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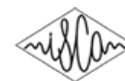
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The effects of prosodic training with logatomes and prosodic gestures on L2 spontaneous speech

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Abstract

Training L2 suprasegmental features benefits pronunciation accuracy and comprehensibility, especially through the use of hand gestures. However, studies have mainly looked at the effect of prosodic training in controlled tasks and less is known about spontaneous speech. The present study explores the effect of prosodic training with and without gestures depicting prosody on several dimensions of pronunciation in spontaneous speech.

Fifty Catalan learners of French practiced oral reading and sentence-by-sentence imitation with short dialogues during three 30-minute sessions in one of three conditions: *speech-only*, repeating a selection of sentences from the dialogues; *logatome*, repeating logatome sequences (series of same consonant-vowel syllable leaving out lexical information) corresponding to the prosody of target sentences; and *logatome+gesture*, additionally mimicking gestures representing phrasal prosodic patterns.

Perceptive evaluations of learners' spontaneous speech at pre- and posttest revealed that training prosody did not have any significant effect on participants' comprehensibility, accentedness, and suprasegmental accuracy in spontaneous speech. Acoustic analyses further showed null effects of prosodic training on fluency and the pronunciation of difficult vowel contrasts. Our findings suggest that L2 prosodic training should be better tailored for spontaneous speech. Alternatively, learners may need more time to transfer beneficial effects from controlled tasks to spontaneous speech.

Index Terms: L2 prosody, gesture, logatome, pronunciation, spontaneous speech

1. Introduction

Previous studies have stated the important role of prosody in pronunciation evaluations [1], as well as the beneficial role of pronunciation instruction focusing on suprasegmental features [2, 3, 4]. However, most studies have reported improvement on controlled tasks and little is known on the effects of prosodic training on spontaneous speech. Moreover, specific techniques involved in prosodic training are seldom thoroughly described and their effects are not comprehensively tested [5]. Recently, two studies have shown the beneficial effects of prosodic training involving visuospatial hand gestures depicting prosodic features at the phrase level on L2 pronunciation in controlled tasks such as oral reading and sentence imitation [6, 7]. The aim of the present study is to further explore the gains of prosodic training based on phrase-level prosodic gestures on

spontaneous speech through comprehensive pronunciation assessment.

In the second language classroom, teachers spontaneously use gestures to help learners understand difficult pronunciation features. For example, intonation may be illustrated by flat, rising, and falling hand movements representing pitch contours, while vowel duration can be represented by horizontal hand movements. In addition, beat gestures, and tapping or clapping rhythm may function as a way to distinguish syllables or to indicate stress positions [8, 9]. [9] advocates for the integration of body movements and gestures to enhance the perception, pronunciation, and retention of L2 phonological features. There are several reasons to support this claim. First, hand and arm movements may help the acquisition of speech rhythm and melody in a similar way as body movements are used in musical education to enhance the acquisition of musical rhythmic and melodic patterns [10]. In addition, from the field of sign language, there is evidence of the existence of a visuospatial 'phonological loop' in working memory, similar to the phonological loop for speech, and structured uniquely by language [11]. In that sense, the form of a gesture may be processed in a similar way as speech sounds and associated with the corresponding phonological feature. Finally, there is evidence that the mental representation of pitch is visuospatial in nature [12, 13], indicating that making pitch directions and movements and durational patterns visible to the learners may help them process foreign language prosody. Recent studies have started to empirically test these embodied prosody teaching techniques and found a positive role of beat gestures [14, 15 16], hand-clapping [17, 18, 19], durational gestures [20], and pitch gestures [21] on the perception and pronunciation of L2 phonological features.

Regarding classroom practice, the verbotonal pronunciation teaching method (henceforth VT) is based on the notion that prosody acts as a frame for pronunciation development and should be taught from the first stages of language learning [22]. One of the techniques used in VT consists of the repetition of logatomes combined with visuospatial hand gestures that mimic the intonation, rhythm, and phrasing of a sentence [23]. In the present study, we decided to call these gestures *phrase-level prosodic gestures* to indicate that these gestures are depicting several features of prosody at the same time and that they occur at the phrase level. A logatome is a series of the same consonant-vowel nonsense sequences (e.g. /dadada/) that remove any target segmental information but keep the prosodic structure of the sentence intact. Repeating meaningless CV syllables in this fashion, and accompanying them with phrase-level prosodic gestures is believed to have a priming effect and allows

learners to perceptually focus on the suprasegmental features of target utterances while keeping the segmental content controlled. To our knowledge, very few studies have tested the effects of the VT method. One study found that eight weeks of general VT phonetic training sessions improved learners' fluency in L2 French more than training sessions based on activities such as reading aloud, text comprehension, and creative writing, without disentangling the specific role of gestures or of the type of VT technique [24]. A follow-up study compared the VT method to the articulatory pronunciation teaching method, which involves the explicit teaching of segments' articulatory properties, and found that after four weeks, participants following the VT method showed significantly higher gains in their fluency, in particular when their French pronunciation was worse at the outset. However, this advantage disappeared after eight weeks, after the introduction of reading activities during the second half of the course [25]. The difficulty of reading in an L2 may have led to a decline in pronunciation performance, indicating that pronunciation during oral reading should also be practiced. A recent study tested the effects of logatomes and phrase-level prosodic gestures on oral reading with Catalan learners of French [6]. Perceptive ratings of participants' reading of short dialogues at pre- and posttest showed that embodied training involving the imitation of logatomes and phrase-level prosodic gestures helped reduce accentedness and improved suprasegmental accuracy compared to prosodic training involving the imitation of logatomes and to speech repetition. These results were confirmed with a follow-up study comparing prosodic training involving the observation of phrase-level of prosodic gestures during speech repetition to mere speech repetition [7]. The results again revealed positive effects of embodied prosodic training not only for oral reading but also for sentence imitation. Importantly, none of the two studies assessed the potential gains of such embodied training on spontaneous speech.

Interestingly, training prosody may also improve the pronunciation of segments. There is evidence that in L1, vowels pronounced in prominent prosodic positions tend to be hyper-articulated so that certain of their phonological features are reinforced: these vowels are more *canonical* with respect to their unaccented counterparts [26]. For L2, recent studies have confirmed that vowels produced in prominent prosodic positions (or in pitch rising contexts) are better articulated than vowels pronounced in non-prominent prosodic positions (or pitch falling contexts), suggesting that L2 learners may improve their pronunciation of vowels by training their production in strong prosodic positions [27, 28]. Studies testing this aspect have obtained mixed results so far: general VT instruction did not present any advantage for vowel accuracy [29], and regarding the effect of prosodic training with phrase-level prosodic gestures on oral reading, a native perceptive evaluation of segmental accuracy triggered negative results [6]. Yet, an acoustic analysis of front rounded vowels showed improvement after training with prosodic gestures [7].

The present study further explored the role of prosodic training involving the use of phrase-level prosodic gestures by assessing its potential effects on spontaneous speech. This assessment was performed through a comprehensive analysis of speech samples of Catalan learners of French that were collected at pre- and posttest in [6]. French presents some

difficulties for both Spanish and Catalan learners in terms of segmental and suprasegmental features. For example, the vowel /y/ tends to be pronounced as /u/, while /ø/ and /œ/ tend to be pronounced as /e/ or /ɛ/. As for prosody, Catalan learners may have difficulties regarding the realization of a unique demarcative phrasal stress realized through extreme final lengthening [30, 31]. Keeping with the view that a truly comprehensive assessment of the effects of pronunciation instruction on L2 speech must consider both holistic and specific levels of measurement [5], comprehensibility, accentedness, and suprasegmental accuracy was assessed through native perceptive evaluations, fluency was analyzed in terms of articulation rate, and segmental accuracy of challenging phonemes was measured using acoustic analysis.

2. Methods

2.1. Participants

Seventy-five first- or second-year undergraduate students in Translation and Interpreting or in Applied Languages in a Catalan university participated in this study. All of the students reported themselves to be Catalan-Spanish bilinguals ($M_{Catalan} = 65.45\%$, $SD = 24.07$). Participants reported their French proficiency to be between CEFR levels A2 and B1. The pronunciation training was incorporated into their intermediate-level French course and took place over five weeks. Participants were randomly assigned to one of three conditions: speech only, logatome, and logatome+gesture. From the 75 participants, 50 of them were selected for the present study, based on the requirements for the acoustic analysis: a) enough audio quality, and b) same gender (female) to allow for stricter phonetic comparisons. As a result, the speech-only (S) group counted 15 participants ($M_{age} = 19.73$, $SD = .89$), the logatome (L) group 17 participants ($M_{age} = 19.65$, $SD = 1.32$), and the logatome+gesture (G) group 18 participants ($M_{age} = 19.22$, $SD = .73$).

2.2. Materials

2.1.1. Audiovisual stimuli for pronunciation training

As described in [6], the materials used in the training sessions consisted of a set of dialogues taken from a French-language textbook that focuses on teaching oral skills through meaningful, enjoyable texts [32]. Nine dialogues were used in total, with a different set of three employed in each of the three training sessions. The dialogues included a variety of intonation contours arising from different situational contexts.

A total of five sentences in each dialogue were selected (around 42% of the total number of sentences) to be target stimuli for repetition during the training sessions. Video recordings were then made of three instructors performing the 45 stimuli (5 sentences \times 3 dialogues \times 3 sessions) in the three experimental conditions. The instructors (2 females, 1 male) were two specialists in the VT method and the first author of this study.

In all recordings, the frame of the image was set to show the upper half of each instructor's body to allow a clear view of the face and all hand movements. For the S condition, the instructors simply pronounced the target sentences clearly while standing still. For the L condition, the instructors pronounced the syllable "da" instead of the phrase's syllables, but without changing the intonation of the phrase. As for the G condition, as the logatome was uttered, the right hand, palm open facing downward, made a sweeping left-to-right

movement across the body at chest level that mimicked through upward and downward movements the rises and falls of the pitch contours of their oral utterance as they spoke. Importantly, these movements served to depict not only intonational pitch movements but also the rhythmic and phrasing features of their speech by increased or decreased velocities and short pauses in the hand's movement. During stimuli edition, the videos were flipped for the participants to watch the gesture from left to right.

Finally, the nine dialogues were acted out by amateur actors and video-recorded. After each dialogue had been trained, the participants would be shown the corresponding enactment as a kind of wrap-up activity. Altogether, for each condition, three sets of stimulus materials were created, one for each training session. In the three conditions, the dialogues featured the same pair of instructors, and the pairs of instructors varied across dialogues.

2.2.2. Pre- and posttest materials

Participants' pronunciation was tested before and after training through a spontaneous speech task involving two topics that had been both treated during their regular classes. At pretest, participants were asked to answer the following question: "Please explain in a few sentences your experience as an Erasmus exchange student. Where and when did you go? Was everything fine? What are your best memories? Would you like to live in a foreign country again?". At posttest, they were asked to discuss the following topic: "Explain in a few sentences who your best friend is and describe her/his physical appearance. How did you meet? What do you like and don't like about her/him?"

2.3. Procedure

A week before the first training session, participants did the pretest by video-recording themselves using their computer and headset in a quiet environment and uploaded the file in a shared folder. The purpose of video recording was to ensure that the task was done properly. The audio tracks from the recordings were extracted and saved for further analysis. Pronunciation training took place on the university premises in individual soundproofed booths equipped with computers and microphones. Depending on the experimental group to which the participant had been randomly assigned previously, the teacher emailed a link to the corresponding set of training materials. After reading some initial instructions, participants completed training individually at their own pace, recording their speech output throughout the session using Audacity software. For each training session, the training procedure consisted of completing a set of subtasks associated with three dialogues: reading silently, reading aloud, watching the training sequence, reading aloud, watching the native performance and reading aloud. The order of presentation of the dialogues was randomized automatically by the presentation software. Each training session lasted roughly 30 minutes, about 10 minutes per dialogue unit. While the training session was in progress, the instructor monitored participant behavior from outside the individual booths, particularly to ensure that participants in the embodied logatome training were duly performing the required hand movements. One week after the third and last training session took place, participants recorded the posttest under the same conditions as the pretest.

2.4. Pronunciation evaluations and statistical analysis

Pronunciation was evaluated using perceptive and acoustic measurements and analyzed statistically in SPSS 23 and R. Perceptive evaluations on comprehensibility, accentedness, and suprasegmental accuracy were carried out by three raters (2 females 1 male), all native speakers of French with extensive L2 teaching experience. Each rater evaluated the totality of speech samples taken from participant-recorded pre- and posttest audio files (a total of 100 files) for each of the five pronunciation dimensions on nine-point Likert scales (1 = worst score, 9 = best score). The files lasted between 40-60 seconds each and were presented in randomized order to the raters. Interrater reliability scores showed moderate to good agreement among the raters: $ICC_{comprehensibility} = .71$, $ICC_{accentedness} = .63$, and $ICC_{suprasegmental\ accuracy} = .63$. Three general linear mixed models (GLMMs) were run, each with one of the dependent variables: comprehensibility, accentedness, and suprasegmental accuracy. Group (3 levels: speech, logatome, logatome+gesture), test (2 levels: pretest and posttest), and group \times test were set as fixed factors; random intercept was set for participants. Sequential Bonferroni pairwise comparisons were used.

Participants' fluency achievements were determined in terms of articulation rate (number of syllable/phonation time) using a Praat script to automatically detect syllable nuclei in the speech samples and extract the articulation rate scores [33]. A GLMM was run with the dependent variable articulation rate. The rest of the analysis settings was as above.

For segmental accuracy, the audio files were first orthographically transcribed and aligned in Praat [34] for inter-pausal units, words, syllables, and segments (consonants and vowels). The target round front vowels /y/ and /ø/ were selected for analysis since they are especially challenging for Catalan learners of L2 French. To evaluate any potential significant improvement in the pronunciation of target vowels, we computed separate manovas for /y/ and /ø/ with F1, F2, F3 as dependent variables and with group, test, and group \times test as independent variables. Additionally, we measured the acoustic overlap between realizations for difficult target vowels (in this case /y/, /ø/) and the counterparts with which they tend to be confused (in this case, /u/, /e/), with the assumption that lesser overlap indicates more precise and more accurate pronunciation [28]. The acoustic overlap for the /e/ \sim /ø/ and /y/ \sim /u/ contrasts was quantified by computing the average realization for each target vowel for each participant, and then obtaining Pillai scores [28, 35] for each of the three groups at pre- and posttest. Pillai scores were extracted in R from manovas computing manovas with F1, F2, F3 as dependent variables, and vowel as a fixed effect.

3. Results

Mean scores and the standard deviations obtained for each of the five pronunciation variables are specified in Table 1. Results of the three GLMM on perceptual ratings did not show any significant effect of neither group nor test on comprehensibility ($p = .89$, $p = .89$), accentedness ($p = .48$, $p = .97$), and suprasegmental accuracy ($p = .54$, $p = .62$). Similarly, the result of the GLMM on articulation rate scores did not show any significant effect of neither group ($p = .31$) nor session ($p = .31$). Results of manovas for /y/ and /ø/ revealed no significant effect of group (/y/: $p = .79$; /ø/: $p = .16$), test (/y/: $p = .37$, /ø/: $p = .55$), nor group \times test (/y/: $p =$

.91, /ø/: $p = .96$). In terms of vowel overlap, we find that realizations for /y/ and /u/ showed less overlap in pretest than in posttest, while realizations for /ø/ and /u/ show greater overlap in pretest than in posttest (see Figure 2). All in all, these results reveal that no significant improvement in spontaneous speech occurred from pretest to posttest for any of the groups.

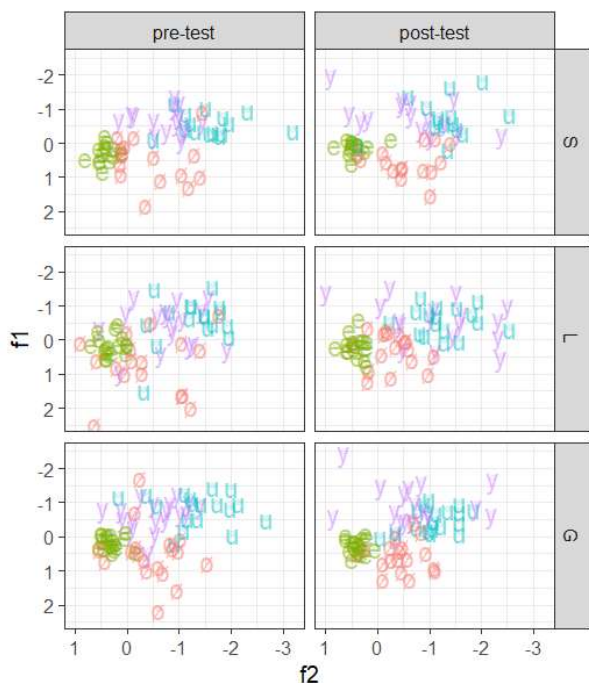


Figure 1: $F1 \times F2$ plot diagrams of the four target vowels at pre-and posttest in the three groups showing vowel overlaps

4. Discussion

The present study aimed at exploring the effect of a three-session prosodic training with or without phrase-level prosodic gestures on L2 learners' pronunciation in a spontaneous speech task. Results showed that training dialogue reading and sentence repetition with speech-only, logatomes, and logatomes and phrase-level prosodic gestures did not have any beneficial effects on spontaneous speech in any of the five measures, namely comprehensibility, accentedness, fluency, and suprasegmental and vowel accuracy.

Our results contrast with previous findings showing positive effects of the same prosodic training with logatomes and phrase-level prosodic gestures for accentedness and suprasegmental accuracy in a dialogue-reading task [6].

Hence, the beneficial effects of such prosodic training with phrase-level prosodic gestures did not transfer from oral-reading and sentence imitation to spontaneous speech. Similarly, our results contrast with the positive effects of prosodic training with speech and prosodic gestures for accentedness, suprasegmental accuracy, and vowel accuracy in both dialogue-reading and imitation tasks [7]. Following the *specificity of skills* hypothesis [37], it may be the case that training reading and imitation may only lead to improvement in those two modalities, at least in the short term. Results may have been different with a prosodic training design involving spontaneous speech itself. Alternatively, a longer or more intense training period may be necessary to trigger learning transfer from one skill to the other, as suggested previously [24]. Furthermore, regarding segmental accuracy, the stimuli in the present study were not designed to improve any specific target segments. For example, the frequency of the target vowels was not incremented as in [7] and the analysis included target vowels produced both in non-prominent and prominent prosodic positions. A qualitative analysis of the vowels in prominent positions at pre- and posttest may reveal different results.

Importantly, this study and many previous studies have tested the effect of gestural prosodic training in laboratory settings or strictly controlled conditions, which are different from a completely ecological classroom environment, where learners may experience higher cognitive demands, as they would not focus solely on pronunciation. For this reason, it is important to continue exploring how prosodic and gestural training may trigger pronunciation improvements in spontaneous speech, which requires the learner to mobilize more cognitive resources.

5. Conclusions

All in all, the present study indicates that three short L2 prosodic training sessions taking place during regular class and involving oral reading of short dialogues and repetitions of sentences from these dialogues in three conditions did not help improve learners' spontaneous speech in none of the conditions. Longer training periods and training materials involving directly spontaneous speech should be tested in order to trigger potential effects of prosodic training on spontaneous speech.

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Table 1: Mean results at pre-and posttest for the three groups in the five pronunciation dimensions.

Condition	Test	Comprehensibility		Accentedness		Suprasegmentals		Fluency		Vocalic features	
		Rating scores				Articulation rate				Pillai scores	
		<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	/y/ ~ /u/	/e/ ~ /ø/
Speech-only	Pretest	7.42	1.01	6.31	1.36	6.80	1.10	3.94	.11	.46	.50
	Posttest	7.04	1.22	6.11	1.31	6.80	1.06	3.86	.11	.16	.68
Logatome	Pretest	7.23	1.11	6.14	1.05	6.98	1.12	4.00	.10	.15	.39
	Posttest	7.39	1.05	6.21	1.22	6.94	1.19	4.06	.10	.02	.56
Logatome +Gesture	Pretest	7.22	1.11	6.39	1.20	6.99	1.07	4.17	.10	.36	.53
	Posttest	7.46	.82	6.55	1.18	7.18	1.10	3.93	.10	.27	.68

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