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Effect of phonetic training on the perception of English consonants by Greek speakers in quiet and noise

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The present study employed high-variability phonetic training (multiple words spoken by multiple talkers) to improve the identification of English consonants by native speakers of Greek. The trainees completed five sessions of identification training with feedback for seven English consonants (contrasting voiced vs. voiceless stops and alveolar vs. postalveolar fricatives) each consisting of 196 trials with a different English speaker in each session. Another group of Greek speakers served as controls, i.e. completed the pre-/post-test but received no training. Pre-/post-tests included English consonant identification in quiet and noise. In the noise condition, participants identified consonants in the presence of a competing English speaker at a signal-to-noise ratio of -2dB. The results showed that training significantly improved English consonant perception for the group that received training but not for the control group in both quiet and noise. The results add to the existing evidence that supports the effectiveness of the high-variability approach to second-language segmental training.

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1. Introduction

It has been shown that a short period of computer-based perceptual training whereby the trainees are exposed to natural minimal pairs spoken by multiple talkers contrasting the target sounds in multiple environments (high-variability phonetic training) improves the perception of second-language (L2) consonants (e.g. Logan, Lively & Pisoni, 1991; Lively, Logan & Pisoni, 1993; Iverson, Hazan & Bannister, 2005). Importantly, perceptual learning generalizes to new talkers and stimuli and is retained several months after training (Lively, Pisoni, Yamada, Tohkura & Yamada, 1994; Bradlow, Akahane-Yamada, Pisoni & Tohkura, 1999).

To date, the majority of studies have trained binary L2 contrasts, including the English /r/-/l/ distinction by Japanese speakers, the English word final /t/-/d/ distinction by Chinese speakers and the Hindi dental-retroflex stop distinction by English and Japanese speakers. In addition, relatively little is known on whether learning generalizes to L2 consonant perception in adverse listening conditions. This is important because everyday communication rarely takes place in ideal listening conditions, which increases perception difficulty for L2 learners. In fact, it has been found that even early bilinguals' perception suffers more than L1 perception from noise in tasks such as sentence intelligibility (Mayo, Florentine & Buus 1997; Bradlow & Bent 2002), word identification (Nabelek & Donahue 1984) and phoneme identification (Garcia Lecumberri & Cooke 2006; Cutler, Garcıa Lecumberri & Cooke 2008).

The present study examined the effect of high-variability phonetic training on native Greek speakers' identification of English consonants. The trainees completed five sessions of identification training with feedback for seven English consonants (contrasting voiced vs. voiceless stops and alveolar vs. postalveolar fricatives) which have been shown to cause difficulties to native Greek speakers (Lengeris & Nicolaidis, 2014). Another group served as controls, i.e. completed the pre-/post-tests but received no training. English consonant identification before and after training was assessed in two listening conditions: in quiet and in the presence of an 8-speaker babble.

2. Method

2.1 Participants

The participants were twenty-two Greek learners of English, all females, with a mean age of 20 years (range = 19-21 years). They were all students at the Aristotle University of Thessaloniki and had received 10–12 years of formal English instruction in a foreign language setting with very little, if any, interaction with native English speakers. None of the participants had spent a period of more than one month in an English-speaking environment. Their proficiency level was relatively uniform (Cambridge FCE, CPE) and they all reported normal hearing and no language impairment. Thirteen participants received training and nine served as controls.

2.2. Pre-/post-tests

The pre-/post-tests were conducted in the Phonetics Laboratory of the School of English, Aristotle University of Thessaloniki. Participants were tested on a battery of tasks assessing their English vowel and consonant perception and production in different listening conditions as well as their cognitive abilities (e.g. phonological short-term memory). This paper reports only the results concerning the identification of English consonants in two listening conditions, in quiet and in an 8-speaker babble. In both conditions, a closed-set identification task with 9 options /p/, /b/, /t/, /d/, /k/, /g/, /s/, /ʃ/ and /ɹ/ designed in TP (Rauber, Rato, Kluge & Santos, 2012) was used. Consonants were presented for identification in the context C-/æt/ embedded in a carrier sentence 'say __ again'. Participants clicked on one of the options displayed on a computer screen (using English orthographic labels, e.g. *bat*, *rat*). In the noise condition, the multi-talker babble was played simultaneously with the sentences at a signal-to-noise ratio of -2 dB. For each listening condition, there were 36 presentations in the pre-/post-test (2 speakers × 9 consonants × 2 repetitions). Presentation was blocked by speaker and consonants were fully randomized within each block. Before testing, participants heard all of the sentences spoken by one speaker once (the initial presentation of sentences for the noise condition was presented with noise).

2.3. Training

The trainees completed five sessions of identification training with feedback for seven English consonants /p/, /b/, /t/, /d/, /k/, /s/ and /ʃ/. A different English speaker was used in each session (3 female, 2 male). The English voiced-voiceless distinction in plosives is difficult for Greek speakers because, although both languages employ such a distinction, there is difference in the phonetic realization of the two categories between Greek and English; Greek distinguishes voiceless unaspirated vs. fully voiced plosives whereas English distinguishes voiceless aspirated vs. not fully voiced plosives. The English alveolar-postalveolar distinction in fricatives is difficult for Greek speakers because Greek has only alveolar fricatives whose place of articulation is somewhat in between English alveolar and postalveolar fricatives (Nicolaidis, 2001).

Training was conducted at the participants' homes using the TP software (Rauber, Rato, Kluge & Santos, 2012); the training software was installed on their laptops/desktops and the training sessions were conducted in a quiet room. Stimuli were presented at a comfortable level set by each individual. The details of the training sessions (e.g., participant details, day and time of session) were automatically saved and were protected by password to ensure that all trainees completed all sessions. There were 196 stimuli per session (7 consonants × 7 words × 4 repetitions). The training words contained the vowels /iː/, /ɪ/, /ɒ/, /ɔː/, /ɑː/, /æ/ and /ʌ/. For example, for English /p/ there were four repetitions of *pill*, *peel*, *pock*, *pork*, *part*, *pat* and *putt* in the training materials. Each training session lasted about 30 minutes.

3. Results

Figure 1 displays the identification accuracy for English consonants for the control and the trained group of Greek speakers before and after training in the quiet condition. In Figure 2, the identification accuracy for English consonants in the noise condition for the same participants is shown. The two groups did not differ in their pre-test performance (control = 90.3% correct vs. trained = 91% correct) or in noise (control = 86.3% correct vs. trained = 86.7% correct), $p > 0.05$. A repeated-measures analysis of variance (ANOVA) on identification scores with Group (trained, control) as a between-subject factor and Listening condition (quiet, noise) and Test (pre-test, post-test) as within-subject factors showed a significant main effect of Listening condition, $F(1,20) = 22.11$, $p < 0.001$, indicating that noise reduced L2 identification accuracy. There were also significant main effects of Group, $F(1,20) = 5.03$, $p < 0.05$ and Test, $F(1,20) = 4.7$, $p < 0.001$ and a significant Test × Group interaction $F(1,20) = 4.2$, $p < 0.05$, which was explored through simple effect tests. The simple effect of Test was significant only for the trained group, $p < 0.01$. Across listening conditions, the trained group improved from pre-test (89% correct) to post-test (95% correct), demonstrating (a) the effectiveness of training on the learning of English consonants for Greek speakers and (b) the generalization of learning to speech-in-noise perception.

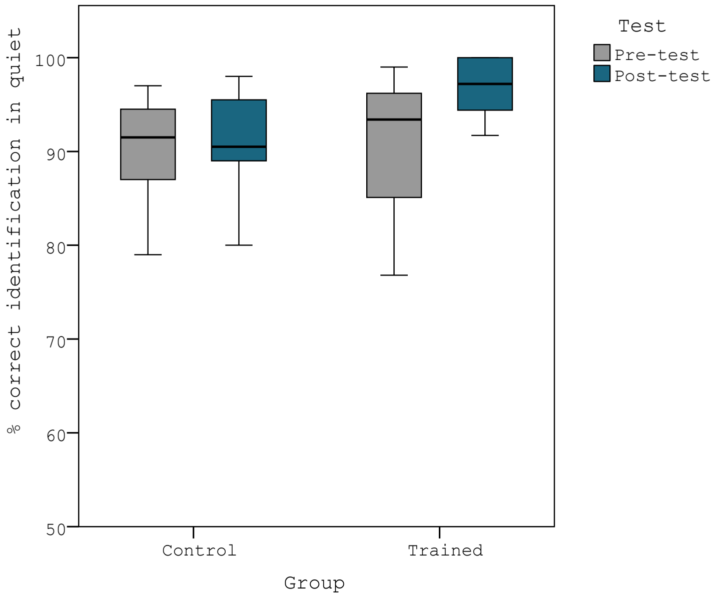

FIG. 1. Boxplots showing identification accuracy for English vowels for the control and the trained group of native Greek speakers in quiet in the pre-/post-test. Whiskers extend to at most 1.5 times the interquartile range of the box.

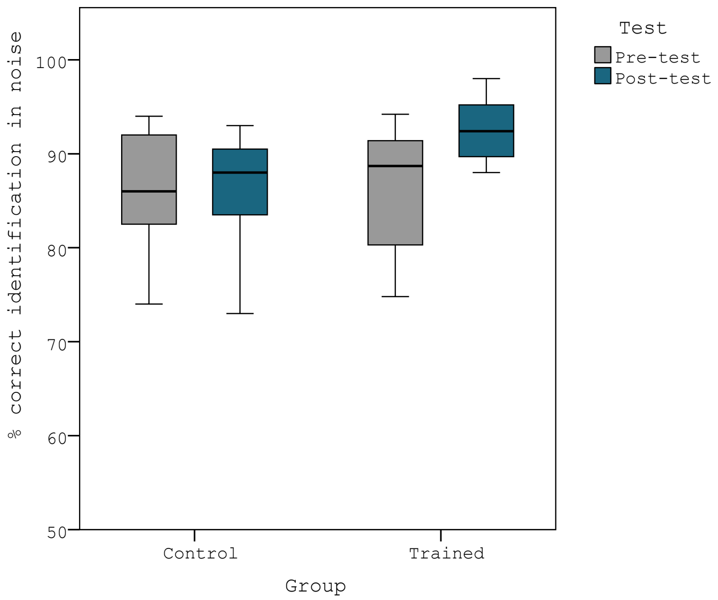

FIG. 2. Boxplots showing identification accuracy for English vowels for the control and the trained group of native Greek speakers in quiet in the pre-/post-test. Whiskers extend to at most 1.5 times the interquartile range of the box.

4. Discussion

This study examined the effect of high-variability phonetic training on the identification of English consonants by native speakers of Greek in a foreign language setting. The trainees completed five sessions of identification training with feedback for seven English consonants (contrasting voiced vs. voiceless stops and alveolar vs. postalveolar fricatives). The use of a control group of Greek speakers assessed any learning effect that would come from test repetition. The results showed a modest yet significant improvement in English consonant perception for the group that received training but not for the control group. It is therefore possible to successfully train several L2 consonants at the same time which is consistent with previous vowel training studies that have used high-variability phonetic training (Lambacher, Martens, Kakehi, Marasinghe & Molholt 2005; Nishi & Kewley-Port, 2007, 2008; Iverson & Evans 2009; Lengeris & Hazan 2010). Given that the trainees in this study performed well in the pre-test (around 90% correct), a relatively small degree of improvement compared to an improvement of 10-20 percentage points reported in previous training studies may be due to a ceiling effect. The results also showed that, as expected, noise had a detrimental effect on English consonant identification. At the same time, perceptual learning in quiet generalized to speech-in-noise L2 identification, i.e., to more realistic listening conditions. Taken together, the findings of this study add to the existing evidence that supports the effectiveness of the high-variability approach to second-language segmental training.

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