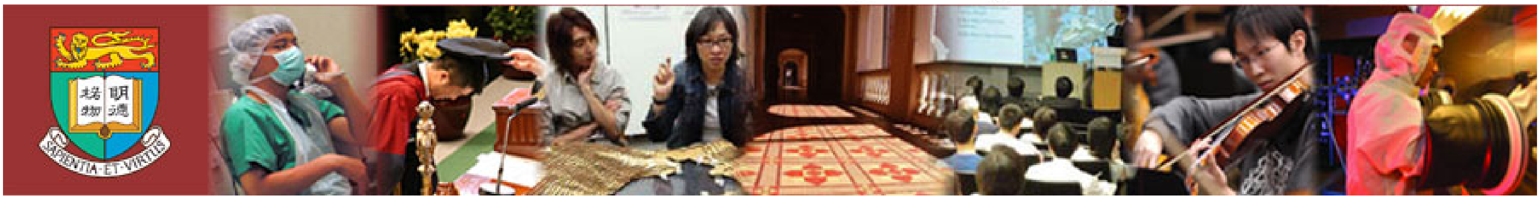

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The Use of Feedback in Training American Listeners to Perceive Cantonese Tones

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Abstract

The present study investigated the effect of feedback in Cantonese tone perception training in naïve listeners. Fifteen male and 15 female Americans without tonal language background were trained to identify 4 Cantonese tones. One group of participants received training with feedback while the other group did not. Significant improvement was found in both groups after training. Feedback group was argued to have better performance due to the faster completion of training session and the success of all participants in completing the whole training program. This result supported Vollmeyer and Rheinberg's (2005) cognitive-motivation process model which emphasized that augmented feedback triggered deeper processing of learning task and guided learners to employ a more systematic strategy that contributed to better performances.

Introduction

Auditory training, a type of training with the provision of auditory stimuli using simple laboratory procedures, had been a commonly used method by different researchers to facilitate perceptual learning in different domains. A number of studies had been carried out focusing on the use of auditory training to assist second language acquisition (Bradlow, Pisoni, Yamada, & Tohkura, 1997; Wang, Spence, Jongman & Sereno, 1999; Wayland & Guion, 2004) and to improve the reliability of perceptual evaluation of voice quality (Chan & Yiu, 2006). Different training methods were used in which discrimination and identification tasks were frequently employed in studies involving second language learning (Wang et al., 1999; Wayland & Guion, 2004). Chan and Yiu (2006) compared the effectiveness of anchoring training and paired-comparison training on perceptual evaluation skills. Stimuli used also vary in which monosyllabic words (Wang et al., 1999), carrier phrases (Wayland & Guion, 2004) and sentences (Chan & Yiu, 2006; Law, 2007) were used. However, the training procedures or any possible factors that would affect the progress of learning had not been systematically investigated and it was unclear which particular training approach was more effective in facilitating perceptual learning. The focus of the present study was to investigate the effect of feedback in tone perception training.

The implementation of auditory training was based on the assumption that humans' perceptual mechanisms were subject to change due to perceptual learning (Goldstone, 1998).

Perceptual learning referred to the long-term improvement in the responsiveness of the perceptual system to the environment (Goldstone, 1998). Based on this hypothesis, a number of auditory training studies were carried out focusing on the effect of training on the identification of segmental distinctions, where Japanese listeners were asked to identify English /r/ and /l/ (Bradlow et al., 1997; Logan, Lively & Pisoni, 1991). The percentage accuracy increased from 78% to 86% (Logan et al., 1991) and from 65% to 81% (Bradlow et al., 1997) respectively after training. Studies regarding the acquisition of supra-segmental contrasts were also carried out, focusing on training English and Chinese listeners to perceive Thai tones (Wayland & Guion, 2004) and American listeners to perceive Mandarin tones (Wang et al., 1999). A significant increase of 21% (from 69% to 90%) was detected in American's Mandarin tones identification after training (Wang et al., 1999). These training studies supported the idea that auditory training facilitated second language learning. However, methods of training were not studied. Only the variability of the phonetic contexts of stimuli and talker's variability were controlled (Logan et al., 1991). Although feedback which indicated the correctness of response was provided throughout the training (Bradlow et al., 1997; Logan et al., 1991; Wang et al., 1999; Wayland & Guion, 2004), its effect on second language learning was not investigated at all. It would be advantageous to identify possible influences caused by feedback on the progress of second language learning.

Feedback was defined as the information provided to learners that verifies the occurrence of learning (Gagne, 1985). The process of learning was described as a loop that was initiated by external environmental stimulation (Gagne, 1985). Feedback, which was either aroused from or provided by external environment, acted as the final closing link of the loop and completed the entire learning process. Feedback could be generated internally by kinesthetic sense, through learners' own observations, or provided by an external source. Augmented feedback, which was the focus of our present study, was the information provided by an external source to enhance the intrinsic feedback generated (Schmidt & Lee, 1999). Knowledge of results, a kind of augmented feedback commonly used in auditory training and studies of second language learning (e.g. Bradlow et al, 1997; Wang et al, 1999), was the information provided to learners regarding the correctness and the extent of correctness of response made to the external stimuli (Gagne, 1985). Magill (1998) mentioned knowledge of results as the information regarding the outcome of skill performing or goal achieving.

Augmented feedback was shown to be effective in promoting the progress of classroom learning and visual learning. Kulhavy and Wager's (as cited in Vollmeyer & Rheinbery, 2005) historical overview suggested that augmented feedback increased motivations of learning, provided information that allowed adjustments of previous response made and increased satisfaction obtained through the learning. Vollmeyer and Rheinbery (2005) used the cognitive-motivational process model and examined the effect of feedback using a biological laboratory task. Learners were told to identify linkages between three medicines and substances found inside human body. The learning task included three rounds. More participants in the feedback group finished the learning tasks in the first round (18) than the no feedback group (8). They confirmed that augmented feedback improved performance, enhanced knowledge acquisition and application. Moreover, they argued that the expectation towards the provision of augmented feedback led to a use of a more effective strategy in learning, rather than unsystematic trial-and-error strategy. Herzog and Fahle (1997) investigated the role of feedback in learning a vernier discrimination task under seven conditions: trial-by-trial feedback; no feedback; block feedback (providing feedback at the end of each block); uncorrelated feedback (trial-by-trial feedback which was uncorrelated to learners' response); partial feedback (providing feedback for half of the response); manipulated block feedback (uncorrelated block feedback) and reverse feedback (correct response was indicated as incorrect). An average improvement of 14.7% was found in participants provided with trial-by-trial feedback while only 2.9% when no feedback was given. A 16.5% and 10.5% improvement were shown in conditions of block and partial feedback respectively. Only 2.8% and 4.3% improvement were shown in participants who received uncorrelated and manipulated block feedback. The study put forward the idea that conditions with correct feedback yielded a larger improvement than conditions with manipulated feedback and no feedback.

Nevertheless, a number of studies doubted the effectiveness of augmented feedback in assisting learning. Steinhauer & Grayhack (2000) pointed out that adverse effect of feedback on performance was observed in a voice motor task of nasalizing a sustained vowel. An increase in the frequency of knowledge of results brought about a decrease in performances (14.08% of constant error in group provided with immediate trial-by-trial knowledge of results, 4.96% in group provided with knowledge of results every another trial and 6.19% in group provided with no knowledge of result). They argued that knowledge of results might be too incorporated into the task that it prevented learners from generating their own inherent feedback. As a result, performances of participants without feedback were better than those provided with feedback in retention (3.60% of variable error in the no feedback group and 7.10% in feedback group) and generalization tasks (14.57% constant error in no feedback group while 25.20% in feedback group). Law (2007) conducted a study examining the effect of feedback on the effectiveness of paired-comparison training of perceptual voice evaluation skills. Naïve listeners were trained to judge if the severity of breathiness was identical in pairs of stimuli provided. One group received feedback during training while the other group did not. Both groups showed significant differences of performances between the pre-training (feedback group: 69.25%, no feedback group: 69.33%) and post-training sessions (feedback group: 79.43%, no feedback group: 75.25%). Both training with and without augmented feedback were found to be effective. Listeners could be easily exposed to the voice quality -

breathiness in daily life situations. The intrinsic feedback generated might already be enough for building up internal standards for severity. Augmented feedback might thus be less useful and resulted in the lack of difference between groups. Effectiveness of feedback on perceptual voice learning remained controversial. Besides, these studies mainly focused on motor learning (Schmidt & Wulf, 1997; Steinhauer & Grayhack, 2000), perceptual voice learning (Chan & Yiu, 2006; Law, 2007) and visual discrimination (Herzog & Fahle, 1997). Focus was not put on the effect of feedback on speech training. The present study was hence inspired to examine if feedback facilitated learning and its effect on speech training.

Several studies were done focusing on training native English speakers to perceive Mandarin tones (Shen, 1989; Wang et al., 1999). However, acquisition of Cantonese tones was not investigated. Both Cantonese and Mandarin are tonal languages in which lexical meanings are marked by tone contrasts. Cantonese is more complicated than Mandarin in terms of tone levels and tone contours. Combinations of three tone levels (high, mid and low) and three tone contours (level, rising and falling) result in six contrastive tones in Cantonese (Fok-Chan, 1974). Yet, there are only four tones in Mandarin, namely high level, high rising, low dipping and high falling (Chao, 1984, as cited in Wang et. al, 1999). Different training outcomes might be obtained due to the difference in two languages. Based on the principles of learning of Goldstone (1998), it was hypothesized that repeated presentation of tokens with different tones might direct listeners’ attention towards the difference in tone among stimuli.

Listeners would thus be able to develop internalized receptors for different tones and finally be able to distinguish tones in Cantonese. This study applied Goldstone's (1998) principles to auditory modality to investigate the effect of feedback through training American listeners to perceive Cantonese tones and to see if the effect of feedback could be generalized to novel stimuli. It was hypothesized that participants provided with feedback would yield a greater improvement than those without feedback. American listeners were naïve towards tone perception due to the absence of these supra-segmental contrasts in their native language. Augmented feedback was assumed to be necessary to complement rather than to inhibit the generation of intrinsic feedback to develop self-reference of tone perception.

Method

Participants

Fifteen men and 15 women with mean age of 21.2 years (SD=1.32 years; range = 19-26 years) who had met the following criteria: 1) native speakers of American English, 2) had no history of speech and hearing impairments and 3) no tonal language background, were selected in this study. Participants were randomly assigned to two gender-balanced groups: the feedback group (seven males and eight females) and the no feedback group (eight males and seven females). All of them were students studying in a University in USA. All were paid for their participation.

Stimuli

The stimuli were a Cantonese carrier phrase embedded with different monosyllabic words of four different tones (high level (55) – Tone 1, high rising (35) – Tone 2, low falling (21) – Tone 4 and low rising (23) – Tone 5). A carrier phrase ‘This word is x’ was chosen so that the target tone could be produced in a more realistic way which resembled natural conversation. Only four Cantonese tones were chosen to reduce the degree of difficulty for the listeners. The monosyllabic words embedded were chosen to have combinations of different initial and final consonants, vowels, and different syllabic structures (CV, CVV, CVC) to ensure a large variety in context (Posner & Keele, as cited in Logan et al, 1991). A total of 80 monosyllabic words were included: 40 words for training (10 for each tone) and 40 words for testing generalization (10 for each tone) (Appendix A).

All stimuli were recorded from one female Cantonese speaker. The stimuli were recorded and digitized using a professional sound card and microphone in a soundproof booth in the Division of Speech and Hearing Sciences of the University of Hong Kong. Each phrase was recorded three times. Phrases with noticeable perceptual problems like roughness, pitch break and decrease in volume were not chosen. The best phrase with comparative loudness, speech rate and tone was selected out of the three as the stimuli.

The stimuli recorded were judged by three native Cantonese speakers (two female and one male) before the stimuli were included in testing in order to ensure the accuracy of stimuli. Listeners were asked to identify the tone of the word. A list of all six Cantonese tones was presented during the listening task. The listeners had accuracies of 98.1%, 99.4% and 100% respectively. All recorded stimuli were included in the study.

Procedure

The study consisted of a pre-test session, a training session and a post-test session. All sessions were carried out in the USA. The pre-test was carried out immediately before the training session on the same day, and the post-test was conducted one day after the training session. A computer-based program, E-prime (Psychology Software Tools, Pittsburgh, PA), was used for presentation of stimuli and collection of response. Stimuli were presented binaurally using headphones at appropriate sound level (approximately 60dB). Listeners were instructed to indicate their response by pressing the number keys on the keyboard which corresponded to the four Cantonese tones chosen in this study. All sessions were carried out in sound treated booth. A printed hardcopy of an introduction and definitions of the four Cantonese tones was given to the participants before the test as reference (Appendix B).

Pre-test

All participants took the pre-test. They were required to identify the tone of the target word out of four choices. In each trial, the carrier phrase was presented twice before participants were prompted to respond. Eighty monosyllabic words (40 trained and 40 untrained) were embedded into the carrier phrase. Each word was tested twice, yielding a total of 160 trials. Words were randomized and presented with an inter-trial-interval of two seconds. Two practice trials were provided before the start of test to familiarize participants with the testing procedure. No feedback was given. The pretest lasted about 20 minutes.

Training session

The training session was carried out immediately after the pre-test. Both groups participated in the training session. The feedback group was provided with feedback after each trial, with text indicating if the answer was correct or not. Feedback was not given to the no feedback group. All participants were asked to identify the tone of the stimulus presented. The training program consisted of a total of seven blocks with increasing difficulty. In each of the first six blocks, only two tones were targeted (i.e. Tone 1 and Tone 4, Tone 1 and Tone 5, Tone 2 and Tone 4, Tone 1 and Tone 2, Tone 4 and Tone 5, and Tone 2 and Tone 5). For both groups, a two-alternative identification task was used in which participants were presented with one stimulus in each trial and they were requested to select the correct tone from two given choices. Contrast of tone height (high and low), tone contour (rising and falling) and both tone height and contour could be found within these tone pairs. A total of 20 monosyllabic words (10 for each tone) were included in each block. Each word was repeated twice, resulted in a total number of 40 trials in each training block. The last training block which consisted of words of all four tones (40 trials: 20 words in total, 5 for each tone, each token repeated twice). The participants were asked to identify the tone of the targeted word out of four choices. Tones to be trained were introduced once at the beginning of each training block. A training criterion of 60% accuracy was set for the first six training blocks. The training block would automatically be carried out again if the criterion could not be reached. No training criterion was set for training block 7. Participants were allowed to take a short break at the end of each training block. The training session lasted approximately one hour and 15 minutes. Participants who failed to complete the training session within three hours were removed from the study. They did not have to return for post-test.

Post-test

All participants who completed the training session took the post-test one day after the training session, in which the procedures and stimuli used were identical to the pretest.

Data analysis

Independent t tests were used to compare the performances of the trained and novel stimuli in the pre-test and post-test to investigate the effect of feedback on generalization. Due to the imbalanced number of participants who completed the study in the two groups: feedback group (15 participants) and no feedback groups (10 participants), non-parametric tests were used to analyze the effect of training and feedback. The Wilcoxon Signed-Ranks Tests were used to investigate the effects of training within the feedback group and the no feedback group. The Mann-Whitney U tests were used to determine if significant difference occurred in the pre-tests and post-tests between the feedback and the no feedback group.

Results

A training criterion of 60% accuracy was set in the first six training blocks. All 15 participants in the feedback group completed the whole training session. However, only 10 participants in the no feedback group were able to finish the whole training session. Five participants failed to reach the training criterion of 60% accuracy after attempting a number of cycles. Four participants terminated their training session in training block 4 (Tone 1 and Tone 2). Among these four participants, three repeated the training block four times and one repeated the training block nine times before they gave up. One participant terminated the training session in training block 6 (Tone 2 and Tone 5) where 12 cycles were attempted. Data obtained from these participants who failed to complete the whole training session were not included in the statistical analysis.

Generalization Effect (Trained vs Novel stimuli)

The mean accuracy and standard deviation in identifying the tones of the trained and novel stimuli in different tests was shown in Table 1. Novel stimuli were included in the pre-tests and the post-tests. The effect of generalization could be obtained by making comparison between the data of the trained stimuli and the novel stimuli.

Two independent t tests were carried out: one for comparing the performance in the pre-test and one for those obtained in the post-test. No significant difference was found between the performance of the trained and novel stimuli in the pre-tests ($t(48) = 0.076$, $p = 0.94$), as well as in the post-tests ($t(48) = 0.097$, $p = 0.92$). Generalization effect occurred as comparable mean accuracies were obtained from the trained stimuli and the novel stimuli in the post-test. This implied that the tone identification skills acquired in the training session could also be transferred and utilized when stimuli not included in the training session were presented. As no significant difference could be shown, responses for the trained and novel stimuli were collapsed for further analysis.

Table 1. *Mean Accuracy and Standard Deviation in Identifying the Tones of Trained and Novel Stimuli Across Tests*

		Mean Accuracy (%) (SD)	
Group	**N**	**Trained stimuli**	**Novel stimuli**
		Pre-test	
F	15	51.75 (17.24)	50.26 (16.76)
NF	10	47.88 (15.94)	49.25 (14.72)
		Post-test	
F	15	62.25 (20.21)	62.25 (22.95)
NF	10	61.13 (16.09)	59.75 (20.15)

F = feedback group that received feedback in training session, NF = no feedback group that received no feedback in training session, N = number of participants

Training Effect (Pre-test vs. Post-test data)

The mean accuracy and standard deviation in identifying the tones in the pre-test and post-test was shown in Table 2. Comparison between the pre-test and the post-test of each group demonstrated if training was effective in improving tone perception ability in each condition (when feedback was provided and was not provided). Two Wilcoxon Signed-Ranks Tests were carried out to investigate the training effect within each group by comparing the performance of the pre-test and post-test of the feedback and no feedback group . Significant improvement was found in the feedback group (Z = -3.41, 2-tailed, p = 0.001), as well as in the no feedback group (Z = -2.70, 2-tailed, p = 0.007). 11.79% increase in mean accuracy between the pre-test and the post-test of the feedback group was obtained while the no feedback group yielded 11.69% increase in mean accuracy.

Feedback Effect (data of feedback group vs. data of no feedback group)

Performances in the pre-tests and the post-tests between the two groups were compared using two separate Mann-Whitney U tests to investigate the effect of feedback on training. Effect of feedback occurred if difference could be obtained between the performances of the post-tests between groups. No significant difference could be found between the two groups in both the pre-tests ($p = 0.74$) and the post-tests ($p = 0.82$). Difference of mean accuracy between the two groups was 1.71% in the pre-tests while 1.81% difference was found between the post-tests. Results of statistical analysis suggested that training with or without the provision of augmented feedback contributed to improvement in tone perception ability. No difference in the degree of improvement of performances between groups could be found.

Table 2. *Mean Accuracy and Standard Deviation of Tone Identification in the Pretests and Post-tests*

		Mean Accuracy (%) (SD)	
Group	N	Pre-test	Post-test
Feedback	15	50.46 (16.58)	62.25 (21.33)
No Feedback	10	48.75 (14.81)	60.44 (17.87)

N = number of participants

Retention Effect (Block 7 vs. Posttest data)

Table 3 illustrated the performances of tone identification of the two groups in training block 7 and the post-tests. Trained stimuli of all four tones were included in training block 7. It could act as an immediate post-test directly after the training session. The post-tests were carried out one day after the training session. Retention of tone perception ability could thus be measured comparing the performance in training block 7 and the post-tests. Wilcoxon Signed Ranks Tests were carried out comparing the performances in block 7 and post-tests for each group. No significant difference was found in the feedback group ($Z = -2.24$, $p =$

0.025) as well as in the no feedback group (Z = -2.25, p = 0.052). Mann-Whitney U tests were used to investigate if significant group differences occurred in the performances in training block 7 and post-tests. No significant group differences were found in the performances in training block 7 (p = 0.76), as well as in the performance in the post-test (p = 0.82). The mean percentage decrease between block 7 and post-test was 6.75% in the feedback group while 6.83% decrease was obtained in the no feedback group.

Table 3. *Mean Accuracy and Standard Deviation of Tone Identification in Training Block 7 and the Post-tests*

		Mean Accuracy (%) (SD)	
Group	N	Training Block 7	Post-test
Feedback	15	69.00 (19.31)	62.25 (21.33)
No Feedback	10	67.27 (19.83)	60.44 (17.87)

N = number of participants

Mean accuracy obtained of both groups in each training block

The mean accuracy and standard deviation of the tone identification performances of the two groups in each training block was shown in Table 4. The table indicated the difference of performances of participants in both groups in each training block. Comparable accuracy was obtained in the two groups. An overall mean accuracy of 82.57% was obtained in the feedback group. Mean accuracies of over 80% were obtained in each block until training block 6. On the other hand, an overall mean accuracy of 79.49% was found in the no feedback group. A drop of accuracy lower than 80% was found in training block 4.

Table 4. *Mean Accuracy and Standard Deviation of Tone Identification in Each Training Block*

Mean Accuracy (%) (SD)								
Group	N	Block1 (T1, T4)	Block 2 (T1, T5)	Block 3 (T2, T4)	Block 4 (T1, T2)	Block 5 (T4, T5)	Block 6 (T2, T5)	Blk7 (T1, T2, T4, T5)
Feedback	15	87.50 (12.10)	87.17 (11.01)	88.50 (12.17)	86.50 (11.17)	85.33 (12.71)	74.00 (10.60)	69.00 (19.31)
No Feedback	15	85.47 (11.52)	83.13 (13.74)	87.97 (12.36)	75.47 (22.01)	86.67 (14.97)	70.42 (8.03)	67.27 (19.83)

T = tone, N = number of participants

Time Effect (learning time – number of cycles taken in each block)

Table 5 demonstrated the percentage of participants in the two groups who passed the training blocks within 1 or 2 cycles. A passing criterion of 60% accuracy was set for the first six training blocks. Data of the table demonstrated the effect of feedback in assisting participants successfully accomplish the whole training session by achieving accuracy higher than 60% within a short period of time in each block. The feedback group was found to have relatively higher percentages of participants succeeded in passing the training blocks within 1 to 2 cycles. Percentage of the no feedback group was found to drop in training block 4 while that of the feedback group remained high (80%) at the final block with highest difficulty.

Table 5. *Percentage of participants who passed the training blocks with 1 or 2 cycles*

Group	N	Block1 (T1, T4)	Block 2 (T1, T5)	Block 3 (T2, T4)	Block 4 (T1, T2)	Block 5 (T4, T5)	Block 6 (T2, T5)
Feedback	15	100%	100%	100%	100%	93.30%	80%
No Feedback	15	93.33%	93.33% +	93.33%	66.67% *	73.33%	40.00% #

T = tone, + = 9 cycles were attempted by one participant to pass the training block, * = 9 cycles were attempted but the participant still failed to pass the training block, # = One participant attempted 12 cycles but still failed to pass the training block

Discussion

The study was conducted to investigate the effect of augmented feedback on tone perception ability through auditory training. Native American listeners were asked to identify Cantonese tones before and after auditory training. It was demonstrated that the perception of Cantonese tones could be improved using simple auditory training task (two-alternative identification task) in both the feedback group and the no feedback group. Generalization effect could also be observed in listeners' performance of identifying novel stimuli. Retention effect was measured by comparing the tone identification performances of listeners immediately after the training session and one day after the training session. Each type of effects would be discussed in details in the following sections.

Training effect and feedback effect

One objective of the present study was to determine if augmented feedback facilitated auditory perceptual learning. Significant improvement after training was observed in both the feedback group and the no feedback group (Table 2). Improvement was shown in both the trained and novel stimuli (Table 1). Results suggested that both training with and without augmented feedback were effective in facilitating tone perception ability of naïve listeners. No significant differences could be found between the two groups in the pre-tests and post-tests. It appeared that training with or without augmented feedback contributed to the same degree of acquisition. However, attention should be paid on the number of participants who succeeded in completing the whole training session. Participants were required to achieve an accuracy of 60% or above in the first six training blocks in order to go to the next training block. The failed block would automatically repeat if the criterion was not reached. It should be noted that five participants in the no feedback group failed to accomplish the whole training session due to the inability of meeting the 60% passing criteria of training blocks after several number of cycles attempted (a maximum of 12 cycles, Table 5). As these lowest accuracies obtained by these participants were not included in the data analysis procedures, performances of the no feedback group could have been overestimated. Furthermore, participants in the no feedback group had relatively lower percentage of accuracy in training block 4 than those in the feedback group, where four participants failed to pass the block after repeating the block for a maximum of 9 times (Table 4 and 5). On the other hand, the mean percentage accuracy of the feedback group remained over 80% until training block 6. The average percentage of participants who finished a training block within 1 to 2 cycles in the feedback group was 95.55% (100% for the first four blocks) whereas it was obviously lower, with only 76.67% for the no feedback group (Table 5). Feedback contributed to a better degree of acquisition.

On the whole, the hypothesis that feedback improved performance was supported by the results of faster completion of training blocks, as well as the successful completion of the entire training program of all participants in the feedback group. Tones were generally considered as difficult for native English speakers to acquire (Shen, 1989; Wang et al., 1999) due to the absence of these supra-segmental contrasts in their native language. According to Schmidt and Lee (1999), the intrinsic feedback generated by learners' own effort should work along with an already learnt reference of correctness so as to detect errors of performances. Native English speakers without tonal background had never been exposed to tones prior to this training program. As a result, no self reference of the classification of tones could be generated. Without such a reference of rightness, inherent feedback alone would not be sufficient and efficient enough in identifying errors in the performance of tone identification tasks. These resulted in the incapability of several participants in the no feedback group in reaching the training criteria and finishing the whole training session. Alternatively, knowledge of results supplemented the intrinsic feedback to build up an internal representation of correctness for participants to refer to. Learners could be confident towards the correctness of response made when it was indicated to be correct. Amendments could also be made accordingly when response made was told to be inaccurate and resulting in better performances in the feedback group. The representation was built up in a faster way than with intrinsic feedback alone and it was enhanced upon each correct trial in tone identification. These contributed to the success of the feedback group in completing the whole training session by achieving accuracy higher than the training criteria.

In addition to building up of internal representation of correctness, Kulhavy and Wager's (as cited in Vollmeyer & Rheinbery, 2005) idea of augmented feedback acting as a motivator of learning was also consistent with the current findings in the present study. Based on the data obtained concerning the percentage of participants who passed the training blocks within one to two cycles, we were able to assume that participants in the feedback group were generally more alert and motivated towards accomplishing the tasks. Being informed with the accuracy of response made, they were more willing to put more effort such that they completed the whole training session within a shorter time than those of the no feedback group. Satisfaction gained upon correct identification enhanced motivation towards learning. The data could also be analyzed using Vollmeyer and Rheinbery's (2005) cognitive-motivational process model. The cognitive-motivational process model suggested that incentive for paying more effort to task would be enhanced through the provision of knowledge of results which allowed people to realize how well they performed. The information would trigger learners to think thoroughly towards the task structure, resulting in using a more systematic and effective strategy to cope with tasks. This explained the reason why participants in the feedback group demonstrated a faster completion of training session than those in the no feedback group.

Generalization Effect (Trained vs Novel stimuli)

The second objective of the present study was to investigate whether the effect of feedback, if any, could be generalized to untrained stimuli. Improvements were found in both trained and novel stimulus in both training groups. No significant difference was found between the performance of the trained and novel stimuli in the pre-test (t (48) = 0.076, p = 0.94), as well as in the post-test (t (48) = 0.097, p = 0.92). The feedback group demonstrated similar generalization effect to the novel stimuli as the no feedback group. The result disagreed with the idea proposed by Steinhauer & Grayhack (2000) that better performances in generalization tasks were expected from those participants not provided with feedback. Their idea that knowledge of results prevented learners from generating and attending to their own inherent feedback was not supported. In this present study, stimulus variability, instead of the effect of feedback, might have contributed to the comparative generalization effects noted in both groups. Stimuli with a large variety in context ,which involved combinations of different initial and final consonants, vowels, and different syllabic structures (CV, CVV, CVC), were used throughout the whole training program. By presenting a large number of stimuli of Cantonese tones in different phonetic contexts, naive American listeners could be exposed to a full range of acoustic-phonetic cues which demonstrated the characteristics of each Cantonese tone across different phonetic environments (Logan et al, 1991). These cues helped listeners recognize and identify Cantonese tones across different phonetic contexts and assisted identification of novel stimuli in generalization tasks. The result supported the idea put forwarded by Posner and Keele's (as cited in Logan et al, 1991) study on the classification of visual stimuli. They suggested that better performances in novel stimuli were obtained in the group that was provided with high-variability stimuli during training than the group provided with low-variability stimuli.

Retention (Block 7 vs. Post-tests data)

Training block 7 consisted of words of all four tones. Participants were asked to identify the tone of the targeted word out of four choices. As trained stimuli of the four tones were included in training block 7, it could act as an immediate post-test straightly after the training session testing the performance of tone identification when stimuli of four tones were provided at a time. The post-tests were carried out one day after the training session. A comparison between the performance in training block 7 and the post-test illustrated the participants' ability to retain the learned skill in tone identification. No significant difference could be obtained comparing the performances of training block 7 and post-tests within each group. No significant group differences were found in the performances in training block 7, as well as in the performance in the post-tests. These results did not support the guidance theory proposed by Schmidt and Wulf (1997) which emphasized the idea that poorer outcomes in generalization and retention tasks would be resulted if augmented feedback was provided during practice. They suggested that knowledge of result was considered to have guidance functions, assisting learners making proper responses. Learners relied deeply on augmented feedback and became less capable in processing intrinsic information generated, which was crucial in generalization and retention tasks. Nevertheless, results obtained by the present study revealed that performances of both groups in training block 7 and post-tests were similar. Attention should also be put on the fact that the data of the five participants in the no feedback group who failed to finish the whole training session could not be obtained. Possibility of overestimating the performances of the no feedback group existed. The feedback group could have performed even better than the no feedback group in generalization and retention tasks.

Clinical implications

The result of this study suggested that the provision of augmented feedback contributed to better improvement in tone perception ability in naïve listeners. This was supported by the faster completion of training blocks, as well as the successful completion of the entire training program of all participants in the feedback group. Augmented feedback supplemented the intrinsic feedback generated by learners to build up a reference of correctness to refer to (Schmidt & Lee, 1999). As a result, augmented feedback could effectively assist the learning of Cantonese as a second language in which it helped learners develop internal standard of tones classification that was originally absent.

Limitations and further studies

Several limitations of the present study were identified. The effect of frequency and different distribution of feedback on training could not be examined due to the use of concurrent feedback along training session. Schmidt and Lee (1999) pointed out that a gradual decrease of feedback would enhance knowledge acquisition. Steinhauer & Grayhack's (2000) study suggested that adverse effect on performance was observed in which an increase in the frequency of knowledge of results brought about a decrease in performance. Further studies should be carried out focusing on the effect of frequency and distribution of feedback on tone perception training to find out how these factors of feedback affect the acquisition of tone perception ability. Moreover, some participants were found to have obtained high accuracy in the pre-tests, provided that they had no tonal background. Music background was suspected to be one of the contributing factors towards high accuracy attained. Schon, Magne and Besson’s (2004) research on the effect of music training on pitch processing on music and language concluded that perception of pitch contour in spoken language could be facilitated by extensive musical training. Further studies could be done investigating how music background influences the acquisition of tone perception ability.

Conclusion

In summary, significant improvement after training was observed in naïve listeners’ ability in tone perception, in both the feedback group and the no feedback group. However, the overall performance of the feedback group was concluded to be better, due to the faster rate of completion of training blocks, as well as the number of participants who successfully completed the whole training program. This result supported the cognitive-motivation process model proposed by Vollmeyer and Rheinberg (2005) which emphasized that augmented feedback triggered deeper processing of learning task and led learners to employ a more systematic strategy that contributed to better performances during training. The result was not consistent with the guidance theory which suggested performance in generalization and retention tasks in the feedback group would be poorer than that of the no feedback group.

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Appendix A

Stimuli lists

Trained stimuli

	Syllabic Structure	Transcription	Tone 1	Tone 2	Tone 4	Tone 5
1.	CV	fu	夫	苦	扶	婦
2.	CV	$ts^hɔ$	初	楚	鋤	坐
3.	CVV	mui	妹	梅	霉	每
4.	CVV	ŋɐu	勾	嘔	牛	偶
5.	CVV	$k^hɐi$	畸	棋	奇	企
6.	CVV	p^hei	披	鄙	皮	被
7.	CVC	sœŋ	傷	想	常	上
8.	CVC	lIŋ	拎	擰	零	領
9.	CVC	wan	彎	玩	還	挽
10.	CVC	jyn	淵	宛	圓	遠

Untrained stimuli

	Syllabic Structure	Transcription	Tone 1	Tone 2	Tone 4	Tone 5
1.	CV	tsƐ	遮	者	姐	這
2.	CV	ji	衣	椅	兒	耳
3.	CVV	tʰɔi	胎	枱	台	怠
4.	CVV	lou	撈	佬	勞	老
5.	CVV	sœy	衰	水	誰	緒
6.	CVC	kwʰɐn	坤	菌	裙	kwʰɐn5
7.	CVC	hɔn	刊	罕	寒	捍
8.	CVC	mɐn	蚊	文	民	敏
9.	CVC	fan	翻	反	凡	販
10.	CVC	tsʰuŋ	衝	寵	蟲	重

Appendix B

Definitions of Tones

Tone 1	Tone 2	Tone 4	Tone 5
High level	High rising	Low falling	Low rising