



Research Article

Mutual influences between native and non-native vowels in production: Evidence from short-term visual articulatory feedback training



Natalia Kartushina^{a,b,*}, Alexis Hervais-Adelman^c, Ulrich Hans Frauenfelder^a, Narly Golestani^c

^a Laboratory of Experimental Psycholinguistics, FPSE, University of Geneva, 42 bd du Pont d'Arve, 1205 Geneva, Switzerland

^b Basque Center on Cognition, Brain and Language, Paseo Mikeletegi, 69, 20009 San Sebastian, Spain

^c Brain and Language Lab, Campus Biotech, Faculty of Medicine, University of Geneva, 9 Chemin des Mines, 1202 Geneva, Switzerland

ARTICLE INFO

Article history:

Received 3 April 2015

Received in revised form

26 April 2016

Accepted 2 May 2016

Keywords:

L2 production

Articulatory training

L1–L2 interactions

Intra-speaker variability

Production training

Stability in production

Individual differences

ABSTRACT

We studied mutual influences between native and non-native vowel production during learning, i.e., before and after short-term visual articulatory feedback training with non-native sounds. Monolingual French speakers were trained to produce two non-native vowels: the Danish /ɔ/, which is similar to the French /o/, and the Russian /i/, which is dissimilar from French vowels. We examined relationships between the production of French and non-native vowels before training, and the effects of training with non-native vowels on the production of French ones. We assessed for each participant the acoustic position and compactness of the trained vowels, and of the French /o/, /ø/, /y/ and /i/ vowels, which are acoustically closest to the trained vowels. Before training, the compactness of the French vowels was positively related to the accuracy and compactness in the production of non-native vowels. After training, French speakers' accuracy and stability in the production of the two trained vowels improved on average by 19% and 37.5%, respectively. Interestingly, the production of native vowels was also affected by this learning process, with a drift towards non-native vowels. The amount of phonetic drift appears to depend on the degree of similarity between the native and non-native sounds.

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1. Introduction

Second-language (L2) learners often experience considerable difficulty in producing non-native speech sounds, resulting in a foreign accent. Accents are largely attributed to a bias in the perception of L2 sounds, arising from the native (L1) phonology. While the effects of L1 on the production of foreign sounds are well established, less is known about the impact of L2 on the production of native sounds, particularly in novice L2 learners. This study aims to explore the effects of production training with the Danish /ɔ/ and Russian /i/ vowels on the production of native French vowels in speakers with no previous experience with Danish or Russian.

1.1. The influence of L1 on the production of L2 sounds

The effect of the native language on second-language production has been widely documented (Flege, MacKay, & Meador, 1999; Goto, 1971; Long, 1990; Piske, MacKay, & Flege, 2001). For instance, Korean and Spanish learners of English have difficulty in producing the /i/-/ɪ/ contrast, whereas Italian learners experience more difficulty with the /ə/-/ʌ/ contrast (Flege, 2003). Here we will try to address how the native language affects L2 production.

It is assumed that at the beginning of L2 learning, L1 phonology influences that of the L2; L1 is used to process L2 sounds in terms of their similarity/dissimilarity¹ to native categories (Archibald, 1998; Flege, 1995). According to Flege's (1995) Speech Learning Model (SLM), for example, similar L2 sounds assimilate perceptually to L1 categories by a mechanism of equivalence classification.

* Corresponding author at: Basque Center on Cognition, Brain and Language, Paseo Mikeletegi, 69, 20009 San Sebastian, Spain.

E-mail address: n.kartushina@bcbl.eu (N. Kartushina).

¹ Depending on the theoretical framework adopted, the similarity can be phonetic (Speech Learning Model [SLM] by Flege (1995)), gestural (Perceptual Assimilation Model [PAM] by Best (1995)) or acoustic (Second Language Linguistic Perception Model [L2LP] by Escudero (2007)).

This mechanism can block L2 category formation, and native sounds may be used to produce similar L2 sounds. Dissimilar L2 sounds (i.e., those that are sufficiently phonetically different from the closest native category to be perceived as being different from it) do not perceptually assimilate to L1 categories, and novel categories are expected to be established for them.

Consider, for instance, Korean and Japanese learners of the Australian-English /e/-/æ/ contrast. While the English /e/ vowel is assimilated to the respective similar /e/ vowels in both Korean and Japanese, only in Japanese is the English /æ/ vowel phonetically distinct from the closest /e/ category, whereas in Korean it also assimilates to /e/. Consequently, many Korean learners of English do not produce the English /e/ and /æ/ vowels distinctly: the acoustic spaces for these vowels largely overlap, suggesting that they use one native-like category to produce both the English /e/ and /æ/ vowels. Japanese speakers, on the other hand, produce /e/ and /æ/ contrastively since a new category is created for the dissimilar English /æ/ vowel, and the existing L1 /e/ category is used to produce the English /e/ (Ingram & Park, 1997).

Even over extended learning periods, advantages for dissimilar over similar vowels seem to persist. For instance, Japanese speakers assimilate the English /ɹ/-/l/ contrast to one Japanese /r/, with the English /l/ being perceptually more similar to the Japanese /r/ than to the English /ɹ/. At the end of one year of formal learning, native Japanese children improved more in their production of the English /ɹ/ than of /l/, as judged by native English speakers (Aoyama, Flege, Guion, Akahane-Yamada, & Yamada, 2004).

The age of onset of L2 learning influences the production of similar (i.e., difficult) L2 sounds. Early bilinguals produce similar cross-language sounds distinctly, whereas late bilinguals do not (Guion, 2003; MacLeod, Stoel-Gammon, & Wassink, 2009). This suggests that they use the native category to produce similar L2 sounds (Baker & Trofimovich, 2005). These results show that early L2 learners are more likely to create novel categories for similar L2 sounds than are late L2 learners.

In addition to the acoustic similarity of L1 and L2 sounds, the distribution, and more specifically the compactness of L1 sound categories, has more recently been shown to influence the perception and production of L2 sounds (Kartushina & Frauenfelder, 2013, 2014). In these studies, the compactness of person-specific vowel productions was measured by quantifying the spatial distribution, that is, the spread of produced tokens in the F1-F2 vowel space (see methods for more on how this was calculated). It was shown that Spanish speakers whose L1 productions were more compact (i.e., less variable) produced French (L2) sounds more accurately than those whose productions were more variable. This was attributed to the fact that speakers with more compact L1 productions have a greater proportion of their acoustic space available for the formation of new L2 sounds. Conversely, speakers with more variable L1 productions have little acoustic space available for the formation of new L2 sounds, which are therefore more likely to fall within the space of existing L1 sounds and to be confused with them (Kartushina & Frauenfelder, 2014). These results are consistent with Flege's postulate regarding a shared L1-L2 space, which claims that "sounds are related to each other at a position-sensitive allophonic level" (1995, p. 239).

To summarize: (1) dissimilar L2 sounds are produced and acquired more easily than similar ones; (2) the detrimental effects of cross-language similarity on L2 production increase with the age of L2 acquisition, and (3) the compactness of L1 categories and their similarity to L2 sounds affect L2 production.

1.2. The influence of L2 on the production of L1 sounds

While the effects of L1 on L2 production have been extensively described, less is known about the effects of L2 learning on the production of native speech sounds. Grosjean (1989) argued that L1 and L2 coexist and interact constantly in bilinguals. For instance, the extent of use of either the native or second language has been shown to affect speakers' performance in the other language. Piske and colleagues (Piske et al., 2001) have shown that the strength of the L2 accent is affected by the amount of continuous use of the native language. In Anglophone areas of Canada, native Italian speakers who continuously and frequently used Italian in their everyday life (on average 53%) were perceived by native Canadian speakers as having a stronger Italian accent when speaking English than those who used Italian less frequently (on average 10%). Conversely, and more curiously, native productions may themselves become foreign-language accented after only a few months of immersion in an L2-speaking country. In a case study, Sancier and Fowler (1997) showed that, following a four-month stay in the US, productions of a native Brazilian Portuguese speaker were perceived by native Portuguese listeners as being American-English (AE) accented (for effects of L2 immersion on L1 production latencies, see Baus, Costa, and Carreiras (2013), Ivanova and Costa (2008), Linck, Kroll, and Sunderman (2009)).

So how, specifically, does L2 use affect L1 production? In the SLM model, Flege postulates that "phonetic categories established in childhood for L1 sounds evolve over the lifespan to reflect the properties of all L1 and L2 phones" (p. 239, 1995). Although to date there are no longitudinal studies available having tracked the evolution of L1 and L2 categories, some existing studies on L1 and L2 phonetic production in bilinguals support this claim (Barlow, 2014; Flege, 2003; Flege & Eefting, 1987a, 1987b; Flege, Schirru, & MacKay, 2003; Fowler, Sramko, Ostry, Rowland, & Hallé, 2008; Guion, 2003; MacLeod et al., 2009; Mora, Keidel, & Flege, 2015; Mora & Nadeu, 2012; Sancier & Fowler, 1997; Sundara, Polka, & Baum, 2006). These studies reveal that experience with an L2 can have three possible effects on native categories (see Fig. 1): (1) no change, (2) drift toward the L2 category and (3) deflection away from the L2 category, to maximize opposition with it.

The type of change that L1 sounds can undergo depends on several factors, mainly including: (1) the degree of (perceived) similarity to the closest L2 sound, (2) experience with the L2 and L1 (i.e., related to age of acquisition, amount of use, etc.), and (3) proficiency in the L2. These (and other) factors have recently been reviewed in a paper by Kartushina, Frauenfelder, & Golestani (accepted), and are briefly described in the next sections.

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