The in-out effect: Examining the role of perceptual fluency in the preference for words with inward-wandering consonantal articulation

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Abstract

Words whose consonantal articulation spots wander inward, simulating ingestion movements, are preferred to words featuring the opposite consonantal articulation direction, that is, resembling expectoration movements. The underlying mechanism for this so called in-out effect is far from settled. Contrary to the original explanation proposing an oral approach-avoidance mechanism, recent evidence has been used to support an oral motor-fluency mechanism, suggesting that inward-words are preferred because they may be more common and/or easier to pronounce. Across six experiments (n=1123) we examined the impact of different fluency sources in the emergence of the in-out effect. The preference for inward-wandering words persisted both with classical font-type and figure-ground contrast fluency manipulations, and no systematic additive effects were observed. The in-out effect was also replicated for the first time with a between-participants design. These results suggest that the in-out effect may be permeable to fluency-manipulations, but it is not dependent upon a plain fluency-mechanism.

Keywords: in-out effect, approach-avoidance, fluency, embodiment

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Written language requires the ability to read visual codes and to associate them in a meaningful way. Yet, recent evidence has been demonstrating that the way in which the muscular apparatus is recruited in the oral cavity during word articulation, even in silent reading, may present an alternative source of information.

The *In-out effect* documents a small, yet highly replicable, preference for words that are articulated with muscular contractions wandering inward in the oral cavity, by opposition to words whose pronunciation implies outward wandering muscular contractions. The word BATEKO, for instance includes the labial phoneme [b] that is pronounced with the lips, the alveolar [t] pronounced with the front part of the tongue and, finally, the velar [k] pronounced with the rear of the tongue. In contrast, the outward-wandering word KATEBO, involves the same consonantal articulation spots, because it combines the same phonemes, but arranged in the reverse order. After the initial demonstration of the in-out effect, Topolinski, Maschmann, Pecher and Winkielman (2014) argued that this effect could be explained by approach-avoidance motivational states that are automatically triggered by the biomechanical resemblance between the movement caused by word articulation and deglutition/ expectoration movements. More recently there has been an interesting stream of evidence suggesting that the preference for inward-words may be caused by an oral motor-fluency mechanism instead (Bakhtiari, Körner, & Topolinski, 2016; Körner, Bakhtiari, & Topolinski, 2019).

The role of subjective experiences naturally occurring during the processing of information in shaping judgment is a well-established finding (e.g., Schwarz et al., 1991). This subjective feeling associated with cognitive processing is also known as fluency, that is,

the ease with which a target may be perceived or examined. Such metacognitive experiences occurring during judgment (for a review, see Schwarz, 2004) may occur in several stages: when the content is seen (visual fluency), perceived (perceptual fluency), understood (conceptual fluency), or remembered (retrieval fluency). Fluency has been shown to feed into a wide range of judgments such as attractiveness (e.g., Reber, Winkielman, & Schwarz, 1998), preference (e.g., Beilock & Holt, 2007), frequency (e.g., Schwarz et al., 1991), familiarity (e.g., Koriat & Levy-Sadot, 2001; Monin, 2003), representativeness and categorization (e.g., Oppenheimer & Frank, 2008), impression formation (e.g., Laham, Koval, & Alter, 2012), truth (e.g., McGlone & Tofighbakhsh, 2000; Reber & Schwarz, 1999), fame (e.g., Jacoby, Kelley, Brown, & Jasechko, 1989), risk for disease (e.g., Rotliman & Schwarz, 1998) or economic performance (e.g., Alter & Oppenheimer, 2006).

Historically the literature about fluency effects on preference judgments has grouped most of these multi-level processes and manipulations under two fluency types (Winkielman, Schwarz, Fazendeiro, & Reber, 2003). Conceptual fluency refers to basic metacognitive feelings experienced because of the semantic relatedness of the stimuli to previous knowledge structures, that is, the easiness / difficulty when facing high-level operations such as attribution processes (e.g., Whittlesea, 1993). Perceptual fluency refers to the metacognitive feeling resulting from the stimuli physical properties, that is, the easiness / difficulty when facing low-level operations such as the visual features of the stimulus (e.g., Reber & Schwarz, 1999).

Recent accounts have gathered evidence on other fluency sources and related manipulations (e.g., linguistic fluency, McGlone & Tofighbakhsh, 2000; retrieval fluency, Schwarz et al., 1991). Additionally, inspired by an embodied cognition perspective emphasizing the link between cognition and action, motor-fluency has also been advanced as another fluency source (e.g., Milhau, Brouillet, & Brouillet, 2015; Topolinski, 2010). Indeed,

it has long been established that positive (or negative) feelings that spill over the judgment process may occur due to unrelated tasks that provide bodily feedback and ease stimuli processing (e.g., Stepper & Strack, 1993; Strack, Martin, & Stepper, 1988, about the unsettled replication debate see Strack, 2017, a recent failed attempt to replicate the effect Wagenmakers et al., 2016 and an interesting pacifying approach, Noah, Schul, & Mayo, 2018). One of such fluency manipulations is training, which not only accelerates action - because stimuli become easier to process, but has also exerts a positive impact on stimuli evaluation (e.g., Körner et al., 2019; Van den Bergh, Vrana, & Eelen, 1990).

Critically, it has already been established that all of these metacognitive processes, even if not always categorized under the fluency framework (Topolinski, 2013), satisfy "the definition of fluency as the subjective experience of ease associated with processing information" (Alter & Oppenheimer, 2009, p.224). Fluency, or processing fluency as an integrative term, is conceptualized as a general metacognitive cue, referring to the easiness/difficulty when processing external information, that may result from a wide range of cognitive processes (Schwartz, 2004). To that extent, processing fluency researchers have been "using a vast array of techniques, which, despite their diversity, produce remarkably similar judgmental consequences" (Alter & Oppenheimer, 2009, p.219; for a discussion about fluency as a unitary construct see Unkelbach & Greifeneder, 2013).

The converging effects of different fluency sources can be illustrated by the work of Whittlesea, Jacoby, and Girard (1990) demonstrating that perceptual fluency (manipulated by visual clarity and presentation duration) increased liking for the stimulus in the same way as repeated exposure does. Repeatedly showing words to participants leads to pronunciation simulation (even if covertly). Given that simulating an action makes it easier to repeat

(Topolinski & Strack, 2009), processing fluency increases and feelings of familiarity with those words are enhanced (Yang, Gallo, & Beilock, 2009).

Empirically, all these sources of fluency have been shown to have a similar influence, skewing liking judgments of fluent stimuli to the right (for a review, see Winkielman, Schwarz, Fazendeiro, & Reber, 2003) and thus, may be confidently folded under the general umbrella of processing fluency (Schwartz, 2004).

One exception to this converging literature reporting how apparently different fluency types result in the same general emotional contagion comes from non-affective judgments. There are reports about domain specificity in the use of fluency as a cue for particular judgmental domains such as recognition, memory or truth judgments (e.g., Olds & Westerman, 2012; 2014; Silva, Garcia-Marques, & Mello, 2016; Whittlesea, 1993). Nevertheless, reports about how the positive affect generated by fluency can cue judgments in virtually any situation (Winkielman, Halberstadt, Fazendeiro, & Catty, 2006) emphasize the significant role of fluency on cognitive and affective processes.

Fluency can either act as a direct cue toward judgment or work indirectly through other pathways such as emotion. The feelings-as-information model, for instance, argues that feelings can be used as a source of information (e.g., Schwarz & Clore, 1983; for a review see Schwarz & Clore, 1996). Therefore, it is plausible to suspect that a feeling of easiness caused by inward words, when compared to outward words, can directly prompt preference, or other positive feelings like familiarity, that can be misread as preference.

The in-out evidence making the case for this alternative oral-motor fluency explanation demonstrated that: there are more inward than outward words in English and German; that inward-consonantal strings are pronounced faster and rated as easier to pronounce than those wandering outward (Bakhtiari et al., 2016); and more recently, that training words with each consonantal direction may affect the in-out preference (Körner et

al., 2019). Nevertheless, evidence supporting the original oral approach-avoidance argument persists and needs to be conciliated with this new evidence supporting an alternative oral motor-fluency explanation.

The fluency explanation fails to predict a set of modulations of the in-out effect reported over the past years. For example, the effect was shown to be present only when naming edible products, that is, words congruent with the ingestion function of the oral apparatus (Godinho, Garrido, Zürn, & Topolinski, 2018) and seems to be pertinent for warmth, but not for competence-related judgments (Garrido, Godinho, & Semin, 2019). Additionally, contrary to what was observed in support for an oral motor-fluency mechanism for the mere exposure effect (Zajonc, 1968; reported modulation Topolinski & Strack, 2009) and for the false-fame effect (Jacoby et al., 1989; idem, Topolinski & Strack, 2010) - the in-out effect could not be disrupted by oral motor interference (Lindau & Topolinski, 2018). Moreover, even in the first work arguing in favor of a fluency explanation for the in-out effect, fluency failed to fully mediate the in-out effect in a crucial mediation test (Bakhtiari et al., 2016). Finally, in a recent work showing that training articulation-sequences modulates the effect (Körner et al., 2019), training 60 outward-wandering words (Experiment 1) led to a marginally significant attenuation of the in-out effect, and only with intense training (120 outward-wandering words, Experiments 2 and 3) it was possible to reverse it. Such evidence suggests that the in-out effect can be modulated or even overruled by (intense) fluency manipulations, simply because fluency effect sizes are larger, but that its underlying mechanism remains elusive.

The current research further tests the fluency explanation as the underlying mechanism for the observed preference for inward when compared to outward-wandering words.

Overview of the Present Research

The first set of experiments presents inward/outward words with varying degrees of perceptual fluency manipulations. Common readability manipulations play with font type (e.g., Carr, Rotteveel, & Winkielman, 2016; Novemsky, Dhar, Schwarz, & Simonson, 2007), figure-ground contrast (e.g., Unkelbach, 2007), as well as other features such as the amount (e.g., Tsai, Klayman, & Hastie, 2008) or familiarity of the information (e.g., Zajonc, 1968).

Relative preference for inward versus outward words was measured as a function of established fluency manipulations such as font type (Experiments 1a and 1b), and figure-ground contrast (Experiments 2a and 2b).

Our predictions were grounded in Whittlesea's (Experiment 5, 1993) contrasting processing fluency manipulated by previous exposure (similar to the training manipulation in Körner et al., 2019) and conceptual fluency, manipulated with a semantically predictive context. The results revealed that these two fluency sources produced an additive effect on pleasantness ratings because "fluency from multiple sources has greater impact on the pleasantness decision than fluency from one source" (1993, p.1245). The cumulative impact of fluency manipulations was also reported in Reber, Zimmermann and Wurtzs' work (2004) showing that words, normally associated with greater fluency (in comparison with nonwords), are judged as having higher contrast, and larger font sizes. These results indicate that the greater fluency resulting from a particular fluency source (previous exposure to particular letter combinations) can be extended to judgments of fluency regarding other fluency sources.

Our rationale was built upon the assumption that if the in-out effect rests upon a fluency mechanism, the introduction of another fluency source (visual) should have a direct additive effect on participants' preference. Specifically, words benefiting from two simultaneous fluency sources (e.g., inward words with high visual fluency) should be rated

higher than in any other condition (the reverse being outward wandering words presented in the low visual fluency condition).

Finally, previous research shows that perceptual fluency effects work best (if not solely) in within-participants designs (Wänke & Hansen, 2013, 2015). The extension of this evidence to motor fluency is supported by the acknowledgment that different fluency sources have similar impact on affective judgments (Schwartz, 2004). Nonetheless, there is already some evidence available suggesting that motor or processing fluency manipulations are not effective with between-participants designs.

Classical work about how letter-dyads typed with different fingers (vs. same-finger) are preferred by skilled typists (but not by novice typists), suggests that the previous training in typing particular letter-dyads increases the perceived motor fluency and affects the affective judgments of such keyboard sequences (Beilock & Holt, 2007; Van den Bergh et al., 1990). However, most of these experiments measured whether skilled or novice-typists significantly prefer different-finger letter combinations vs. same-finger, and raw liking-scores, that could allow comparisons between-groups, are not available. More recently, while researching whether fluency arising from the motor system also impacts recognition memory, Yang, Gallo and Beilock (2009) asked both skilled-typists and novices whether they liked each letter dyad (*yes* or *not* liking rating) and conducted a 2 (typing expertise: expert, novice) X 2 (dyad type: same-finger, different-finger) ANOVA to compare directly the expert–novice difference. The absence of a main effect of typing expertise in the observed ratings suggests that these motor-fluency manipulations are only effective within-participants. In other words, the fluency advantage is dependent upon the comparison between the trained and the untrained letter-dyads combinations and when that comparison is not possible, motor-fluency effects on preference judgments are not observed.

Experiments 3 and 4 present an innovative between-participants test of the in-out effect. Departing from previous evidence, we predict that if the in-out effect results from a fluency mechanism (that requires the simultaneous exposure to the contrasting fluency conditions), in a between-participants manipulation of consonantal articulation direction, inward and outward words should be equally preferred.

Experiments 1a, 1b, 2a and 2b: The role of Perceptual Fluency

Experiments 1a and 2a had a between-participants design - 2 (fluency: high vs. low; between) X 2 (articulation direction: inward vs. outward; within). In Experiments 1b and 2b, all manipulations were within-participants - 2 (fluency: high vs. low; within) X 2 (articulation direction: inward vs. outward; within). Inward and outward words were presented with a fluent versus disfluent font (1a, 1b), or, with a high versus low color figure-ground contrast (2a, 2b).

3.1 Experiments 1a and 1b

3.1.1 Method

Power analysis. Sample sizes were determined based on previous research about the in-out effect in Portuguese speaking samples (Godinho & Garrido, 2017). The effect sizes from the four experiments in that work were averaged (with sample size weighting), $d_z = .40$. With a power of .95, $\alpha = .05$, the required sample size was 84. The calculation of effect sizes based on experiments using similar fluency manipulations (e.g., Alter, Oppenheimer, Epley, & Eyre, 2007; Carr et al., 2016) would require smaller samples. Because data collection was set to stop at the end of the day the sample reached the required number of participants, the sample in Experiment 1b is larger. The final sample in Experiment 1a was slightly smaller,

because some participants were excluded. Nevertheless, no preliminary analyses were made prior to the end of the data collection period.

Participants. Seventy-nine Portuguese-speaking adults (41 female, M_{age} = 45, *SD* = 10.5, $N_{\text{high fluency condition}}$ = 35) were included in the final sample for Experiment 1a and 95 (69 female, M_{age} = 39, *SD* = 13.9) in Experiment 1b. Prior to any data analysis, five participants in Experiment 1a and four in Experiment 1b were discarded for not being Portuguese native speakers. Participants were randomly distributed across experiments and conditions.

Design. The key manipulation in Experiments 1a and 1b was the font (high vs. low fluency fonts) in which the stimuli (inward vs. outward words) were presented. To examine the role of fluency in articulation direction, explicit preferences for words presented in each condition were measured between (1a) and within-participants (1b). Materials were the same in both experiments.

Materials and procedure. All manipulations and measures are reported. Stimuli were randomly selected from a pool validated for Portuguese phonation (Godinho & Garrido, 2016). For each word a high-fluency and low-fluency version was created using Calibri (high fluency) and Blackadder ITC (low fluency, Oppenheimer & Frank, 2008) fonts. Calibri font was chosen because of its visual size equivalence to the disfluent font.

In Experiment 1a, participants rated 48 randomly selected nonsense words (24 inward; 24 outward) presented either in a fluent or a disfluent font. In Experiment 1b, participants rated 48 random stimuli composed of 12 inward words presented in a fluent font; 12 inward words in a disfluent font; 12 outward words in a fluent font and, 12 outward words in a disfluent font.

Apart from the between/within-participants design, the procedure was identical. An invitation was sent by email for participants to join a research about the role of distracting elements in stimuli evaluation. After following a link leading to the Qualtrics platform and

agreeing with the informed consent, participants were asked to provide quick and spontaneous ratings. All words were presented in random order. To measure words' relative preference, participants rated each word in a Likeability scale, ranging from 1- *I do not like it at all*, to 10 - *I like it very much*. Afterwards, besides demographics (gender, age and professional occupation) and native language, participants were further required to reason about their ratings and whether they had detected anything conspicuous or suspicious in the words.

Results and Discussion

None of the participants revealed a valid suspicion about the in-out manipulation.

In Experiment 1a, a clear main effect of articulation direction emerged, $F(1,77) = 16.35$, $p < .001$, $\eta_p^2 = .18$, 90% CI [.06, .30]. Participants preferred inward ($M = 3.59$, $SE = .23$) over outward words ($M = 3.42$, $SE = .23$). To provide relevant data for future meta-analysis about the in-out effect, pairwise comparisons were also computed, $t(78) = 3.94$, $p < .001$, $d_z = .45$, 90% CI [.25, .64]. No main effect of fluency was observed, $F(1,77) = 2.10$, $p = .151$, meaning that the difference between the ratings of the words presented in the fluent font ($M = 3.18$, $SD = 1.83$) and in the disfluent font ($M = 3.83$, $SD = 2.09$) was not significant, $t(77) = -1.45$, $p = .151$. The interaction between fluency and consonant wandering was also not significant, $F(1,77) = 1.14$, $p = .289$, (high-fluency condition: $M_{inward} = 3.29$, $SE = .34$; $M_{outward} = 3.07$, $SE = .34$; low-fluency condition: $M_{inward} = 3.89$, $SE = .30$; $M_{outward} = 3.77$, $SE = .30$).

In Experiment 1b, inward-wandering words ($M = 3.56$, $SE = .16$) were again preferred over outward-wandering ones ($M = 3.45$, $SE = .16$), $F(1,94) = 10.53$, $p = .002$, $\eta_p^2 = .10$, 90% CI [.02, .20], $t(94) = 3.25$, $p = .002$, $d_z = .33$, 90% CI [.16, .51]. However, there was also a fluency main effect, $F(1,94) = 40.24$, $p < .001$, $\eta_p^2 = .30$, 90% CI [.18, .41]. Words presented

in Calibri (M = 4.08, SE = .20) were preferred to those presented in the disfluent font (M = 2.94, SE = .17). Importantly an interaction effect, $F(1,94) = 7.78$, $p = .006$, $\eta_p^2 = .08$, 90% CI [.01, .17], revealed that the in-out effect was not observed in the low-fluency condition ($M_{inward} = 2.95$, SE = .17; $M_{outward} = 2.92$, SE = .17, $t(94) = 1.08$, $p = .284$), but it emerged in the high-fluency condition ($M_{inward} = 4.17$, SE = .20; $M_{outward} = 3.99$, SE = .20, $t(94) = 3.65$, $p < .001$, $d_z = .37$, 90% CI [.20, .55]).

The in-out effect was observed in both experiments. While in Experiment 1a the main effect of fluency was not observed, confirming previous research showing that between-participants fluency manipulations are not effective (e.g., Hansen, Dechene, & Wänke, 2008); In Experiment 1b, there was a significant main effect of fluency, with higher ratings for all the stimuli presented with a fluent font. Critically, the additive effect of the two manipulations was not found: the preference for inward-words was observed in the fluent font condition but was blocked in the disfluent font. If the in-out effect is a fluency effect, the preference for inward-wandering consonantal strings should have been present even in the disfluent condition.

Nevertheless, an alternative explanation is also possible, namely that in the disfluent condition the font was so hard-to-read, that participants were not able to encode the phonetic features of the words presented, and thus disrupting the word articulation manipulation. Experiments 2a and 2b were designed to clarify these results.

Experiments 2a and 2b

To further test the role of fluency in shaping the in-out effect, in Experiments 2a and 2b another well-established fluency manipulation was used: figure-ground contrast.

3.2.1 Method

Power analysis. Effect sizes in experiments using the figure-ground contrast manipulation (e.g., Reber & Schwarz, 1999; Unkelbach, 2007) are smaller than those observed with the previous fluency manipulation. Therefore, a power of .95, $\alpha = .05$ and the smallest effect size obtained in the last set of experiments for the in-out effect ($\eta_p^2 = .10$) determined a sample size of 124 participants. The size of our samples was slightly larger because data collection was set to stop at the end of the day each sample reached the required number participants. No preliminary analyses were made.

Participants. One-hundred-and-thirty-four Portuguese-speaking adults (70 female, $M_{age} = 49$, $SD = 10.5$, $N_{\text{high fluency condition}} = 65$) were included in the final sample in Experiment 2a, and 130 (81 female, $M_{age} = 48$, $SD = 10.1$) in Experiment 2b. Prior to any data analysis, four participants were discarded in Experiment 2a: one for being bilingual and three for not being Portuguese native speakers. In Experiment 2b, three participants were excluded for not being Portuguese native speakers. Participants were randomly distributed across experiments and conditions.

Design. Again, fluency was manipulated both between (2a) and within-participants (2b). Materials were the same for both experiments. Two fluency conditions (high and low) manipulated the figure-ground contrast in which inward and outward words were presented.

Materials and procedure. High contrast has been shown to increase perceptual fluency (Reber & Schwarz, 1999; Reber, Zimmermann, & Wurtz, 2004). All words were presented in the same fluent font (Calibri, e.g., Unkelbach, 2007) with red letters against the white background. However, while in the high fluency condition the color had a high contrast, in the low fluency condition it had a low contrast. Contrast was manipulated with RGB (red, green, blue) component of the red color, using the combination of R _255, G_100, B_100 for high contrast (fluent) and R_255, G_240, B_240 for low contrast (disfluent).

The same large word pool from Experiments 1a and 1b was used (participants rated a subsample of 48). Each word was duplicated across high-fluency and low-fluency versions. Aside from the materials being prepared differently (font vs. figure-ground contrast) the procedures from the previous experiments were replicated: number of stimuli rated, number of stimuli per condition, sample recruitment, instructions as well as the rating scale, demographic and control questions.

Results and discussion

Control questions revealed no valid suspicion about the in-out manipulation.

Results from Experiment 2a presented a clear main effect of articulation direction, $F(1,132) = 41.30$, $p < .001$, $\eta_p^2 = 0.24$, 90% CI [.14, .34], $t(133) = 6.46$, $p < .001$, $d_z = .56$, 90% CI [.40, .71]. Participants preferred inward ($M = 3.65$, $SE = .14$) over outward words ($M = 3.45$, $SE = .14$). No main effect of the fluency condition, $F(1,132) = .01$, $p = .942$, with similar ratings for words presented in the fluent ($M = 3.54$, $SD = 1.72$) and in the disfluent font ($M = 3.56$, $SD = 1.58$, $t(132) = -.072$, $p = .942$), nor interaction effects were observed, $F(1,132) = .28$, $p = .598$ (high-fluency condition: $M_{inward} = 3.64$, $SE = .21$; $M_{outward} = 3.45$, $SE = .21$; low-fluency condition: $M_{inward} = 3.67$, $SE = .20$; $M_{outward} = 3.45$, $SE = .20$).

In Experiment 2b, inward-wandering words ($M = 3.45$, $SE = .15$) were preferred over outward wandering ones ($M = 3.36$, $SE = .15$), $F(1,129) = 9.91$, $p = .002$, $\eta_p^2 = 0.07$, 90% CI [.02, .15], $t(129) = 3.18$, $p < .001$, $d_z = .28$, 90% CI [.13, .43]. As in Experiment 1b, there was a fluency main effect, $F(1,129) = 39.23$, $p < .001$, $\eta_p^2 = 0.23$, 90% CI [.13, .33]. Words presented with high figure-ground contrast ($M = 3.63$, $SE = .17$) were preferred to words presented with low contrast ($M = 3.18$, $SE = .15$). Importantly there was a marginal interaction effect, $F(1,129) = 3.37$, $p = .059$, $\eta_p^2 = 0.03$, 90% CI [.00, .09], indicating that the in-out effect was attenuated in the high fluency condition. This effect indicated that while

inward wandering words (M = 3.25, SE = .15) were preferred to outward wandering ones (M = 3.11, SE = .15) in the low fluency condition, $t(129) = 3.43$, $p < .001$, $d_z = .30$, 90% CI [.15, .45], the preference for inward (M = 3.65, SE = .17) over outward words (M = 3.60, SE = .17) was not observed in the high fluency condition, $t(129) = 1.33$, $p = .187$. In line with the results obtained in Experiments 1a and 1b, the main effect of consonantal wandering direction persisted. Again, there were no main or interaction effects of fluency in Experiment 2a, and a main effect of fluency and an interaction emerged in Experiment 2b.

Experiments 1a and 2a, replicated previous literature showing that fluency effects do not hold-on in between-participants designs. Such findings do not contribute directly to the present argument, so they will be further addressed in Experiments 3 and 4.

The distinct interaction patterns between articulation direction and fluency condition (Experiments 1b and 2b) are at odds with simple fluency account of the in-out effect. In Experiment 1b the fluency manipulation disrupted the in-out effect in the low fluency condition while in Experiment 2b, the fluency manipulation (marginally) disrupted the in-out effect only in the high fluency condition. The confirmation of a fluency hypothesis was dependent upon additive effects, where all fluency manipulations would either increase or decrease word preference. Since Experiments 1b and 2b are sufficiently powered, the distinct interaction patterns found seem to support our argument that the relation between the in-out effect and fluency is not as straightforward as a mere fluency explanation for the in-out effect would predict.

To further support this conclusion, an alternative design could have been used to contrast the effects directly. One example could have been to ask participants to rate inward-wandering words in disfluent font and outward-wandering words in a fluent font. If the in-out effect results from a fluency-mechanism, it would be expected that the competing fluency manipulations would cancel each other and the differences in preference for inward and

outward words would not emerge. Such design (and similar ones) would present, however, one crucial flaw: Fluency manipulations have larger effect sizes than the in-out effect (regardless of what the real underlying mechanism for the in-out effect might be). Therefore, we argue that a decisive way to test whether the in-out effect is based in a fluency-mechanism would be to test it in a condition where fluency manipulations are not effective, that is, with a between-participants design.

Experiments 3 and 4

In the previous experiments we systematically addressed the complex interactions between fluency and the in-out effect. These two arguable sources of fluency did not produce systematic additive effects in the preference for inward and outward wandering words. Moreover, Experiments 1a and 2a conveniently demonstrated that fluency manipulations are not effective in between participants' designs, suggesting a simple but parsimonious way to test the role of fluency as the potential trigger of the in-out effect. If fluency manipulations are only effective when the contrasting fluency conditions are presented simultaneously (e.g., Hansen et al., 2008), and the in-out preference results from the increased fluency of inward words, when compared to outward wandering words, the in-out effect should not be observed in a between-participants design.

Method

Power analysis. Due to the novelty of this test, in Experiment 3 we decided to force a large sample and defined a total of 125 participants for each articulation-direction condition (N_{Total} = 250). However, the final sample was slightly smaller because a few participants were excluded.

Experiment 4 was designed as a pre-registered replication study (Godinho & Garrido, 2019). A power of .90, α = .05 and the effect size obtained in Experiment 3 for the in-out effect (d = .28) determined a sample size of 440 participants.

Prior to any data analysis, seven participants were discarded in Experiment 3 for not being Portuguese native speakers and two for being bilingual. In Experiment 4 no exclusions were made.

Participants. Two-hundred-and-forty-five native Portuguese-speaking adults (154 female, M_{age} = 41, SD = 11.0, $N_{\text{Inward Condition}}$= 120) were included in the final sample in Experiment 3 and 440 native English speaking-adults (279 female, M_{age} = 36, SD = 12.7, $N_{\text{InwardCondition}}$= 220) in Experiment 4.

Participants were randomly distributed across conditions.

Design. To examine the role of articulation direction we asked participants to rate either inward or outward words (2 Consonantal Direction; between).

Materials and procedure. All manipulations and measures are reported. Participants in both experiments rated 30 inward or 30 outward words presented in a random order. In Experiment 3 the words were randomly selected from the same stimulus pool validated for Portuguese phonation used in the previous experiments (Godinho & Garrido, 2016), while for Experiment 4, conducted in English, words were randomly selected from a stimulus pool validated for English phonation (Topolinski et al., 2014). All the procedures were similar to the ones used in the previous experiments.

Results and Discussion

Again, no one reported a valid suspicion about the in-out manipulation.

In Experiment 3, a clear main effect of articulation-direction emerged, $t(243) = 2.23$, $p = .035$, $d = .14$, 90% CI [.04, .25]. Participants preferred inward ($M = 4.00$, $SD = 1.57$) over outward-wandering words ($M = 3.60$, $SD = 1.41$).

The results from Experiment 4 replicated the main effect of articulation-direction, $t(438) = 2.57$, $p = .010$, $d = .13$, 90% CI [.04, .20]. Participants preferred inward ($M = 4.71$, $SD = 1.36$) over outward-wandering words ($M = 4.36$, $SD = 1.50$).

General Discussion and Conclusion

The role of fluency as an alternative account for the in-out effect was tested by probing the in-out effect against classical fluency manipulations and, for the first time, by examining it in a between-participants design. While the effect of fluency manipulations was only observed in within-participants designs, the in-out effect was observed across all experimental designs. Critically, the additive effects that a fluency-explanation for the in-out effect would theoretically suggest were not observed.

Overall the present evidence speaks against the operation of a fluency mechanism as the origin for the in-out effect, supporting instead, that perceptive fluency manipulations interact with the actual underlying mechanism. Such conclusion supports previous evidence showing an inverse relation between the intensity of the fluency manipulations used and the effect size of the in-out effect (Körner et al., 2019). In other words, as fluency manipulations get stronger, the preference for inward wandering consonantal strings (over outward) decreases or even disappears.

Nevertheless, it may still be the case that the subtle mechanism causing the preference for consonantal sequences that wander inward in the oral cavity results from a deeply rooted fluency-source caused by a lifetime training-experience (of swallowing and pronouncing words), that has a stronger effect than perceptual fluency manipulations (for a review, Silva,

Garcia-Marques, & Mello, 2015). However, after being established that different fluency-sources (including those resulting from covert oral-motor simulations caused by word repetition, that is, by training) have equivalent impact on affective judgments, this alternative explanation seems implausible.

Moreover, since the impact of fluency seems to be dependent upon the direct contrast between fluency conditions, the prevalence of the in-out effect observed with a between-participants design also speaks against a fluency explanation as the underlying mechanism. Indeed, in such a design it is not plausible to argue that participants might have had a strong default comparison anchor for the consonantal wandering direction. While a disfluent font type could be easily recognized in a between-participants design as such, because there is a clear baseline on how a fluent font should look like, the differences in consonantal wandering direction in such a design, are hardly distinguishable. It is difficult to argue that the preference for inward versus outward wandering words, observed in a between-participants design (in the absence of the contrasting experimental condition), derives from participants' ability to recognize and process these differences.

Acknowledging that the in-out effect fails to behave as any other fluency source and suggesting that it results from a mechanism other than fluency is likely to guide future research endeavors namely by emphasizing the need for further the empirical examination of the originally proposed mechanism of oral approach-avoidance.

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