When vowels make us smile: The influence of articulatory feedback in judgments of warmth and competence

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The data that support the findings of this study are openly available in OSF at https://osf.io/wukdm/?view_only=cfd2919cd9d44bcebab05f62194a2801.

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Abstract

In six studies (*N*=725), we extended the articulatory feedback hypothesis to person perception, examining how words featuring /i:/ sounds that activate the zygomaticus major muscle and words featuring /u:/ sounds activating the orbicularis oris muscle affect preference, warmth, and competence judgments of mock-usernames. Users with usernames including /i:/, in contrast to /u:/ sounds, were always preferred and judged as warmer and more competent. The impact of this manipulation in shaping preference as well as judgments on the core dimensions of social perception confirms the stability of the vowel-emotion link and the role of articulatory feedback in social information processing.

Keywords: articulatory feedback hypothesis, oral articulation, embodiment, impression formation, warmth, competence.

When vowels make us smile: The influence of articulatory feedback in judgments of warmth and competence

The assumption that smiling makes us happier (James, 1950) suggests that bodily states are capable of inducing emotions and feelings directly, that is, without the mediation of cognitive mechanisms such as attributions or inferences (e.g., Dimberg, 1982). Facial feedback has been one of the most explored mechanisms in explaining how smiling and frowning affect emotional experience (e.g., Strack et al., 1988; see Noah et al., 2018; Wagenmakers et al., 2016, about the replication debate) and, importantly, affective judgments (e.g., Ohira & Kurono, 1993). Facial feedback has typically been examined with muscle mechanical manipulations (Strack et al., 1988), by instructing participants to adopt particular facial postures (e.g., Tourangeau & Ellsworth, 1979), display expression exaggeration (e.g., Demaree et al., 2006), or even using Botox injections to suppress facial muscle activity (e.g., Davis et al., 2010). Most of these studies were conducted under the assumption that the physiological activation of particular oro-facial muscles or facial regions commonly associated with specific emotions may directly trigger the congruent emotional states or, in contrast, that the suppression of the same muscular apparatus inhibits those emotional experiences.

This bi-directional motor-to-affect link has recently been explored with speech, based on the assumption that during word articulation, the oro-facial musculature is also activated. The central tenet of this *articulatory feedback hypothesis* (AFH) is that the direct link between vowel identity and mood is caused by a proprioceptive mechanism that misreads the overlapping information between the oro-facial musculature, involved in both oral communication and the expression of emotions (Rummer et al., 2014, Rummer & Schweppe, 2019). Specifically, the AFH suggests that the production of the front vowel /i:/ requests the

activation of the *zygomaticus major muscle* (ZMM), causing positive affect. While the articulation of the back, rounded vowel /o:/ activates the *orbicularis oris muscle* (OOM), which works as an antagonist of the previous, causes negative affect. In support of this hypothesis, Rummer and colleagues demonstrated, with several ingenious experiments, that positive or negative induced moods led participants to generate more words featuring /i:/ or /o:/ sounds, respectively (Experiment1, 2014), and to create more names containing /i:/ sounds for positive and /o:/ sounds for negatively valenced faces (Experiments 1 and 2, 2018) and objects (Experiments 3 and 4, 2018). Conversely, compared with the condition where /o:/ was repeatedly articulated, the activation of the ZMM by repeatedly articulating the sound /i:/ led participants to rate cartoons as funnier (Experiment 2, 2014).

An alternative account, the *frequency code hypothesis* (FCH), proposes that phonetic associations result from the naturally occurring variations in ecological sounds, building upon the co-occurrences of auditory stimuli with valence dimensions. The underlying rationale is that because high pitch sounds are likely to be produced by non-threatening, small-sized animals or objects and low resonant frequencies by larger vocal tracts belonging to more threatening or aggressive creatures, vocalizations of high-frequency vowels (e.g., /i:/) become associated with positive valence and low-frequency vowels (e.g., /o:/) with negative valence (Ohala, 1994).

Based on the assumptions of the AFH, the current research was designed to examine how the activation of the ZMM through vowel articulation affects the core dimensions of person perception. The results may, nevertheless, present useful insights disentangling how alternative accounts contribute.

Complementing previous approaches that address cognition in terms of representational structures drawing on the fundamental concepts and principles of computer science (e.g., Vera & Simon, 1993), recent evidence has been presenting social perception as

embodied. Among this socially situated cognition perspective (e.g., Smith & Semin, 2004), we can find evidence linking physical and social temperature (e.g., IJzerman & Semin, 2010; Williams & Bargh, 2008; Zhong & Leonardelli, 2008), motion and competence judgments (e.g., Horchak et al., 2016) or even articulatory consonantal-wanderings (oral approach-avoidance; e.g., Godinho & Garrido, 2019; Topolinski et al., 2014) and affective judgments. However, whether the affective cues resulting from oral-motor stimulations caused by the ZMM and the OOM activation modulate impression formation about social targets remains rather unexplored.

Extending the AFH to the social perception domain, we examined how the bodily feedback provided by vowel-articulation may affect judgments about the "Big Two" dimensions (Paulhus & Trapnell, 2008) of person perception (namely across cultures, e.g., Judd et al., 2005). Previous evidence has already shown that approach and avoidance motivations (e.g., Freddi et al., 2014), even when induced by consonantal-articulatory manipulations (Garrido et al., 2019), were informative for warmth but not for competence related judgments (c.f., Godinho & Garrido, 2020), confirming that warmth evaluations are sensitive to affective cues. However, we expect that, since the articulatory manipulations of the ZZM and the OOM convey general affective cues able to contaminate overall mood, vowel-manipulation will be relevant for judgments in both warmth and competence dimensions.

Overview of the experiments

Across six experiments, we manipulated mock usernames to include either /i:/ or /u:/ sounds that would selectively activate the ZMM or the OOM. Word manipulations were always made within-designs, that is, all participants rated usernames with /i:/ and /u:/ sounds.

Experiment 1 was a conceptual replication of Rummer and Schweppe (2019) and tested the AFH with a different method, as well as with a different set of stimuli adapted to a different language (European Portuguese phonation). After establishing the reproducibility of the effect with a likeability scale, Experiments 2 and 3 were designed to test our specific hypothesis, namely that the emotional cue provided by the activation of the ZMM would contaminate warmth and competence judgments. While in Experiments 2 and 3, the articulatory manipulations were used within-participants, but the participants made either warmth or competence judgments, Experiment 4 features a full within-design. Finally, Experiments 5a and 5b were designed to discard potential confounds resulting from the measurement scales used.

Experiment 1

The first experiment compared the preference for mock usernames that, in their articulation, activate the ZMM or the OOM. Replicating previous findings, we expected a general preference for usernames activating the ZMM (compared to the OOM).

Method

Power Analysis and Sampling Plan. Sample size (N = 73) was defined with G*Power (Faul et al., 2007), using the effect size of d_z = 0.43 (Experiment 1, Rummer & Schweppe, 2019) and the parameters 1-β = .95, α = .05. Because data collection stopped only at the end of the sampling day on which it reached the defined number of participants, the sample size was slightly larger.

Participants. Twelve participants were excluded for being non-native European Portuguese speakers (N= 10) or for being bilinguals (N = 2). The final sample included 80 Portuguese participants (Mage = 23.25, SD = 7.86; 41 female) recruited by emails sent to

personal contacts and through social media platforms. In this message, participants were asked to join an online survey about the way people evaluate usernames.

Stimuli. Forty-eight words including /i:/ or /u:/ sounds were created using the vowels [I] and [U]. Since that in European Portuguese the letter [O] presents very different articulation possibilities, depending on the contiguous letters or its position in the word, in the current experiments we used the letter [U]. The articulation of this back vowel in the sagittal plane also requires a close / close-mid articulation, involves a rounded lip position and the contraction of the OOM (Zampaulo, 2018). Furthermore, since the f0 of /u:/ is much more frequent than the f0 of /o:/ (Whalen & Levitt, 1995) such option prevents alternative explanations related to different natural distributions of the phonemes selected.

Importantly, the consonants were controlled so that they would not feature consonantal articulation spots wandering either inward or outward (e.g., the in-out effect, Topolinski et al., 2014). To this end, we adapted the stimuli from a previous set of words used to test the in-out effect in European Portuguese (Godinho & Garrido, 2016). To make the usernames more realistic, these words were merged with @gmail.com (e.g., MIBIMI@gmail.com or MUBUMU@gmail.com).

Procedure. Data was collected in line with the host institution's ethical guidelines. After entering the Qualtrics platform, participants read and agreed with the informed consent, guaranteeing that all data collected would be treated anonymously and published in scientific outlets only. Participants were then informed that the study aimed to understand the way people perceive usernames and that their task was to evaluate a set of those usernames. Participants were also told that there were no right or wrong answers. Then they were asked to silently read and rate the usernames according to their 'preference' (1-*Do not like it at all* to 10-*Like it very much*).

Each participant rated the entire pool of stimuli (half including /i:/ and the other half /u:/ sounds). The words were presented one at a time in a random order alongside the rating scale. There was no time limit for answering, and the word was visible until the rating was provided. The rating task was followed by four socio-demographic questions: gender, age, professional occupation, and native language. Finally, two control questions (e.g., Godinho et al., 2019) were used to detect possible awareness of the word manipulation, asking participants to provide their reasoning when rating the words and whether they thought the words had a suspicious structure or any other suspicious features. None of the participants reported valid suspicions about the manipulation used. In the following, we report all the manipulations, measures, and data collected.

Results

The vowels featured in the usernames had a significant impact on participants' preference, $t(79) = 3.387$, $p = .001$, $d_z = .38$, 95% CI [0.15, 0.61]. Usernames featuring /i:/ sounds ($M = 3.73$, $SE = .21$) were preferred over those with /u:/ ($M = 3.37$, $SE = .18$)[1].

Experiments 2, 3 and 4

Experiment 1 established the impact of vowel on general preference for mock-usernames. Experiments 2, 3, and 4 extended the examination of the AFH to the person perception domain by asking participants to rate the same usernames according to their perceived warmth or competence.

Method

[1] Data and stimuli from all experiments can be found at https://osf.io/wukdm/?view_only=cfd2919cd9d44bcebab05f62194a2801

Power Analysis and Sampling Plan. Samples sizes for Experiments 2 and 3 were based on the same parameters as Experiment 1. Again, because data collection was set to stop at the end of the day when the sample reached the defined size, sample sizes were slightly larger than planned. Averaging the power calculations from Experiments 2 and 3 (d_z = .44, 1-β = .95, α = .05) the required sample size for Experiment 4 was 58. However, to ensure sufficient power, we duplicated that number (N = 116).

Participants. Four participants were excluded in Experiment 2, one in Experiment 3, and six in Experiment 4 for not being European Portuguese native speakers. The final samples were 104 participants (*M*age = 33.85., *SD* = 10.94; 72 female) in Experiment 2; 92 participants (*M*age = 26.92, *SD* = 11.90; 69 female) in Experiment 3; and 110 participants (*M*age = 33.65, *SD* = 15.57; 70 female) in Experiment 4. Participants were recruited with the same procedure used in Experiment 1.

Stimuli. The same 48 words, half including /i:/, and the other half /u:/ sounds, used in Experiment 1 were used in Experiments 2 and 3. In Experiment 4, 40 usernames (20 /i:/ and 20 /u:/) were randomly selected from the previous pool.

Procedure. Data was collected online using the Qualtrics platform. All other procedures regarding the informed consent and instructions were exactly as in Experiment 1. Nevertheless, while in the former participants were asked to rate how much they liked each username, in Experiment 2 participants rated the perceived social warmth (1-*Cold* to 10-*Warm*), and in Experiment 3, the perceived competence (1-*Incompetent* to 10-*Competent*) conveyed by the 48 usernames (24 with /i:/ and 24 with /u:/ sounds). In Experiment 4, participants rated 20 usernames (10 with /i:/ and 10 with /u:/ sounds) with the same competence scale and 20 usernames (10 with /i:/ and 10 with /u:/ sounds) with the same warmth scale. Both the stimuli and the warmth and competence scales were randomly presented. Socio-demographic and control questions were the same as in Experiment 1. No

valid suspicions about the manipulation used were reported. All manipulations, measures, and data collected in these experiments are reported.

Results

Experiment 2. Usernames including /i:/ sounds (M = 4.26, SE = .17) were rated as warmer than those with /u:/ sounds (M = 3.74, SE = .17), $t(103) = 4.663$, $p < .001$, $d_z = .46$, 95% CI [0.25, 0.66].

Experiment 3. Usernames with /i:/ sounds (M = 3.93, SE = .23) were rated as more competent than those with /u:/ sounds (M = 3.65, SE = .23), $t(91) = 3.992$, $p < .001$, $d_z = .42$, 95% CI [0.20, 0.62].

Experiment 4. A repeated-measures analysis of variance (ANOVA) showed that the vowel sounds inserted in the usernames exerted a significant impact on participants' ratings, $F(1,109) = 5.677$, $p = .019$, $\eta_p^2 = .05$, 95% CI [.00, .15]. Overall participants provided higher ratings for usernames with /i:/ sounds (M = 3.88, SE = .17) than those featuring /u:/ sounds (M = 3.69, SE = .17), regardless of the trait being rated. A main effect of the trait being rated was also observed, $F(1,109) = 16.156$, $p < .001$, $\eta_p^2 = .13$, 95% CI [.03,.25], with warmth judgments receiving higher ratings (M = 3.98, SE = .18) than competence ones (M = 3.59, SE = .17). No interaction effects were observed.

Experiments 5a and 5b

Experiments 5a and 5b tested whether the previous results were not merely reflecting a shift toward positive valence. Specifically, these experiments were conducted to examine whether a positive mood induced by /i:/-words would not simply fit better to the (positive) unmarked ends, namely "warm" and "competent" (polarity correspondence; Proctor & Cho, 2006) of the bipolar scales used. The following alternative unipolar scales were used instead:

1-*Not warm at all* to 10-*Very warm*; 1-*Not cold at all* to 10-*Very cold* (Experiment 5a); 1-*Not competent at all* to 10-*Very competent;* and, 1-*Not incompetent at all* to 10-*Very incompetent* (Experiment 5b).

Method

Power Analysis and Sampling Plan. Based on the effect size of $d_z = 0.38$ (Experiment 4) and the parameters 1-β = .95, α = .05, the sample size suggested by G*Power (Faul et al. 2007) was $N = 77$. To make sure that we would have enough power to account for any spurious interactions with these new measurement scales, we decided to double this figure. Therefore, the samples in Experiment 5a presenting two unipolar warmth scales (warm and cold) and in Experiment 5b presenting two unipolar competence scales (competent and incompetent) were intended to include 154 participants each. Again, since data collection stopped only at the end of the sampling day on which it reached the defined number of participants, sample sizes for all experiments were slightly larger.

Participants. In Experiment 5a, four participants were excluded for being non-native European Portuguese speakers (N = 3) or for being bilinguals (N = 1). There were no exclusions in Experiment 5b. The final samples were 160 (*M*age = 48.48, *SD* = 11.02; 99 female) in Experiment 5a and 179 (*M*age = 48.10, *SD* = 14.04; 95 female) in Experiment 5b. The method used to recruit participants was similar to the previous experiments.

Stimuli. Participants were asked to rate 40 usernames, 20 with /i:/ and 20 with /u:/ sounds.

Procedure. All the instructions and procedures were the same as in the previous experiments. The scales used for the ratings were, however, different. In Experiment 5a, participants were asked to silently read and rate 20 usernames on the warmth dimension on a scale ranging from 1-*Not warm at all* to 10-*Very warm* and another 20 usernames on a scale

ranging from 1-*Not cold at all* to 10-*Very cold*. In Experiment 5b, 20 usernames were rated on the competence dimension on a scale ranging from 1-*Not competent at all* to 10-*Very competent* and another 20 on a scale ranging from 1-*Not incompetent at all* to 10-*Very incompetent.* Both the scales in each experiment and the stimuli being rated were presented in random order.

All the remaining socio-demographic and control questions were kept from the previous experiments. None of the participants reported being aware of the manipulation used. No other manipulations, measures, or data were collected.

Results

Before the statistical analysis, the "negative" unipolar scales (cold and incompetent) were reversed.

In Experiment 5a a main effect of scale (warm vs. cold) was observed $F(1, 159) = 23.670$, $p < .001$, $\eta_p^2 = .13$, 95% CI [0.05, 0.23], with overall higher ratings observed in the coldness (M =5.31, SE =.18) than in the warmth scale (M = 4.25, SE =.15). Participants were more likely to rate the usernames as "not cold at all" than as "very warm". Importantly, the main effect of vowel was also observed, $F(1, 159) = 7.134$, $p = .008$, $\eta_p^2 = .04$, 95% CI [0.00, 0.12]. Usernames featuring /i:/ sounds (M = 4.86, SE = .13) were preferred to those with /u:/ (M = 4.70, SE = .13). Finally an interaction was also observed between vowel and the scale being used, $F(1, 159) = 3.911$, $p = .050$, $\eta_p^2 = .302$, 95% CI [0.00, 0.09]. The preference for usernames featuring /i:/ sounds over usernames featuring /u:/ sounds was only statistically significant with the warmth scale (p = .002).

The results from Experiment 5b revealed a similar main effect of scale, $F(1, 178) = 9.136$, $p = .003$, $\eta_p^2 = .05$, 95% CI [0.01, 0.14] with overall higher ratings observed in the incompetence (M = 5.78, SE = .20) than in the competence scale (M = 4.66, SE = .20).

Participants were more likely to rate the usernames as “not incompetent at all” than as “very competent”. Again, the main effect of vowel was observed, $F(1, 178) = 4.334$, $p = .039$, $\eta_p^2 = 02$, 95% CI [0.00, 0.08]. Usernames with /i:/ sounds ($M = 5.26$, $SE = .08$) were preferred to those with /u:/ ($M = 4.18$, $SE = .08$). There were no significant interaction effects.

General Discussion

Overall, the results indicate that usernames featuring the front vowel [I], whose articulation requests the activation of the ZMM, positively bias judgments on both warmth and competence compared to usernames including back rounded vowels such as [U] involving the OOM activation. The influence that vowel articulation exerted in the social perception of the username owners suggests that the mere activation of the oral muscular apparatus seems to shape social perception.

The two theoretical accounts competing as mechanisms responsible for this judgmental bias did not necessarily support similar predictions for all the dimensions under evaluation across the six reported experiments. While there is a well-established overlap between positive valence and likeability, which can easily be extended to warmth ratings, the association between positive valence and competence ratings is not a straightforward one. Indeed, the assumed phylogenetic association between small size, appeasing and submissive creatures, and positive valence supports the prediction that /i:/ usernames might cause positive affect as well as higher warmth judgments. Competence ratings, however, are less likely to bind under the same prediction. According to the FCH, low-pitch sounds are associated with large, threatening, active, and powerful creatures, and in all likelihood, competent creatures as well. Therefore, the association between usernames with /o:/ (or /u:/) and competence ratings is a plausible one. Experiments 3, 4, and 5b repeatedly demonstrated

that this was not the case. Usernames with /u:/ vowels were systematically judged as more negative, even on the competence dimension.

Our findings seem, therefore, to support the AFH as the underlying mechanism for the observed results. Yet, empirical support to refute the FCH is still missing. We believe that only future research could settle this debate by further contrasting manipulations that allow different predictions from the FCH and the AFH. For example, testing possible phonemes whose articulation activates the ZMM but produces low pitch sounds simultaneously, or phonemes known to produce OOM contraction (blocking the ZMM) but entailing high pitched sounds. Conceptually another possibility to test both predictions could be to use those very same sounds (e.g., /i:/ and /o:/) while mechanically blocking the respective muscles. Indeed, Rummer and Schweppe (2019, Exp. 2) used the classical pen-between-the-lips manipulation and found that even when blocking the ZMM activity, participants consistently created more names with /i:/ sounds. The support provided by such results for the FCH (since the associations between frequency pitch and valence still occur while facial feedback is hampered) is not decisive though. The main effect of the facial expression of the person being named, could be results also from a simulation made by the perceived of the target smile, working trough a mirror neurons pathway. So, while facial electromyography could be an interesting method to measure the differential involvement of these muscles during the articulation of high and low pitch sounds, a EEG test could provide information on which areas are activated by the /i:/ and /o:/ articulation.

Following previous demonstrations that articulatory feedback affects emotional experience and affective judgments (Rummer & Schweppe, 2019), the present work extended these recently discovered manipulations to the person perception domain. The current studies successfully expanded previous research by demonstrating this articulatory effect with new stimuli and in a new language, thus providing an important conceptual replication (Westfall

et al., 2015). Importantly, by systematically revealing that it is possible to induce positive and negative attitudes towards others by merely manipulating the vowels composing their online usernames, the present approach further confirms that social cognition is, at least to a certain extent, an embodied process.

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