



## Comparing Instructional Reinforcements in Phonetics Pedagogy

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### Abstract

This study contrasts different instructional reinforcements in the teaching of phonetics, i.e., learning tasks that supplement a classroom lecture on a phonetic contrast. 152 introductory linguistics students were split into four groups, each of which received the same lecture but a different instructional reinforcement, as follows: (1) a baseline textbook-style handout explaining the contrast, (2) classroom production practice, repeating after an instructor in unison, (3) pairwise production practice, in which students practice contrasts and give each other feedback, and (4) watching enhanced ultrasound videos illustrating the contrast [1]. Students were given a quiz evaluating their comprehension of the places of articulation and their perception of the contrast immediately after the activities and again one week later. We found that there were no large differences between the groups. While phonetics learning is argued to be improved through student engagement [2, 3, 4], interactivity [5], and pairwise practice [6], group 4 did not receive any of these but nevertheless performed as well as the other groups. We conclude that reinforcement using non-interactive enhanced ultrasound videos can be as effective as traditional classroom reinforcements at teaching phonetic contrasts.

**Keywords:** reinforcement, ultrasound visualization, multimodal, technology

### 1. Introduction

Despite phonetics having been taught as a discipline in its own right for over 150 years, there is a paucity of research on phonetics pedagogy [5, 7]. There is a widespread sense that phonetics pedagogy should include a practical component, allowing students to gain experience in perceiving and producing sounds [5, 8]. With advances in technology, there have been some studies evaluating the effectiveness of new tools and instructional methods for teaching phonetics [9, 10, 11, 12]. However, to our knowledge there is no research directly comparing

different instructional methods for teaching phonetics. The current study addresses that gap. We compare four different instructional reinforcements, i.e., learning tasks that supplement a classroom lecture on a phonetic contrast. Our research question is: which, if any, type of instructional reinforcement is the most effective for students to learn and retain the contrast?

### 2. Methodology

In this section, we describe the participants, procedure, and materials used in the experiment.

#### 2.1. Participants

152 students enrolled in Linguistics 100 (“Introduction to Language and Linguistics”) at the University of British Columbia participated in the experiment. As there are no prerequisites for the course, we assume the students had no prior experience learning phonetics as an academic discipline. The students were separated into four groups (corresponding to the four conditions), based on the tutorial sections they were enrolled in.

#### 2.2. Procedure

In their tutorial groups (in separate classrooms, but at the same time), the students watched a pre-recorded video lecture on the distinction between voiceless palatal, velar, and uvular fricatives [ç], [x], and [χ], respectively. The video was approximately three minutes in duration, and focused on the place of articulation contrast. The lecturer introduced the names of the articulators and used articulatory diagrams to show the place distinctions between the sounds. Following the lecture, the four groups each received a different instructional reinforcement (all taking approximately five and half minutes) and then they all completed the same quiz. The quiz was given again one week later, with the same questions but presented in a different sequence, in order to test the students’ retention of what they learned. Fewer students completed the second quiz than the first one. Details about the reinforcements and the quiz are given in section 2.3 below.

## 2.3. Materials

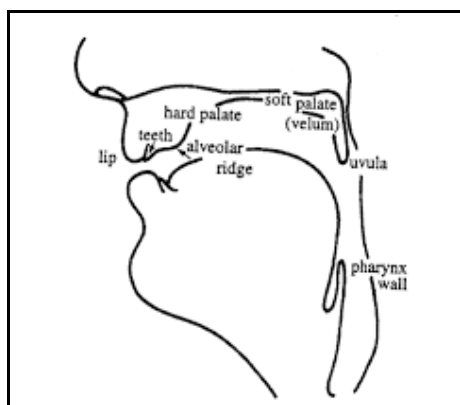
### 2.3.1. Reinforcement Materials

Each group of students received a different instructional reinforcement, as summarized in Table 1 below.

**Table 1:** Instructional reinforcements by group

Group 1	Group 2	Group 3	Group 4
Textbook (baseline) n = 44	Classroom practice n = 43	Pairwise practice n = 21	Ultrasound videos n = 44

Group 1 was instructed to read a textbook-style handout explaining the place of articulation contrast. It included a diagram of the vocal tract with the articulators labelled (see Figure 1), and used prose to reference key terms introduced in the video lesson, such as *fricative*, *palate*, *velum*, and *uvula*.



**Figure 1:** Diagram in textbook-style handout

Group 2 was instructed to mimic in unison an instructor in a “listen-and-repeat” type drill of the variety commonly used in language learning classes [13]. The instructor’s voice was pre-recorded, and the students heard audio recordings with the following message: “repeat the following sound,” followed by the sound of one of the fricatives [ç], [x], or [χ]. The students then produced the sound in unison. This process was repeated for each of the three sounds.

Group 3 was instructed to work in pairs in class to produce the three sounds and give each other feedback on their productions. The instructor (a trained phonetician) facilitated the pairwise practice session.

Group 4 watched a video that used ultrasound visualization technology [1] to illustrate the place of articulation contrast. The video consisted of an introductory segment explaining how ultrasound can be used to learn and visualize speech sounds, as well as three ultrasound overlay segments, i.e., videos

which combine ultrasound images of tongue movements in speech with external profile views of a speaker’s head. Ultrasound overlay videos for each of the fricatives [ç], [x], or [χ] were included; each included a number of iterations of the fricative, produced either with the [a] vowel after the fricative (e.g., [ça]), or with the [a] vowel produced both before and after the fricative (e.g., [açɑ]). Some of the iterations included freeze frames which isolate the articulation of the fricative itself. A screenshot of an ultrasound overlay video is given in Figure 2, and the videos themselves can be viewed at <http://enunciate.arts.ubc.ca>.



**Figure 2:** Ultrasound overlay video screenshot

### 2.3.2. Quiz Materials

The quiz consisted of four multiple choice questions, two of which were designed to test the students’ knowledge about the contrast and two which were designed to test their perception of the contrast. Regarding the knowledge questions, one asked students to identify a sound based on its articulatory description, and the other asked students to identify a sound based on an image of its articulation. The perception questions made use of audio files played during the quiz: one question asked students to identify which place of articulation was used in producing a sound, and the other asked students to identify the correct order in which three sounds were played in sequence.

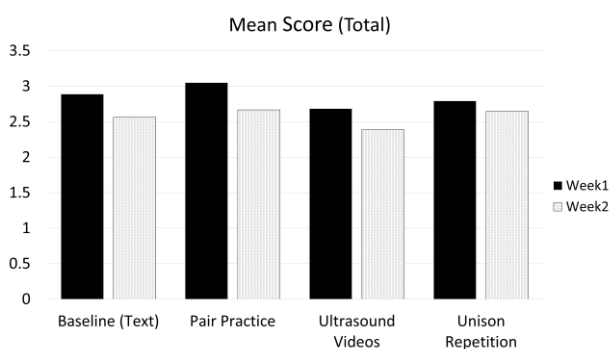
## 3. Results

The mean scores, standard deviations, and number of participants for each group for each week are presented in Table 2 below.

**Table 2:** Quiz results

Condition	Week 1	Week 2
1.Text (baseline)	2.87 (0.92); N=44	2.56 (1.05); N=39
2.Unison repetition	2.79 (1.04); N=43	2.65 (1.17); N=17
3. Pair practice	3.04 (0.92); N=21	2.67 (1.23); N=12
4. Ultrasound video	2.68 (1.2); N=44	2.39 (0.99); N=31

These same results are presented graphically in Figure 3 below.



**Figure 3:** Quiz results

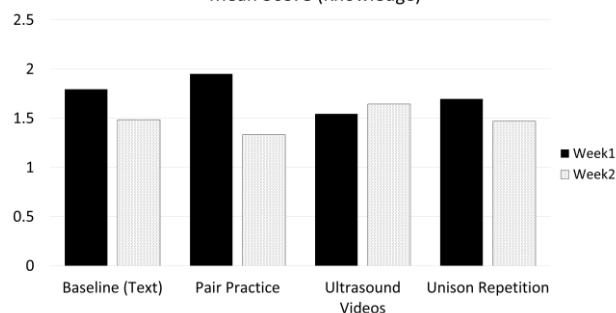
There were no statistically significant differences between the groups in either Week 1 or Week 2 (Week 1 ANOVA:  $[F(3, 148) = 0.665, p = 0.575]$ . Week 2 ANOVA:  $[F(3, 95) = 0.328, p = 0.805]$ ). Group size discrepancies limit the statistical analysis but preliminary results do not show large differences across the four groups.

Overall, the students performed better on the knowledge questions than they did on the perception questions. The mean scores and standard deviations for the knowledge questions are given in Table 3 and Figure 4. As with the pooled results, group size discrepancies limit the statistical analyses. Week 1 ANOVA:  $[F(3, 148) = 0.665, p = 0.575]$ . Week 2 ANOVA:  $[F(3, 95) = 0.328, p = 0.805]$ .

**Table 3:** Quiz results for knowledge questions only

Condition	Week 1	Week 2
1.Text (baseline)	1.795 (0.461)	1.487 (0.683)
2.Unison repetition	1.698 (0.558)	1.471 (0.717)
3. Pair practice	1.952 (0.218)	1.333 (0.778)
4. Ultrasound video	1.545 (0.589)	1.645 (0.551)

Mean Score (Knowledge)



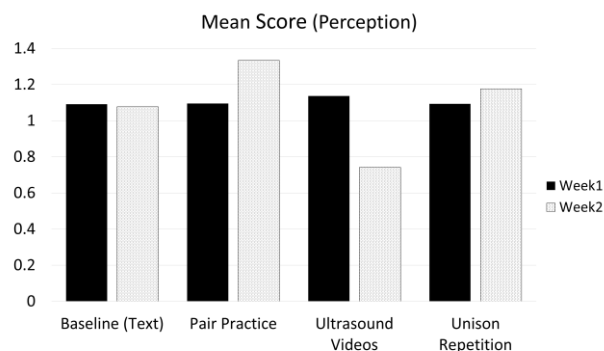
**Figure 4:** Quiz results (knowledge questions)

The only group whose performance improved on the knowledge questions from Week 1 to Week 2 was the group that saw the enhanced ultrasound videos; all the other groups went down in terms of their performance. We speculate that the videos may have sparked their interest in learning more about the sounds in question, which led to them seeking out more information between Weeks 1 and 2.

As for the perception question results, these are given in Table 4 and Figure 5 below.

**Table 4:** Quiz results for perception questions only

Condition	Week 1	Week 2
1.Text (baseline)	1.091 (0.91)	1.077 (0.839)
2.Unison repetition	1.093 (0.868)	1.176 (0.728)
3. Pair practice	1.095 (0.944)	1.333 (0.778)
4. Ultrasound video	1.136 (0.905)	0.742 (0.773)



**Figure 5:** Quiz results (perception questions)

Again, statistical results were not significant (Week 1 ANOVA:  $[F(3, 148) = 0.665, p = 0.575]$ . Week 2 ANOVA:  $[F(3, 95) = 0.328, p = 0.805]$ ). However, we note here a possible tendency in the means that the groups that practiced saying the sounds improved from Week 1 to Week 2 while those that did not have that practice (the baseline condition and the ultrasound video condition) had lower scores on the perception questions in Week 2. We speculate that practicing making the sounds may be of benefit in being able to identify and differentiate between the sounds.

## 4. Discussion

We observe that there were no significant differences between the four groups with respect to their performance on the quiz. Previous research on methods in phonetics pedagogy suggests that factors such as student engagement [2, 3, 4] and interactivity [5] are important aspects of phonetics learning, and that pairwise production practice can also be of benefit [6]. Notably, group 4 received none of these reported advantages, as they passively watched a video without any level of active engagement and interaction.<sup>1</sup> Nevertheless, this group performed as well as the other groups, suggesting that while technology-enhanced learning, such as that involving the use of ultrasound, does not necessarily guarantee improved phonetics learning outcomes, neither does it not hinder learning compared with traditional methods, at least at the scale of the present study. We predict that exposing students to ultrasound-enhanced videos using methods that are engaging and interactive – particularly involving students producing contrasts themselves – would improve their learning outcomes.

## 5. Conclusions

In this study, we compared four different types of instructional reinforcements in teaching a phonetic contrast in an introductory linguistics course. We did not find significant differences between the four reinforcements, but we observed that the group receiving the high-tech reinforcement involving ultrasound overlay videos performed as well as the groups with more traditional classroom reinforcement, despite this reinforcement being neither interactive nor engaging. Based on this finding, we are conducting a follow-up experiment in which ultrasound overlay videos are used as a part of an engaging and interactive instructional reinforcement. We predict that this type of reinforcement will yield improved learning outcomes for phonetics students.

## 6. Acknowledgements

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<sup>1</sup> An anonymous reviewer noted that the number of participants in Group 4 decreased more so than that of the others groups, and speculated that this may point to a lack of interest on behalf of the students. While this may be related to the lack of engagement and interactivity for Group 4, it could also be related to other independent factors. We had no way to control whether the students attended the tutorials each week.