Effects of Practice Variability on Learning of Relaxed Phonation in Vocally Hyperfunctional Speakers

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Summary: The present study investigated the effects of practice variability on the learning of relaxed phonation using a motor learning perspective. Twenty-one individuals with hyperfunctional voice problems were evenly and randomly assigned to three groups of practice conditions: constant, blocked, and random practice conditions. During training, participants in the constant practice condition were asked to read aloud sentence stimuli with four Chinese characters. Participants in the blocked practice condition were asked to read aloud sentence stimuli with increasing sentence length, starting from sets of two characters to five characters. Participants in the random practice condition were asked to practice reading sentence stimuli of variable length from two to five characters presented in a random fashion. Surface electromyographic feedback (sEMG) from the thyrohyoid muscle site was given to each participant after reading every two sentence stimuli. Results demonstrated that for all the participants, voice motor learning was evidenced by the decreased sEMG levels in delayed retention test. Generalization to untrained passage was shown as well. However, results did not reveal any difference in the learning among the three practice conditions. The findings from the present study did not support the hypothesis of contextual interference, which states that practice using variable items presented in a random mode is more beneficial to learning than practice using constant items.

Key Words: Variable practice–Voice motor learning–Dysphonia–Contextual interference–Surface electromyography (EMG).

INTRODUCTION

Hyperfunctional voice disorders can be characterized by the use of excessive laryngeal muscle tension during phonation.[1] Voice training that aims at reducing muscle tension in perilaryngeal area during phonation (or, relaxed phonation) has been widely accepted as an effective approach for treating hyperfunctional voice disorder.[2] During the voice training, motor learning is involved because dysphonic individuals learn new skills in adjusting and coordinating their phonatory organs through practice so that they can phonate effectively with minimal effort.[3] Motor learning is defined as a set of processes that results in relative permanent changes in movement capabilities after practice or experience.[4] Therefore, learning should be assessed using long-term follow-up performance rather than performance during training. Long-term follow-up performance can be evaluated using retention tests and generalization transfer tests with novel, untrained stimuli.

The literature has documented different learning parameters that can affect how individuals learn a motor skill. One of these parameters is practice variability. It refers to the different variety of movements and context characteristics the learner experiences when practicing a motor skill.[5] It is argued that practicing a motor skill under various conditions can provide learners with a wider range of movement experiences.[6] Three practice conditions have been frequently used in the motor learning literature. They are constant, blocked, and random practice. Constant practice involves practicing a motor skill under one condition.[7] Blocked practice involves practicing a skill under different conditions that are arranged in a fixed sequence.[6] Random practice involves practicing a skill under different conditions. Unlike blocked practice, the conditions in random practice are arranged in a random order.[7]

Contextual interference has been used to explain the effects of practice variability on motor learning. Contextual interference refers to the disruption effects on motor performance and motor learning that are caused by various practice conditions of a motor task. Practice under conditions with high contextual interference (as in random practice condition) results in better retention and transfer performance than practice under conditions with low contextual interference (as in constant practice condition). Currently, there are two different hypotheses proposed to account for the type of cognitive processing that contributes to the effects of contextual interference: Elaboration Hypothesis[8] and Forgetting and Reconstruction Hypothesis.[9] Shea and Morgan[8] first put forward the Elaboration Hypothesis. It suggests that practice under variable conditions arranged in a random fashion provides learner with the opportunities to compare and contrast the variations of the motor learning skills. This comparison and contrast process facilitates the learner to develop richer mental representations of the motor skills and establish more distinct memories than those in constant and blocked practice conditions. As a result, the comparison process during random practice conditions promotes retention and transfer. On the contrary, constant and blocked practice conditions allow individuals to bypass the comparison process because of the repetitive nature of the task. Therefore, the omission of the comparison process leads to better performance of motor skills during acquisition phase in constant and blocked practice conditions, but the retention and transfer tests that require individuals to undergo more comparisons fail to show such improvement.

Lee and Magill[9] proposed another hypothesis called the Forgetting and Reconstruction Hypothesis to explain the effects of

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practice variability. This hypothesis states that while learning a motor skill, the learner is required to temporarily forget the previous motor trial from the working memory so that the following trials can be planned, reconstructed, and executed effectively. Blocked practice condition omits the "forget and reconstruct" process, which enables the learner to remember the previous motor learning skills and the movement is maintained in the working memory across the block of practice trials. Therefore, blocked practice condition promotes good performance in acquisition. In contrast, random practice condition involves practicing different motor trials, which are arranged in a random sequence, which constantly requires the learner to undergo the "forgetting and reconstruction" process. As practice proceeds, continuous reconstruction skills have been developed through a trial-to-trial basis, and such reconstruction skills facilitate good performance in retention and transfer.

In the field of sport sciences, there have been a number of studies that investigated the effects of contextual interference on motor learning. Shea and Morgan[8] compared two groups of participants' response time in a tennis ball grasping task, with each group engaging in either a blocked or a random practice condition. Each participant was required to perform three tasks in the acquisition phase and each of the tasks required the participants to perform the following actions as quickly as possible: (1) release a start button after either a blue, red, or white stimulus light for each of the task; (2) grasp the tennis ball; and (3) use the tennis ball to knock down three freely moveable, designated barriers in a predetermined order (i.e., knocking the barriers at the right rear, left middle, and right front for the first task; right front, left middle, and right rear for the second task; and left front, right middle, and left rear for the final task). Each participant was required to undergo 18 practice trials for each task, so that a total of 54 trials were accomplished. The participants in the blocked practice group completed the first task before practicing the second and the third tasks, whereas the participants in the random practice group practiced the three tasks which were arranged in a random fashion. The results showed that participants who underwent blocked practice condition showed significantly faster responses (i.e., better performance) during acquisition phase than those who underwent random practice condition. However, participants who practiced using random practice conditions showed significantly faster responses during retention and transfer sessions.

In the area of communication disorders, Knock et al[10] found that random practice conditions facilitated relearning of speech production skills in individuals with acquired apraxia of speech than blocked practice conditions. Recently, attempts have also been carried out to investigate how contextual interference affects motor learning in the voice area. Yu[11] studied how practice variability contributed to motor learning of relaxed phonation in a group of vocally healthy individuals. The participants were randomly assigned to two groups. Participants in group one were required to read aloud the sentence stimuli presented in a random order (random group), whereas participants in the other group were given blocks of sentence stimuli to read aloud (blocked group). Her study did not reveal any significant effects of practice variability between the two groups. However, vocally healthy individuals were used in her study and whether these findings can be generalized to the dysphonic individuals remains to be evaluated. It is possible that dysphonic individuals may show a different attention focus during motor learning practice when compared with vocally healthy individuals. It would be interesting to further investigate the effects of practice variability on learning relaxed phonation task in dysphonic individuals to evaluate if there is a generalization of results to the pathological group.

In the present study, surface electromyography (sEMG) was used as a voice training tool to provide augmented feedback for dysphonic participants to reduce muscle tensions during phonation. The literature has documented the use of sEMG feedback in reducing excessive muscle tensions in laryngeal area for patients with vocal nodules. In the study by Stemple et al,[12] participants with vocal nodules were observed to reduce their laryngeal muscle tension levels significantly after undertaking eight sessions of sEMG biofeedback training. Andrews et al also documented that sEMG could be used as an effective visual feedback tool to treat hyperfunctional dysphonia.[13] Similar achievement was described in a case study by Allen et al,[14] which provided sEMG biofeedback to a 9-year-old young boy with hyperfunctional dysphonia associated with vocal nodules, and the use of such visual feedback was able to help the boy reduce laryngeal muscle tension during phonation. In view of these promising results brought by the use of sEMG in voice therapy, the present study will make use of this instrument as augmented feedback during the relaxed phonation training and as outcome measures of the training.

The aim of the present study was to investigate the effects of practice variability on the learning of relaxed phonation in individuals with hyperfunctional dysphonia. It was hypothesized that the participants receiving random practice condition would demonstrate better motor learning on relaxed phonation when compared with participants receiving blocked practice and constant practice conditions.

METHODS

Participants

Twenty-one dysphonic individuals (18 females and 3 males; mean age = 26.71 years, SD = 8.50, range = 19–48 years) participated in the present study. All the participants (1) could read and speak Cantonese fluently; (2) had been suffering from voice problems and laryngeal discomfort for the past 3 consecutive weeks before the study; and (3) did not receive any prior voice training or have experience in using sEMG before the present study. Participants were excluded from the present study if they (1) failed the hearing screening tested at 30-dB HL (Hearing Level) for octave frequencies between 2 and 8 kHz; (2) had a previous history of, or present with a respiratory disorder and allergy; or (3) had a previous history of, or present with any form of neurological speech and language disorders.

Experimental set-up

sEMG system (AD Instrument PowerLab Unit, model ML 780 with an eight-channeled and Dual Bio Amp model ML 135) and