f/ as front consonants in creating the stimuli, whereas the current paper used only bilabials (/b/, /m/, /p/) or lip smacking consonants.

Footnote 2 – Since the stimuli were visually presented, it is likely that participants read it in a different format (e.g. /bælʌr/).

Footnote 3 – Data of the proportions was normally distributed

References

Allan, K. (2009). *Concise encyclopedia of semantics*. Oxford, UK: Elsevier.

Arciuli, J., & Monaghan, P. (2006). Hidden cues to grammatical category in the spelling of English disyllables. Paper presented at the 15th Australian Language and Speech Conference. *Australian Journal of Psychology*, *58*, 1–13.

Bakhtiari, G., Körner, A., & Topolinski, S. (2016). The role of fluency in preferences for inward over outward words. *Acta Psychologica*, *171*, 110-117.

Hawhee, D. (2006). Language as sensuous action: Sir Richard Paget, Kenneth Burke, and gesture-speech theory. *Quarterly Journal of Speech*, *92*(4), 331-354.

Ingendahl, M., Schöne, T., Wänke, M., & Vogel, T. (2020). Fluency in the in-out effect: The role of structural mere exposure effects. *Journal of Experimental Social Psychology*, *92*, 104079.

Kawahara, S. (2019). Teaching phonetics through sound symbolism. Proceedings of ISAPh.

Kemp, N., Nilsson, J., & Arciuli, J. (2009). Noun or verb? Adult readers' sensitivity to spelling cues to grammatical category in word endings. *Reading and Writing*, *22*(6), 661.

Körner, A., Bakhtiari, G., & Topolinski, S. (2019). Training articulation sequences: A first systematic modulation of the articulatory in–out effect. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *45*(10), 1725.

MacNeilage, P. F. (1998). The frame/content theory of evolution of speech production. *Behavioral and Brain Sciences*, *21*(4), 499-511.

Maschmann, I. T., Körner, A., Boecker, L., & Topolinski, S. (2020). Front in the mouth, front in the word: The driving mechanisms of the in-out effect. *Journal of personality and social psychology*. https://doi.org/10.1037/pspa0000196

Mobbs, I. (2015). Phonoaesthesia, diachronic semantics, and the faculties of performance. Retreived from https://www.academia.edu/234791/Phonaesthesia_and_the_faculties_of_performance on 10 July 2020.

Motoki, K., Saito, T., Park, J., Velasco, C., Spence, C., & Sugiura, M. (2020). Tasting names: Systematic investigations of taste-speech sounds associations. Food Quality and Preference, 80, 103801.

Paget, R. (1930). *Human Speech- Some observations, experiments and conclusions as to the nature, origin, purpose and possible improvement of human speech*. London: Kegan Paul, Trench, Trubner & Co.

Pathak, A., Calvert, G. A., & Motoki, K. (2020). Long vowel sounds induce expectations of sweet tastes. *Food Quality and Preference*, *86*, 104033.

Pathak, A., Calvert, G., & Velasco, C. (2017). Evaluating the impact of early-and late-acquired phonemes on the luxury appeal of brand names. *Journal of Brand Management*, *24*(6), 522-545.

Rossi, P., Pantoja, F., Borges, A., & Werle, C. O. (2017). What a delicious name! Articulatory movement effects on food perception and consumption. *Journal of the Association for Consumer Research*, *2*(4), 392-401.

Sakamoto, M., & Watanabe, J. (2018). Bouba/Kiki in touch: Associations between tactile perceptual qualities and Japanese phonemes. *Frontiers in Psychology*, *9*, 295.

Slobin, D. I. (1973). Cognitive prerequisites for the development of grammar. In *Studies of child language development* (pp. 175-208). New York, USA: Holt, Rinehart, & Winston.

Swadesh, M. (1971). *The origin and diversification of language*. Chicago and New York: Aldine Atherton.

Topolinski, S. (2017). Articulation patterns in names: A hidden route to consumer preference. *Journal of the Association for Consumer Research*, *2*(4), 382-391.

Topolinski, S., & Boecker, L. (2016). Mouth-watering words: Articulatory inductions of eating-like mouth movements increase perceived food palatability. *Appetite*, *99*, 112-120.

Topolinski, S., Maschmann, I. T., Pecher, D., & Winkielman, P. (2014). Oral approach–avoidance: Affective consequences of muscular articulation dynamics. *Journal of Personality and Social Psychology*, *106*(6), 885.

Whissell, C. (2000). Phonoemotional profiling: a description of the emotional flavour of English texts on the basis of the phonemes employed in them. *Perceptual and Motor Skills*, *91*(2), 617-648.

Velasco, C., Woods, A. T., Petit, O., Cheok, A. D., & Spence, C. (2016). Crossmodal correspondences between taste and shape, and their implications for product packaging: A review. *Food Quality and Preference*, *52*, 17-26.

Appendix 1

Inwards words (IW)	Outwards words (OW)
Badag	Gadab
Balag	Galab
Banag	Ganab
Basag	Gasab
Batag	Gatab
Badak	Gadam
Balak	Galam
Banak	Ganam
Basak	Gasam
Batak	Gatam
Badar	Gadap
Balar	Galap
Banar	Ganap
Basar	Gasap
Batar	Gatap
Madag	Kadab
Malag	Kalab
Manag	Kanab
Masag	Kasab
Matag	Katab
Madak	Kadam

Malak	Kalam
Manak	Kanam
Masak	Kasam
Matak	Katam
Madar	Kadap
Malar	Kalap
Manar	Kanap
Masar	Kasap
Matar	Katap
Padag	Radab
Palag	Ralab
Panag	Ranab
Pasag	Rasab
Patag	Ratab
Padak	Radam
Palak	Ralam
Panak	Ranam
Pasak	Rasam
Patak	Ratam
Padar	Radap
Palar	Ralap
Panar	Ranap
Pasar	Rasap
Patar	Ratap

Appendix 2

Brand	Position in the top 500 list	Articulatory pattern
Starbucks	15	INCL
Coca-Cola	19	INCL or partially OW
McDonald's	24	INCL
Pepsi	31	IW
Subway	78	INCL or partially OW
KFC	79	INCL or partially OW
Bud Light	90	INCL or partially IW
Budweiser	92	INCL or partially IW
Tyson	121	INCL
Kellogg's	128	INCL or partially OW
Gatorade	146	INCL or partially OW
Kraft	149	OW
Domino's	152	INCL or partially OW
Wrigley's	153	INCL or partially OW
Sprite	170	INCL
Heinz	191	INCL or partially OW
Whole Foods	193	INCL
Lay's	204	INCL
Jack Daniel's	209	INCL
Mountain Dew	221	INCL or partially IW
Dr Pepper	223	INCL or partially IW
Burger King	230	INCL or partially IW
Pizza Hut	235	INCL

Oscar Mayer	251	INCL or partially IW
Coors Light	259	INCL
Dunkin' Donuts	262	INCL
Tropicana	268	INCL
Fanta	271	IW
Chipotle	272	INCL
Hershey's	289	INCL
Bacardi	294	INCL or partially IW
Wendy's	309	IW
Campbell's	316	INCL or partially OW
7-Up	320	INCL or partially OW
Panera Bread	321	INCL or partially IW
Mars	328	INCL or partially IW
Yoplait	334	INCL
Miller Lite	351	INCL or partially IW
Quaker	358	INCL or partially OW
Folgers	368	INCL or partially IW
Taco Bell	369	INCL
Hormel	405	INCL or partially OW
Grey Goose	410	INCL
Olive Garden	425	INCL or partially OW
Doritos	433	INCL
McCormick	443	INCL or partially IW
Cheetos	461	INCL
Lactaid	486	INCL
Reese's	500	INCL or partially OW

INCL = Inconclusive articulatory pattern; IW = Inwards articulatory pattern; OW = Outwards articulatory pattern

Figure 1a. Taste expectancy in OW words

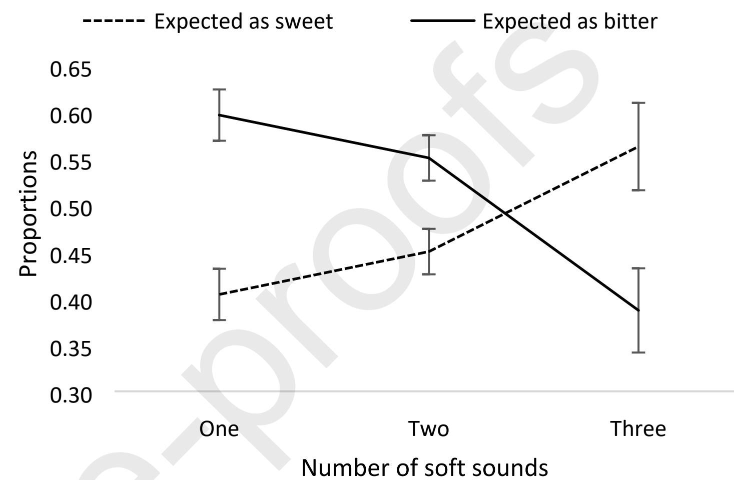

Figure 1b. Taste expectancy in IW words

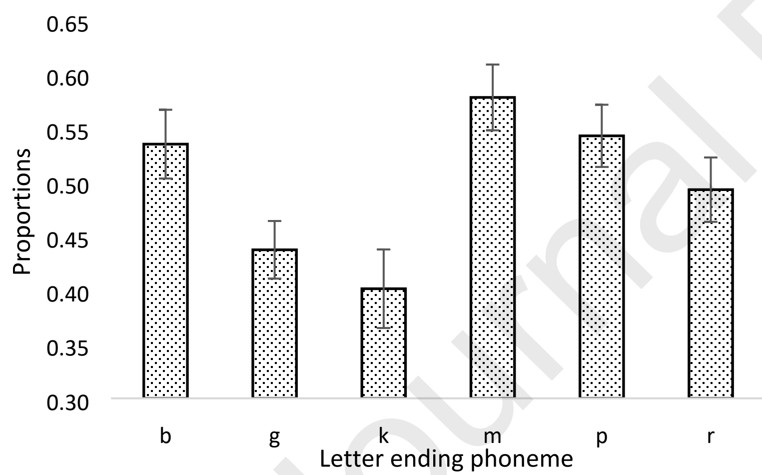

Figure 1c. Effect of the last letter ending on taste expectancy (with sweetness)

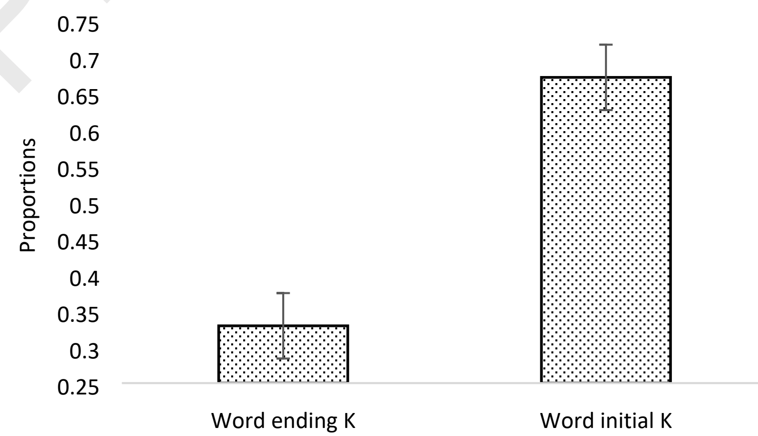

Figure 1d. Comparison of word-ending /k/ (IW) vs. word- initial /k/ (OW) (with sweetness)

***Figure 1.* Study 1**
Error bars represent SE of means in all figures

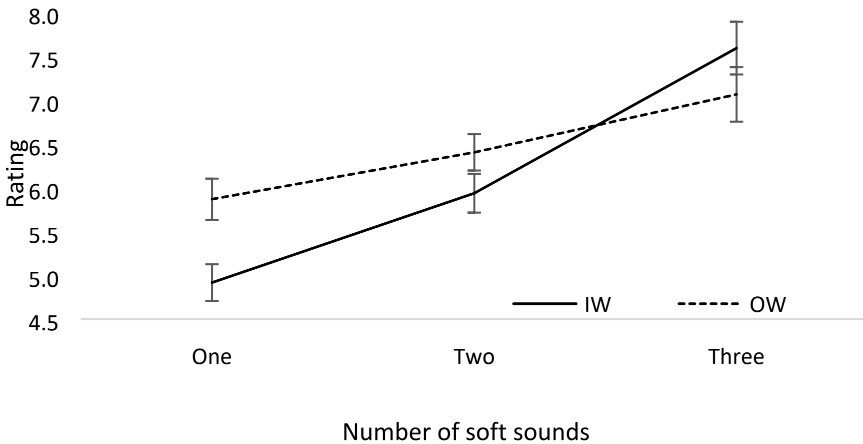

Figure 2a. Number of soft sounds and roundedness (vs. angularity)

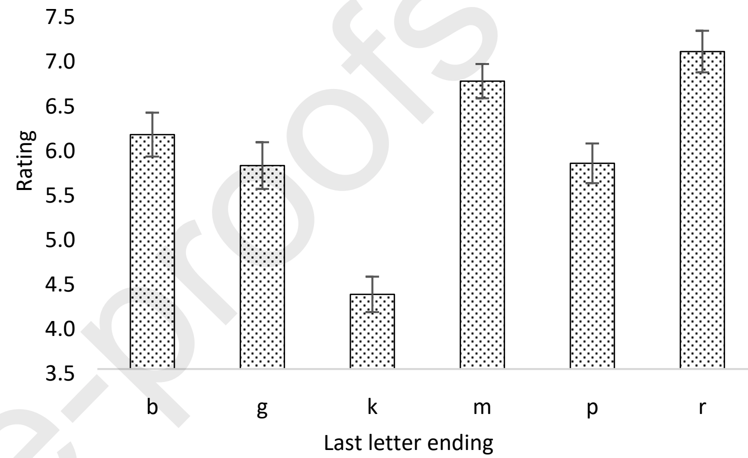

Figure 2b. Effect of the last letter ending on roundedness (vs. angularity)

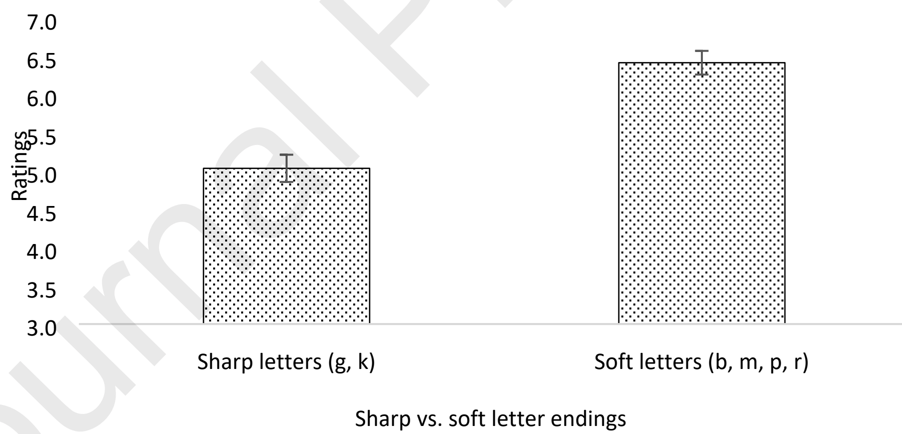

Figure 2c. Effect of the last letter ending on roundedness (vs. angularity)

***Figure 2.* Study 2**
Error bars represent SE of means in all figures

All authors contributed equally to this work

Highlights

- We investigated the alternative explanation of the role of articulatory mouth movements (i.e., muscle movements from lips to the back of the mouth and vice-versa, also called inwards vs. outwards) on the taste continuum.
- Our results show that words with outwards (vs. inwards) articulatory patterns are expected as sweet and round (vs. bitter and sharp)
- Sound symbolism, but not inwards/outwards mouth movement, supports this finding.
- Sound symbolism appears to override the role of inwards vs. outwards mouth movements in sound-taste and sound-shape associations