

## The effect of speaker gender on second-language fricative perception

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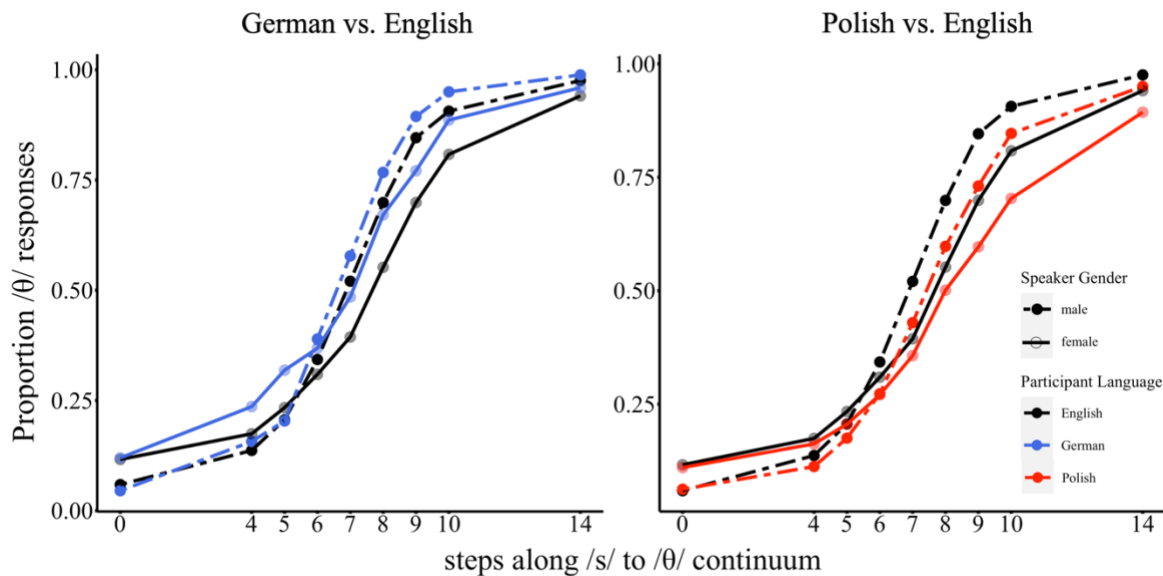
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Speaker gender has long been known to affect fricative perception. Strand and Johnson (1996) first established that when listeners are presented with a sound between /s/ and /ʃ/, they are more likely to classify it as /s/ when it is combined with a word spoken by a male speaker. This effect is attributed to listeners' implicit knowledge of differences in male and female speech and has been replicated numerous times using different manipulations and speaker groups (Reese & Reinisch 2022, Winn 2020). A similar effect has been found with an /s/-/θ/ continuum, in which participants were more likely to classify the fricative as /θ/ when paired with a male voice or a picture of a man (Munson, 2011). It has been argued that unlike the effect of gender on /s/-/ʃ/ classification, these results cannot be explained by acoustic differences in men and women's /θ/ production and may result from learned, language specific variations in men and women's speech. If so, these cues may be less easily accessed by non-native speakers. The present study examines how speaker gender is used as a cue in phoneme categorization in a second language (L2), particularly when listeners are presented with a non-native phoneme contrast. Expectations about gendered production may not be as pronounced for L2 listeners, resulting in a smaller effect of speaker gender. In contrast, if non-native listeners have difficulty processing acoustic detail of non-native phonemes, they may rely more heavily on speaker gender as a cue in phoneme categorization.

To investigate this, we conducted an experiment that tested if native and non-native listeners of English differ in their use of speaker gender as cue in /s/-/θ/ categorization. Three groups of participants participated in a web-based experiment: native speakers of British English ( $N = 55$ , aged 20-42), as well as German ( $N = 55$ , aged 21-41), and Polish ( $N = 50$ , aged 20-39) learners of English. Learners described themselves as fluent in English, however, had not spent more than 6 months outside their home countries. Importantly, neither German nor Polish have /θ/ as a phoneme and learners are known to struggle with /θ/ (e.g., Hanulíková & Weber, 2012). A single /s/-/θ/ continuum was spliced onto ten minimal word pairs produced by one male and one female speaker of British English. In a two-alternative forced-choice task, participants were asked to identify each stimulus as starting with either /s/ or /θ/.

Results were analyzed using a generalized linear mixed-effects model with /θ/-response as the dependent variable, continuum step, speaker gender, listener's native language and all interactions as fixed factors, as well as random intercepts over participants and word pairs with random slopes for continuum step and speaker gender. Overall and across participant groups, more /θ/ responses were given for stimuli combined with the male speaker's voice, replicating Munson's (2011) finding. However, as indicated by a significant interaction between speaker gender and continuum step, at the /s/-end of the continuum this effect reversed for all groups (see Figure 1), in line with other studies on the /s/-/ʃ/ contrast, where more /s/ responses were found for a male voice. Importantly this effect did not significantly differ between the native English listeners and either group of non-native listeners of English. Thus, reliance on speaker gender as cue for /s/-/θ/ categorization was not affected by the listener's native language or the lack of target contrast in that language. In sum, the present study once again demonstrates the robustness of the speaker gender effect in phoneme categorization. Moreover, the results suggest that this effect is not language specific as it appears accessible also to non-native listeners.



**Figure 1. Results of categorization experiment by participant language**

Categorization data (proportion of /θ/ responses) over continuum steps (labeled according to the original continuum). Results are presented according to speaker gender (solid lines and light dots for female, dashed lines and dark dots for male) and by language: on the left, the results for the German listeners (blue) compared to native English listeners (black) and on the right, the results for the Polish listeners (red) compared with the native English listeners (black). A significant interaction between speaker gender and continuum step was found ( $p < 0.001$ ), such that overall, more /θ/ responses were given for the male speaker while more /s/ responses were given for the male speaker at the beginning of the continuum. No significant interaction was found between speaker gender and participant language.

## References

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