

운동 습득 이론에 기초한 말실행증의 치료 접근법 — 증례 보고 —

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Treating Apraxia of Speech (AOS) using the Motor Learning Guided (MLG) Approach —A case report—

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The treatments of AOS have been debated since the late 1960s. Despite a considerable amount of study of intervention approaches to AOS, the effectiveness and efficacy of the treatment of AOS is still unclear. This study investigates the effect of motor learning guided (MLG) approach on individuals with AOS. Two individuals with AOS whose severity ranged from mild to moderate participated in this study. Two sets (each 20 utterance) of stimuli were created (based on high functionality) by the participants and their primary care-givers. Subjects were instructed to produce the target word three times with 4-second pause between each attempt. After 3 attempts, the experimenter provided knowledge of results (KR). Each target word was randomly selected from the written stimulus cards. The results showed that the mean scores of all the subjects increased during the sessions and this effect was transferred to the untrained target words. (**Brain & NeuroRehabilitation 2011; 4: 64-68**)

Key Words: knowledge of results, motor learning, retention

Introduction

Apraxia of speech (AOS) has been described principally as being motoric. Evidence from many empirical studies has supported the concept that AOS is phonetic-motoric based disorder.¹⁻³ The treatments of AOS have been debated since the late 1960s.^{1,4,5} Despite a considerable amount of study of intervention approaches to AOS, the effectiveness and efficacy of the treatment of AOS is still unclear.⁶ Schmidt and Bjork⁷ introduced a theory of motor learning. They suggested that the traditional methods to motor learning (e.g., massed practice, blocked practice, high frequency feedback) may not be very effective for motor acquisition. However, in recent researches, Schmidt

and colleagues reported that random practice order and different levels of reduced frequency feedback improved motor learning although it slowed the rate of motor learning acquisition.⁸⁻¹⁰

Feedback is one of the most important parameters in motor skill learning.¹¹ Particularly, knowledge of results (KR) has been considered an effective feedback on motor learning. KR is the summary information about the performance of the individual after he/she has completed the task. It is general information about the performance whereas Knowledge of performance (KP) is the detail information about the performer's task results. According to Winstein and Schmidt,¹² KR information plays a significant role for error detection and improvement on the next trial. Therefore, the performance could be improved as practice continues. Adams et al.¹³ examined the effect of KR on speech performance in Parkinson's disease. They used two different frequent KR schedules on retention and acquisition phases (a feedback after every trial versus a feedback after every fifth trial). The participants produced 2,400-millisecond (ms) utterance fifty times and the performance feedback was accurately

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received. The two groups received two different frequent KR feedbacks about their performance. Adams et al.¹³ found that the participants showed better performance under the reduced feedback schedule (a feedback after every fifth trial) on retention phase. They even showed the improvement of the performance on acquisition measure after 40 trials. Many studies indicate that reduced feedback may be an important factor to improve motor learning.^{7,14}

Different types of practice are another important parameter on motor skill learning. According to Shea and Morgan,¹⁵ blocked practice, also known drill, would occur when the target goals are in a certain order and each goal is separated in the therapy session. However, in random practice the order of the target goals changed randomly.^{2,7} According to Schmidt and Bjork,⁷ random practice was specifically effective on retention than on acquisition when the learner practiced under the two different practice conditions. That is, the performance under random practice was more accurate on retention than on acquisition measures.¹⁵ Knock et al.¹⁶ investigated the effects of blocked versus random practice on speech production skills in AOS. This study revealed that random practice was more effective than blocked practice on retention phase. More recently, Ballard et al.¹ examined the effect of practice type (random versus blocked practice) on articulatory skills in two individuals with AOS. The participants produced CV, CVC, and VC syllables under two practice conditions when phonetic placement therapy was given. The authors found that the participants showed better performance under random practice than blocked practice and the results of random practice retained in retention phase as blocked practice did not.¹ Consequently, McNeil et al.² concluded that “random practice facilitates the development of motor programs and learning and is more efficient than blocked practice.” (p. 335). Based on Schmidt’s motor learning theory, Hageman et al.¹⁷ developed a multi-step practice approach as a treatment for apraxia of speech (AOS). This treatment approach, termed the “motor learning guided” (MLG), was utilized to people with AOS in this study. Feedback type and frequency was controlled and a pause time (4 sec) was included in this approach to enhance participants to evaluate their speech productions. The purpose of this

study was to investigate the effectiveness of the MLG approach to AOS.

Case Report

1) Participants

(1) Case 1

Patient 1 was a 40-years old male who had AOS with Broca’s aphasia after a traumatic brain injury prior to the beginning of the intervention. His lesion site was near Broca’s area. He fell down from a ladder while working on the top of a telegraph pole on July 1st in 2000. He participated in both inpatient and outpatient speech therapy programs for a while before he came to the speech and voice therapy clinic at the Dan-kook University Medical Center in March 2004. Previously, he participated into some speech therapy programs such as rate control (vowel prolongation) and behavioral cognitive approach. He demonstrated limited spontaneous speech, good auditory verbal comprehension, poor repetition, and poor naming on the Korea Western Aphasia Battery (K-WAB). He also showed the typical apraxic speech characteristics such as difficulties sequencing phonemes and syllables, vowel distortions, intonation and stress inconsistencies, and oral groping movements on the experimenter’s clinical observation and informal test. These results indicated that he had a moderate non-fluent Broca’s type aphasia and AOS.

(2) Case 2

Patient 2 was a 58-years old male who had a mild AOS after a left cerebrovascular accident (CVA) in the winter of 2004. His lesion site was a left middle cerebral artery (MCA). K-WAB showed that he had good spontaneous speech and auditory verbal comprehension, poor repetition and naming. His apraxic speech characteristics observed included groping for the correct articulatory posture, substitutions (a voiceless phoneme for a voiced phoneme) and slower diadochokinetic rate (paʔəkə). The previous traditional AOS therapy approaches for this patient includes imitation of contrast, oral reading (vowel prolongation), and pacing (tapping). The diagnoses of AOS for these two patients were based on the judgment of the experimenter because there is no standardized test for AOS (Table 1).

The therapy sessions for the above 2 patients started in

Table 1. Results of Diagnostic Testing Pre-treatment

Korean Western Aphasia Battery (KWAB)		Participant 1	Participant 2
Aphasia quotient	(/100)	57	94.2
Impairment severity		Moderate	Mild
Spontaneous speech	(/20)	9	19
Comprehension	(/200)	184	200
Repetition	(/100)	26	89
Naming	(/100)	77	92

October, 2005.

2) Procedures

The therapy session was operated in a speech and voice therapy clinic at the Dan-Kook University Medical Center. Each MLG treatment session was conducted with random order of target stimuli. Two sets (each 20 utterance) of stimuli were created (based on high functionality) by the participants and their primary care-givers. One set of stimuli was used for treatment session and the other was used for measurement of untrained targets.

An 11-point multidimensional scoring system was used to score produced target utterances (Table 2). Subjects were seated comfortably at a table with the experimenter. Subjects produced 20 target stimuli without assistance. Based on an 11-point multidimensional scoring system, produced utterances were scored and used as a baseline. The experimenter then produced each target word as a model and the target word was elicited from a written stimulus card in random order. Subjects were then instructed to produce the target word three times with 4-second pause between each attempt. After 3 attempts, the experimenter provided knowledge of results (KR). Each target word was randomly selected from written stimulus cards. All subjects produced each target word three times with 4-second pause between each attempt. The experimenter provided KR for all target stimuli after three attempts of each target word. The feedback comments were generated; extreme positive, negative, and some place in the middle (that's good, that's not bad, and I know it is really hard). The experimenter practiced three feedback comments until these were natural and consistent (e.g., inflection and tone).

After the first baseline session, the subjects had 12

Table 2. 11 Point Rating Scale

Rating scores	Description
11	Accurate (within two seconds)
10	Delay, searching, groping, facial grimace
9	Inefficient, poor prosody, distortion, drawn out, grimace
8	Delayed (2+ seconds), inefficient, poor prosody, facial grimace
7	Addition or deletion of a sound, use of a starter phrase
6	Repeat, asks for repetition
5	Self-correction
4	Incomplete, omits part of word or phrase that changes meaning
3	Error (any articulation error)
2	Error (articulation) plus a delay (2+ seconds)
1	Perseveration (produces previous response)

therapy sessions. Collecting retention data occurred in the beginning of each treatment session. Therapy sessions occurred three times per week. After each treatment session, subjects returned to the clinic and reproduced the previously practiced target utterances when the written stimulus cards were provided. All produced the target stimuli without assistance were scored and recorded. So, the acquired speech production in the beginning of the each treatment session was used for the performance of the retention phase. No feedback was provided during these retention phases.

3) Results

Fig. 1 and 2 indicate the mean scores of each retention phase for participant 1 and 2. The black diamond dots show the mean scores of each patient during twelve therapy sessions. From the Fig. 1, the mean score of each retention probe increased from 6.5 to 9 points. Especially, after three weeks, his productions of target utterances were accelerated until 9.0 point and stabilized at 8.6 point out of 11 points. By the end of the therapy session, his productions of the target utterances remained at a steady 8.6 point. Also, the squares illustrated that the mean score of the untrained targets on each third session increased from 6.6 to 8.1 points. This indicated that the effect of MLG training transferred to untrained target stimuli. In the therapy sessions of participant 2, the mean scores of each retention probe increased steadily from 6.9 to 10.25

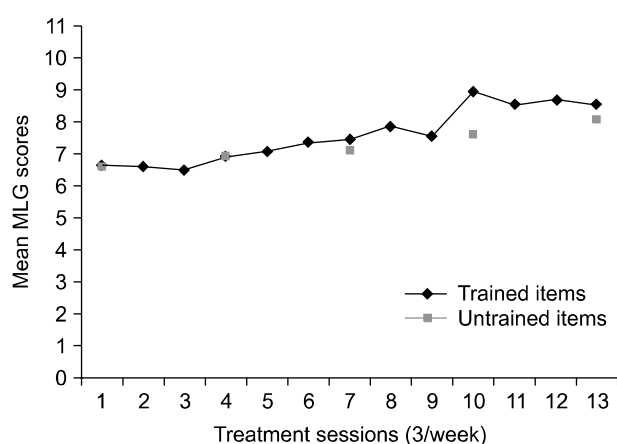


Fig. 1. The result of motor learning guided therapy (MLG) mean scores during 12 treatment sessions (participant 1).

points. By the end of the fourth session, the mean scores stabilized and increased and stabilized again during two sessions and then increased again. Even after the last session, the mean scored increased until 10.26 out of 11 points. The square dots in the Fig. 2 showed that the mean score of the untrained targets on each third session increased steadily from 7.25 to 9.8. This indicated that the effect of MLG training transferred to untrained target stimuli.

Discussion

The results of the treatment showed that the two participants improved their speech productions with MLG approach. The improvement of their speech was effective not only for trained target utterances, but also for untrained target utterances. The treatment approach was more effective for participant 2 who had a mild apraxia of speech (AOS). The current investigation recommends the potential benefits of using motor learning theory based approach. The combination of reduced frequent feedback and random practice was effective in improving speech productions in both of the participants. The result of this investigation is consistent with some of the motor learning based AOS treatment studies.^{16,18,19} This treatment approach is useful but it has its limitation. That is, the current investigation used a modified single subject baseline design with a lack of stable baseline phases. This study did not perform follow-up sessions after retention probes even though we assume that the effect of the

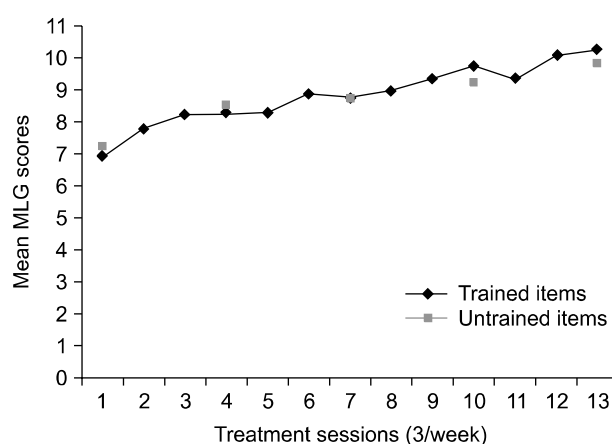


Fig. 2. The result of motor learning guided therapy (MLG) mean scores during 12 treatment sessions (participant 2).

treatment may transfers to longer retention phases. In this study, both used treated target utterances and untreated target utterances share similar linguistic complexity although this study was not intended to test this speculation. Based on previous research in motor learning, more complex stimuli can be more transferable to novel stimuli.^{19,20} However, the findings were not consistent with those of Hula et al.¹⁸ They found that the effects of the feedback variables (reduced or delayed KR) could not override complex stimuli for some participants with AOS. That is, some participants showed a better performance on less complex words regardless of manipulation of feedback types. This issue may need to be investigated in the future. The use of manipulation of motor learning parameters is useful because of clinically functional benefits. However, much remains to be learned how this manipulation works on motor learning skills, although there have been some explanations.⁸ In summary, meaningful effects were observed not only in individual treatment sessions, but in social, group contexts as well. For example, participant 1 stated “I was able to correctly pronounce after having time to remember correct pronunciation through the experimenter’s feedback.” He also said, “I was able to say a sentence faster”, “I was happy because my wife told me that my pronunciation was great”. A further study needs to expend to larger sample sizes, longer therapy periods, a longer transfer effect, and a better study design. In conclusion, the data from the current study suggest that the manipulation of motor learning parameters is an effective treatment approach for individuals with apraxia

of speech (AOS).

References

- 1) Ballard KJ, Granier JP, Robin DA. Review understanding the nature of apraxia of speech: Theory, analysis, and treatment. *Aphasiology*. 2000;14:969-995
- 2) McNeil MR, Robin DA, Schmidt RA. Apraxia of speech: Definition, differentiation, and treatment. In: McNeil MR, ed. *Clinical Management of Sensorimotor Speech Disorders*. New York: Thieme; 1997:311-344
- 3) McNeil MR, Weismer G, Adams S, Mulligan, M. Oral structure nonspeech motor control in normal, dysarthric, and apraxic speakers: Isometric force and static position control. *JSHR*. 1990;33:255-268
- 4) Darley FL, Aronson AE, Brown JR. *Motor Speech Disorders*. Philadelphia: W. B. Saunders Company; 1975:278-287
- 5) Rosenbek JC, Kent RD, LaPointe LL. Apraxia of speech: An overview and some perspectives. In: Rosenbek JC, McNeil MR, Aronson AE. eds. *Apraxia of Speech: Physiology-acoustic-linguistics-management*. San Diego: College-Hill Press; 1984:1-72
- 6) Wambaugh JL. A summary of treatments for apraxia of speech and review of replicated approaches. *Semin Speech Lang*. 2002;23:295-308
- 7) Schmidt RA, Bjork RA. New conceptualizations of practice: Common principles in three paradigms suggest new concepts for training. *Psychological Science*. 1992;3:207-217
- 8) Anderson DI, Magill RA, Sekiya H, Ryan G. Support for an explanation of the guidance effect in motor skill learning. *J Mot Behav*. 2005;37:231-238
- 9) Kim IS. Effect of feedback schedules and number of practice trials on motor retention of novel speech behaviors. Unpublished dissertation, Florida State University; 2007
- 10) Schmidt RA, Lee TD. *Motor Control and Learning: A Behavioral Emphasis*. Champaign, IL: Human Kinetics; 1999: 323-355
- 11) Schmidt RA. *Motor Control and Learning*. Champaign, III: Human Kinetics; 1988:364-400
- 12) Winstein CJ, Schmidt RA. Reduced frequency of knowledge of results enhances motor skill learning. *J Exp Psychol Learn Mem Cognit*. 1990;16:677-691
- 13) Adams S, Page A, Jog M. Summary feedback schedules and speech motor learning in Parkinson's disease. *JMSLP*. 2002; 10:215-238
- 14) Chamberlin C, Lee T. Arranging practice conditions and designing instruction. In: Singer RN, Murphy M, Tennant LK, eds. *Handbook of Research on Sport Psychology*. New York: MacMillan Publishing Company; 1993:231-241
- 15) Shea CH, Morgan RL. Contextual interference effects on the acquisition, retention, and transfer of a motor skill. *J Exp Psychol Hum Learn Mem*. 1979;5:179-187
- 16) Knock BA, Ballard K, Robin D, Schmidt R. Influence of order of stimulus presentation on speech motor learning: A principled approach to treatment for apraxia of speech. *Aphasiology*. 2000;14:653-668
- 17) Hageman CF, Simon P, Backer B, Burda AN. Comparing MIT and motor learning therapy in a nonfluent aphasic speaker. Symposium conducted at the annual meeting of the American Speech Language-Hearing Association, Atlanta, Georgia; 2002
- 18) Hula SN, Robin DA, Maas E, Ballard KJ, Schmidt RA. Effects of feedback frequency and timing on acquisition, retention, and transfer of speech skills in acquired apraxia of speech. *JSLHR*. 2008;42:1482-1498
- 19) Lasker JP, Stierwalt AG, Hageman CF, LaPointe LL. Using motor learning guided theory and augmentative and alternative communication to improve speech production in profound apraxia: A case example. *JMSLP*. 2008;16:225-233
- 20) Schmidt RA, Wrisberg C. *Motor Learning and Performance*. UK: Human Performance Publishers; 2008:255-310