Cross-linguistic phonetic recalibration in bilingual lexical processing

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Theoretical approaches to second language (L2) speech often stipulate that creation of L2 sound categories, distinct from those in the first language, is a critical factor in enabling the acquisition of L2 speech [1]. However, corroborating such theoretical predictions is hindered by the absence of a widely accepted method for determining whether sound categories are separate or integrated across languages in multilingual speakers. In this study, we apply a method based on lexically guided recalibration of phonemic categories, which could provide a window into the structure of sound categories in bilinguals.

Phonetic recalibration, or shift in phonetic categories, is driven by the need to distinguish minimal pairs of words [2]. In lexically guided recalibration, exposure to sounds with non-prototypical acoustic profiles (e.g., fricatives that are acoustically intermediate between [f] and [s]), embedded into disambiguating lexical items (e.g., *ungrateful*), leads to a category boundary shift, such that more of the acoustic continuum between the categories is identified as [f]. In bilingual speakers, inducing recalibration in one language should lead to boundary shifts in both languages if sound categories are integrated across languages. For example, when French–English bilinguals were trained on [f] or [s] only in one of the two languages, they underwent boundary shift in both languages [3, 4].

In limited previous work on bilinguals' phonetic retuning, recalibration was tested exclusively for phonemes that are arguably acoustically identical across the languages tested ([f]-[s]). We induced recalibration between [p] and [k] in English and Spanish, where voiceless stops are implemented differently: aspirated in English and unaspirated in Spanish. Evidence of recalibration in such a case would indicate that acoustically non-identical but related sounds across languages are jointly categorized in bilingual cognitive systems.

Seventy-two Spanish–English bilinguals with diverse linguistic backgrounds (primarily heritage speakers of Spanish in the USA) participated online using Gorilla [5]. During exposure, participants were divided into four groups (exposure to non-prototypical English [p], English [k], Spanish [p], or Spanish [k]) and performed a lexical decision task, which included 144 trials: 18 critical stimuli with sounds intermediate between [p] and [k], 18 words with unambiguous contrasting sounds matching in length and frequency, 36 fillers, and 72 nonce words generated by Wuggy [6]. Exposure stimuli were recorded by a first language (L1) speaker of the corresponding languages. In the post-test, participants identified Spanish and English words from four [p]-[k] minimal pairs (e.g., *pat-cat*) with the first sound spanning a 10-step [p]–[k] continuum (240 trials: 4 minimal pairs × 2 languages × 10 steps × 3 repetitions). The order of the test language was counterbalanced across participants. Stimuli for the continua were created using a custom Python algorithm for direct linear interpolation between audio samples of /p/ and /k/ words, transitioning through 10 progressive steps.

Two Bayesian mixed-effects logistic regression models (one per test language), based on a total of 16,866 data points, were implemented to examine the binary dependent variable [k] vs. [p] (Bernoulli distribution). The models incorporated fixed effects of Exposure Language (Spanish, English), Category ([p], [k]), Step, and their three-way interactions, as well as random effects of by-subject and by-item intercepts and slopes for Step. In the Spanish test, while the recalibration occurred for both exposure groups, the magnitude of recalibration was stronger in participants who were exposed to Spanish as opposed to English. In the English test, phonetic retuning occurred only in the English exposure group. Thus, to the extent to which these results indicate that voiceless stop categories are linked across languages, the connection appears to be asymmetric in nature. While exposure to English induced minor recalibration in Spanish, exposure to Spanish did not lead to recalibration in English. The recalibration effect was also weaker in the English test, even with a matching exposure language. These findings suggest that acoustically distinct but related sound categories are not necessarily linked across languages in bilingual speakers in the same way acoustically identical sounds are. An inquiry into the role of dominance, age, and order of acquisition is also necessary.

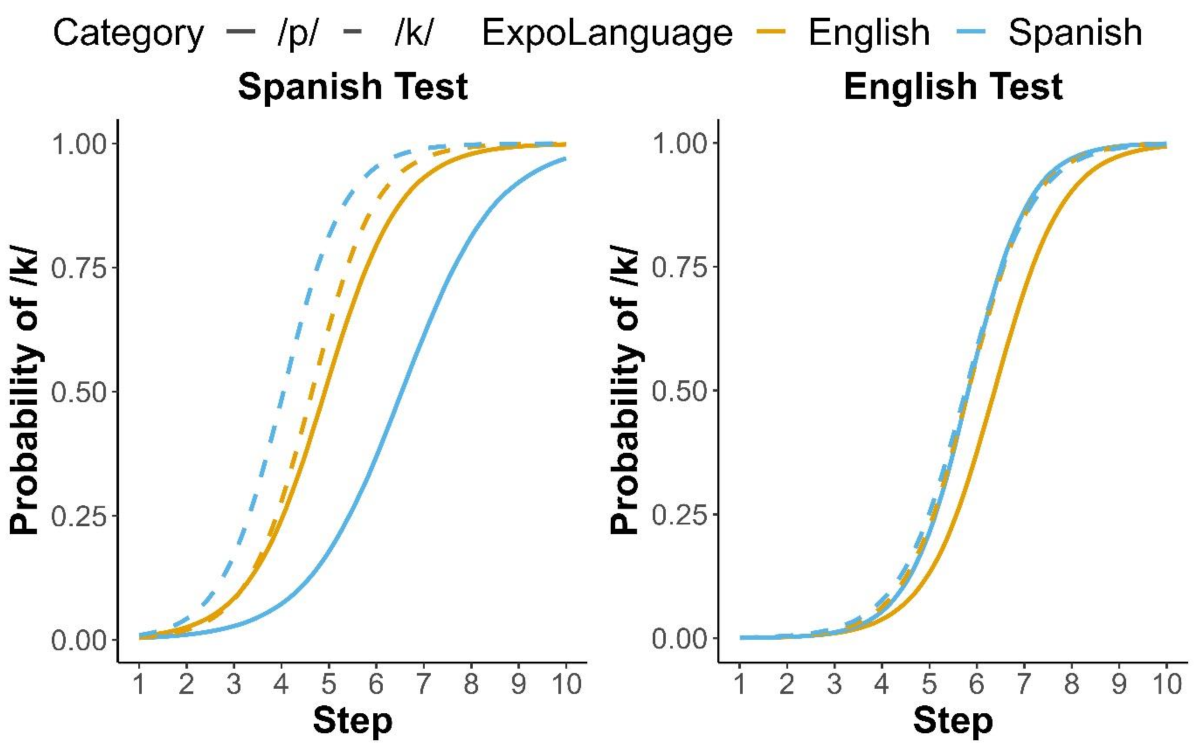

Fig. 1. Bayesian logistic curves representing the predicted probability of /k/ responses across a 10-step continuum for Spanish (left panel) and English (right panel) post-tests based on the conditional effects (Exposure Language, Exposure Category, Step). The presence and magnitude of recalibration is reflected by the offset between the corresponding /p/ and /k/ identification curves.

References

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