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Effectiveness of Pitch Discrimination Practice Using a Method of Listening for Pitch in a Learner's Own Voice Quality

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Abstract

In order to sing in tune, it is necessary to hear a modeled pitch correctly. However, differences in audibility of pitches may arise depending on different sound sources used as exemplars. Previous studies have reported that when one's own familiar voice is used as a model voice, one is able to sing pitches correctly. In this study, we examined whether learners who were unable to distinguish pitches from voices of others would be able to judge the difference in pitches by using their own voice quality as a model voice. The results showed that learners who could not distinguish all pitches from voices of others were able to distinguish all of them correctly with their own voice quality. We think that difference in vocal range and other factors may have contributed to difficulty in hearing when the model sound was from a voice of another person. When the model was their own voice, all they had to focus on was changes in pitch, making it easier for them to notice differences.

Keywords: Singing, Pitch, Vocal Exercises, Voice Expression, ICT.

1 Introduction

In music education, singing on pitch to achieve harmony is important, rendering accurate pitch discrimination one of the highly valued abilities of singers. Correspondingly, pitch training has garnered significant scholarly interest and attention [1] [2]. In typical singing lessons, learners commonly listen to teachers' demonstrations or audio recordings and mimic their voices to internalize pitch variations [3]. However, some researchers have also highlighted that in some cases, training did not proceed smoothly, for practice merely relies on listening to demonstration sounds and the learners' endeavors [4]. Reference [5] showed that two essential abilities are required for pitch accuracy: accurate pitch perception to identify pitch differences and conscious control over the vocal apparatus to tune with the reference pitch. Therefore, to acquire pitch precision, it is crucial to tailor the pitch exercises to accommodate these two factors [6] [7]. In other words, apart from honing the technique of voice control, it is equally vital to cultivate the ability to discern pitch differences. Furthermore, in an experiment focusing on children who could not match pitch accurately, Reference [8] indicated that different model sound sources

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could in fact impact children's pitch accuracy differently. Specifically, the quality of the sound source can affect their ability to discern pitch differences. In light of this finding, it is worth considering whether adjusting the sound source quality in accordance with learners' vocal qualities can improve accuracy in pitch perception. In the same vein, Reference [9] [10] found that echoing pitch using one's voice enables more accurate pitch production, which can be ascribed to the learners' perceptual acuity in discerning and identifying their vocal qualities. Accordingly, it can be inferred that engaging in pitch discrimination exercises centered on one's voice can enhance precision in pitch discrimination, thereby contributing to a deeper understanding of correct pitch. Therefore, one possible method is to incorporate recording and playback of one's produced sound in pitch discrimination exercises. Obtaining the desired pitches manually, however, may turn out to be a daunting task for trainees in actual practice. Nevertheless, by employing the acoustic system Reference [9] [10] used to produce various tones using one's vocal qualities, individuals who struggle with accurate pitch discrimination in other sound sources can successfully develop the ability to perceive pitch accurately.

2 Research Aims and Objectives

We aim to investigate whether the implementation of an acoustic system that reflects learners' vocal qualities can improve their capacity for precise pitch perception. We will also compare and contrast this conventional method, which mainly relies on the demonstrations of teachers' voices, and the training aided by an acoustic system.

3 Methodology

In this study, we utilize an acoustic system, which allows for pitch adjustments based on individual vocal qualities (hereafter referred to as "Acoustic System") as a methodology tool. Concretely, the system can change the pitch of the audio input coming from the participants' microphones without compromising their natural vocal qualities. The sound might then be replayed for them through their headphones. Participants can compare their pitch production with pitches played back over the headphones, allowing for a thorough analysis of their vocal qualities across various pitch levels [Figure 1].

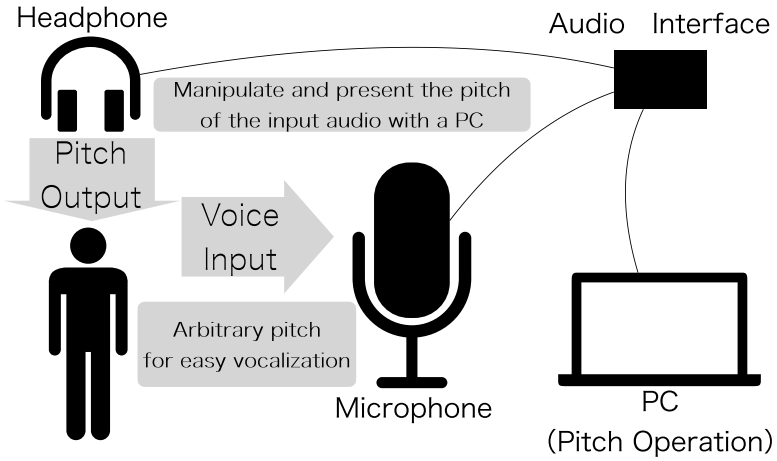

Figure 1: System Diagram

The participants in this study consisted of 20 high school students (12 males and 8 females), who provided informed consent. Notably, none of them had any prior formal musical training. In the beginning, the researcher provided them a preliminary introduction to degrees and music intervals for approximately 10 minutes, followed by a listening exercise in one octave of a major scale. The practice is led by the author, a male music teacher.

The procedure is summarized as follows:

1) The student vocalizes the pitch they find easiest using the vowel sound "a."

2) The student's vocalized pitch becomes the tonic note of the major scale.

3) Using the student's vocalized pitch as the fundamental tone, present either a perfect unison (1st), major third (3rd), perfect fifth (5th), or perfect octave (8th) using one of two pronunciation methods: Method A (pronunciation by the author) or Method B (pronunciation using the acoustic system). Hereafter, the practice using Method A is referred to as "Practice A," and the practice using Method B is referred to as "Practice B." Practice A does not use the acoustic system.

4) The student listens to the vocalized pitch and the presented pitch and identifies the interval between them.

5) Three pairs of intervals were set for the pitch exercises: perfect unison (1st) and perfect octave (8th), perfect octave (8th) and perfect fifth (5th), and perfect fifth (5th) and major third (3rd). We presented each pair of intervals in two patterns, and the student had to choose between the two options.

6) We randomized the order of the pairs of intervals for each student and presented each pair once.

7) The student provided their answers by indicating the interval for each presentation, such as "○ degree the first time and ○ degree the second time."

8) If the answer was incorrect, we repeated the presentation only once. During the repetition, the order of presentation remained the same or was randomly switched.

9) As for the practice sequence, we conducted Practice A first and Practice B second.

10) Each practice session lasted approximately three minutes per student.

We recorded the results of Practices A and B for each subject. In addition, we asked the students to complete a questionnaire before and after the practice. Before the practice, they had to rate their pitch acuity on a scale of 1 to 5, specifically regarding their confidence in their pitch accuracy (Questionnaire 1). Likewise, after the practice, we asked them to rank on a scale of 1 to 5 which practice—the acoustic system or the teacher's demonstrations—they thought was easier and clearer (Questionnaire 2). They could simultaneously share their thoughts, ideas, and feelings on the practices (Questionnaire 3).

4 Research Results

Table 1 shows the practice outcomes and questionnaire results for the two vocalization methods.

The symbol "○" signifies the participants' correct response to the pitch, the "△" signifies the participants 'uncertainty about the response, and the "×" signifies an incorrect response. The answers were assessed by the author, who has experience as a high school music teacher, and subsequently confirmed by the participants. If a student provided an inaccurate response in the first round, we indicate their revised response in the second round in parentheses. Among the twenty high school students in the study, in Practice A, five students (three males and two females) were unable to provide correct answers for certain pitches within the practice time. In Practice B, all students were able to provide correct answers within the practice time. We will compare the results of Practice A for the 5 students (No. 2, 11, 15, 17, 18) who gave uncertain responses "△" or were unable to provide correct answers within the practice time "×" with the results of Practice B.

4.1 Student 2 (female)

This female student claimed to have a strong sense of pitch perception. However, in Practice A, she struggled to differentiate between the perfect fifth and major third. This problem may result from the fact that "male voices were actually harder to discern," as noted in the questionnaire, implying that the differences between males' and females' vocal qualities might compound challenges in perceiving the pitch accurately. In contrast, during Practice B, she successfully identified each pitch and stated that Practice B was generally simpler to understand. This result suggests that, even for those individuals who are confident in their pitch acuity, the disparities between male and female voice ranges could prevent participants perceiving the pitches accurately. In such cases, it could be inferred that the method of echoing the participants' vocal qualities might be effective in improving pitch accuracy.

4.2 Student 11 (male)

This student found assessing his pitch perception skills difficult. He was particularly uncertain about distinguishing between the perfect fifth and major third in Practice A. This result can be juxtaposed with the situations in which many students provided incorrect answers in distinguishing between the perfect fifth and major third, highlighting the difficulty in differentiating these two intervals. On the other hand, in Practice B, he demonstrated an accurate perception of each difference, possibly due to the distinct vocal qualities of the teacher's voice in Practice A, which might be distracting and impair his ability to hear the subtle interval variations. Based on this, we can conclude that by practicing with their echoing voices, the learners who initially encounter such difficulties can eventually develop a keener sensitivity to subtle variations in sound.

4.3 Student 15 (male)

This student, like Student 11 (male), was unable to assess his sense of pitch perception, which was subsequently reflected by his continuous struggle to identify the differences between each interval in Practice A. The reason for this was evident during Practice A because he appeared to struggle with pitch discrimination throughout the practice. Regardless of the pitch combinations, it was apparent that he had difficulty in providing answers. Based on this observation, it is reasonable to suggest that for him, as in the case of student 11 (male), extracting and discerning pitches from other people's voices might compound difficulties, akin to the case of student 11

(male). In contrast, in Practice B, we observed that the student could not only confidently but also accurately respond to the differences in pitches. He also mentioned in the questionnaire that it was considerably simpler to hear and comprehend the pitches in Practice B. Furthermore, he mentioned in the questionnaire that it was "a clear sound" in Practice B. As a result, we may assume that an acoustic system echoing his voice might enable a more stable perception and thus promote direct comparisons, as opposed to the other's voices, which may have pitch fluctuations. We can infer from this result that participants find it easier to distinguish pitches when they listen to their echoes.

4.4 Student 17 (female)

Although this student showed confidence in her ability to perceive pitches, the results revealed that she was unable to distinguish between a perfect fifth and a major third in Practice A. The difficulty in distinguishing the pitches can be related to the differences in voice qualities between males and females, as shown in the instance of student 2 (female). On the other hand, she correctly identified each pitch in Practice B. She also mentioned in the questionnaire that in Practice B, it was significantly easier to hear the sound, highlighting that it allows her to "clearly perceive subtleties of sounds" and "concentrate on distinct differences in pitch." In conclusion, even people who are confident in their ability to recognize pitches might have trouble spotting differences while listening to other people's voices. For these students, echoing exercises that preserve their natural voice quality might be deemed an efficient strategy to improve pitch perception abilities, enabling them to distinguish between pitches with more consistent sounds.

4.5 Student 18 (male)

This student lacked confidence in identifying pitches. He struggled to discern between the perfect fifth and major third in Practice A, resonating with the fact that many students found identifying this combination difficult, especially those who initially had low confidence in pitch perception. Nonetheless, during Practice B, despite identifying one pitch incorrectly in the first round, he was able to make up for it in the second round and correctly identify every pitch. He stated in the questionnaire that Practice B's sounds were easier to hear and that "the computer-generated sound matched my own voice, making it clearer and easier to understand." It may be suggested that practicing with the same vocal quality makes it simpler for people who struggle with pitch perception to understand how it feels when pitches match. In summary, based on the student's actual situation, we can infer that the demonstration sources might influence the difficulty of perceiving pitch differences, indicating that an echoing exercise is an effective training method to cultivate pitch perception skills.

5 Discussion

In this study, we found that with the aid of the acoustic system that reflected the participants' vocal quality, those who had trouble identifying pitches in Practice A were able to identify all pitches successfully in Practice B.

In Practice A, even the learners who had confidence in their pitch accuracy were still unable to identify all differences in pitches accurately, possibly because the demonstration sounds were derived from others' voices, making it difficult to distinguish pitches precisely due to differences

in terms of vocal range and quality.

Furthermore, human vocalization in Practice A might exhibit pitch instability, owing to external factors such as physical conditions and environments. To address such situations, by echoing one's vocal quality, the method of providing stable pitch cues in Practice B offers a clearer and easier alternative. On the other hand, for students who lack confidence in pitch accuracy, Practice B enables them to identify differences in pitch accurately. The main reason is that with their voice as the reference sound, they are better able to focus on the variations in pitch and detect subtle differences. In light of these findings, this study reveals that the practice of echoing one's vocal quality can help learners who have trouble perceiving pitch improve their pitch accurately.

Table 1: The practice outcomes and questionnaire results

Method		The Results of Practice A (Author's Vocal Demonstrations)			The Results of Practice B (The Acoustic System's Reflections)			Questionnaire		
Student / Gender		Interval (Major Scale)			Interval (Major Scale)			① Do you have confidence in your pitch accuracy? (Yes 5, 4, 3, 2, 1 No)	② Which practices– the acoustic system or the vocal demonstrations– was easier to understand? (System 5, 4, 3, 2, 1 Teacher)	③ Reflections on the Practice (Free Description)
		1st / 8th	8th / 5th	5th / 3rd	1st / 8th	8th / 5th	5th / 3rd			
1	Male	○	○	○	○	○	○	1	1	The sound generated by the computer had a peculiar atmosphere, while the teacher's voice felt natural and was very easy to understand.
2	Female	○	○	×	○	○	○	5	4	It was difficult to hear with the men's voice using headphones made it easier to hear.
3	Female	○	○	○	○	○	○	5	4	Unlike me, the teacher had a male voice, so it was easier for me to hear my own voice.
4	Female	○	○	○	○	○	× (○)	5	4	I could clearly hear the harmony in my own voice. When it was someone else's voice, even if the pitch was the same, it was somehow difficult to understand.
5	Male	○	○	○	○	○	○	1	3	There was not much difference between the sound of the computer and the teacher's voice.
6	Male	○	○	○	○	○	○	3	1	The teacher's male voice was incredibly easy to understand even while singing, and it was easy to grasp compared to the mechine-generated voice.
7	Female	○	○	○	○	○	○	3	2	The computer was more difficult to understand because it was my own voice, whereas the teacher's voice was easier to understand.
8	Male	○	○	○	○	○	○	1	3	Both were easy to hear to.
9	Male	○	○	○	○	○	○	3	2	I found the actual human voice easier to understand compared to the mechanical voice.
10	Female	○	○	○	○	○	× (○)	4	2	I felt that it was easier to comprehend the voice coming from a person (the teacher's voice) compared to the sound produced by the machine (computer).
11	Male	○	○	△	○	○	○	3	2	The teacher's voice was clearer in terms of identifying differences in pitch.
12	Male	○	○	○	× (○)	○	○	4	2	The teacher's voice was clear and easy to understand.
13	Female	○	○	○	○	○	○	3	3	Both sounds had distinct differences and can be heared clearly, so I marked "3."
14	Female	○	○	× (○)	○	○	× (○)	2	5	I found it difficult to perceive voice fluctuations in the computer compared to the teacher's voice.
15	Male	△	×	×	○	○	○	3	4	It was a clear sound.
16	Male	○	○	○	○	○	△ (○)	1	1	The teacher's voice was clearer in terms of pitch and easier to understand.
17	Female	○	○	△ (×)	○	○	○	4	5	The computer allowed me to clearly listen to the details, so it was easier to perceive differences in sound.
18	Male	○	○	△ (×)	○	× (○)	○	2	5	The computer provided a clear and understandable match between my own voice and the mechanical voice, making it easier to comprehend.
19	Male	○	○	○	○	○	○	2	1	I felt a bit uncomfortable when listening to my own voice.
20	Male	○	○	○	○	○	○	1	3	Both were equally understandable.

6 Future Work

The results show that employing an acoustic system to echo learners' vocal qualities in pitch perception proves to be an effective approach, particularly for those who initially encounter difficulties in differentiating the pitch when tuning with teachers' voices.

Future work should also include more accurate verification. It is necessary to compare the method using the teacher's voice pronounced from this acoustic system as the sound source with the method using the learner's own voice pronounced from this acoustic system as the sound source. It is necessary to consider whether the effectiveness of the practice is the result of the use of one's own voice or the use of this acoustic system.

Further instruction also requires tailored instruction that accounts for gender variations or particular students' needs. Additionally, it is essential to evaluate learners' auditory perception and singing styles continuously to adapt to various real learning scenarios.

Appendix

We conducted this study with the approval of the Tohoku Seikatsu Bunka University and Tohoku Seikatsu Bunka University Junior College Research Ethics Committee.

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