

# 컴퓨터기술을 통한 제 2 언어 습득에서의 연습지수법칙

변진석\*

요약

이 논문은 보다 더 큰 연구의 일부로서 기술 습득과 관련되어 논의되어 왔던 연습지수법칙 (Power Law of Practice)이 제 2 언어 발달의 자동화 습득에도 적용이 되는지를 반응시간, 실수율, 그리고 발화 총 시간의 관점에서 분석했다. 이를 위해 14명의 영어 원어민 화자들이 3가지의 한국어 문법 규칙을 배우기 위해 5주 이상에 걸쳐 14번의 DMDX, MS Word, Audacity 와 Cool Edit을 통하여 컴퓨터화된 학습, 연습, 시험 과정들에 참여하였고 그 분석 결과는 제 2 언어 발달의 자동화 습득 또한 전체적으로 연습지수법칙을 따른다는 것을 보여 주었다. 이 결과들은 오랜 시간이 걸리는 자동화 습득 과정에서 쉽게 포기해 버리는 제 2 언어 학습자들을 위한 교육적인 제안점들과 관련하여 논의 되어진다.

## Power Law of Practice in SLA through Computer Technology

Jin-Suk Byun\*

ABSTRACT

The present study is a part of a larger study and investigated whether power law of practice, which has been discussed in relation to skill acquisition, applies to the acquisition of automaticity in second language development in terms of reaction time, error rate, and length of time of speech. Fourteen native speakers of English participated in fourteen computerized learning, practice, and test sessions through DMDX, MS Word, Audacity, and Cool Edit over a 5-week period to learn three Korean morphosyntactic rules. The analysis of their performance indicated that overall the acquisition of automaticity in second language development followed a power law pattern. The findings are discussed in relation to their pedagogical implications for second language learners, who often give up the acquisition of automaticity easily.

Key Words : power law pattern, practice, automatization, automaticity, reaction time, length of time of speech

---

\* Department of Childhood Education, University of North Florida (✉jinsbyun@gmail.com)

· 제1저자(First Author) : 변진석 · 교신저자(Correspondent Author) : 변진석

· 접수일(2011년 7월 19일), 수정일(1차 : 2011년 8월 26일), 게재 확정일(2011년 8월 31일)

## I . Introduction

Power law of practice has been discussed in the literature (DeKeyser, 2001; Aoki, Hansen, & Itoh, 2008; Logan, 1988; Newell & Rosenbloom, 1981) for a few decades in relation to the acquisition of skill knowledge. It is a pattern that occurs when a performance is automatized through practice. As general characteristics of automaticity, DeKeyser (2001) has argued for three things: the power law of practice, skill-specificity of automatized behavior, and load independence, which is the elimination of influence by memory set size. Among the three characteristics the power law of practice is related to speed-up processing. Speed-up function in skill acquisition increases substantially through practice at its early stage but soon the degree of speed-up diminishes with further practice (Logan, 1988). This is called power law of practice and is formally represented as  $RT = a + bN^{-c}$ . Here RT is reaction time, and a is asymptote, which is the least possible reaction time that learners could reach after a great amount of practice. b is the difference between initial performance and asymptotic performance, N is the number of practice, and c is the rate of learning. This formula shows that in skill acquisition the reaction time decreases rapidly at its beginning stage because the reaction time operates according to the power function. However, the reaction time decreases gradually soon and when the number of practice is very large, the reaction time will reach the asymptote because  $bN^{-c}$  approaches zero. In other words, the reaction time stays the same and almost does not change. This process is graphically represented in Figure 1.

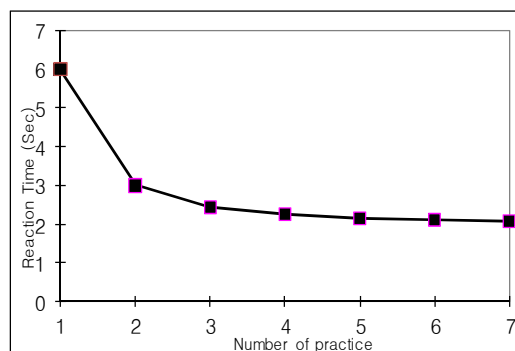


그림 1. 연습지수법칙 그래프

Figure 1. Graphical representation of power law of practice

Though the power law of practice has been discussed in relation to skill acquisition, few studies have investigated power law of practice in relation to the acquisition of automaticity in second language acquisition. Only DeKeyser's (1997) study has been done on the power law of practice and automatization in SLA. In the study, he divided 61 participants into three groups of about 20 each. They participated in 22 sessions of an hour or less for 11 weeks, learning explicitly and practicing 32 vocabulary and four morphosyntactic rules of an artificial language called Autopractan. The findings showed that the automatization of morphosyntactic rules proceeded gradually over time, showing the power law of practice pattern. However, in the study he employed an artificial language and measured only reaction time and error rate. So it needs to be tested whether the same pattern applies to the automatization process of a natural language in SLA in terms of length of time of speech in addition to reaction time and error rate, which Byun (2009) argues must be included in the study of

acquisition of automaticity. Therefore, this study investigates whether the power law of practice pattern applies to the acquisition of Korean morphosyntactic rules in terms of reaction time, error rate, and length of time of speech.

## II. Method

### 2.1 Participants

The participants were 14 native speakers of English and they were randomly selected. The group had eight men and six women. Their age ranged from 19 to 24 with the mean of 20. Originally 15 participants were recruited

for the group through flyers posted on the campus, but the data of one participant were discarded because her speech was not recorded due to technical problems.

The participants were graduate or undergraduate students at the University of Illinois at Champaign-Urbana. Any English native participants with previous experience of learning Ural-Altaic languages, including Korean, were excluded from the study. They were paid \$10 for each session if they had finished the entire sessions and \$7 for each session if they withdrew in the middle of the study. They were paid the total amount of money after they finished their last session.

### 2.2 Target Structures

This study had three Korean morphosyntactic rules as target structures: word order, case-marking for nominative and accusative, and classifier

construction. Word order was selected as the first target structure because Korean has an SOV (subject, object, and verb) word order as opposed to SVO (subject, verb, and object) word order of English. Though Korean also allows OSV, it has SOV as its canonical word order (Kwon, 1992; Sohn, 1999) and the English word order, SVO, is not allowed in Korean.

The second target structure was case-marking. In principal, the subject and the object nominals are followed by nominative and accusative case particles in Korean, respectively (Sohn, 1999). Therefore, case-particles were the second target grammar structure in the present study. Though there are two forms of case particles for nominative and accusative case, only -ka for nominative case and -reul for accusative case were employed for the present study. The last target structure was classifier construction, which is 'noun + number + classifier'. The classifier construction was selected as the last target structure because typologically, Korean is a numeral classifier language whereas English is not (Greenberg, 1972). The example of classifier construction is shown below:

(1) nakta du mari  
 camel two classifier for animals  
 'two camels'

### 2.3. Materials

#### 2.3.1 Training materials

The training materials were designed to provide participants with training on Korean sounds, vocabulary, and grammar. They consisted of explanations and multiple-choice or true-false

practice activities. For the sound training, 14 consonants and 8 vowels were targeted. They were written in a specially developed Romanization for the present study. For the vocabulary training, 22 Korean nouns and verbs, two classifiers, and two numbers were targeted. Twelve words (6 nouns and 6 verbs) were used from the beginning of the experiment and 10 new words were employed as new items later. Finally, for the grammar training, an on-line text was provided to explain each of the three grammatical rules. Also sets of Korean and English sentences were made and digitized for practice activities.

### 2.3.2 Treatment materials

The treatment materials consisted of practice items and test items. Both the practice and test items consisted of Korean sentences that were supposed to be translated orally. A special software program, DMDX, which is a Win 32-based display system used in psychological laboratories to measure reaction times to visual and auditory stimuli, was used to develop the practice and test items.

### 2.4. Design

The entire study consisted of 14 sessions, each of which took 30-40 minutes. It had two phases, a training phase of Korean sounds, vocabulary, and grammar (sessions 1 - 4), and a treatment phase (sessions 5 - 14). During the treatment phase reaction time, error rate, and length of time of speech were measured through test activities to investigate whether the power law of practice applies to the acquisition of automaticity in second language acquisition.

For all tests during the treatment phase participants did two tasks at the same time: translation task and color identification task, where they were asked to indicate the color of sentences on the screen. In other words, they were tested in a dual-task condition to ensure the load independence of the translation task.

### 2.5. Procedure

The experiment took place in a computer-assisted language laboratory with 16 desktop computers at the University of Illinois at Urbana-Champaign. The group participated in 14 sessions, over a 5-week period. The training phase consisted of sound training, vocabulary training, grammar training, and review activity. During this period participants acquired the knowledge of target vocabulary and grammar structures and their performances were checked to ensure their acquisition of the target vocabulary and grammar structures.

The treatment phase consisted of practice and test activities. During the period, participants practiced the knowledge of the target vocabulary and grammar structures, which they had acquired in the previous sessions (sessions 1-4). They had 48 practice items and 8 test items for each session. When they pressed the spacebar of a computer, they saw an English sentence and were asked as quickly as possible to translate it orally into Korean. Then their speech was recorded into the recording software program, Audacity, installed in the local computer, and was analyzed through another software program, Cool Edit. There were one difference between the test activities and the practice activities. The test activities were done in a dual-task condition to ensure the load

independence, which DeKeyser (2001) indicated as another characteristic of automaticity. So the participants were asked to do another task, a color identification task while they were translating English sentences into Korean orally. More specifically, they were asked to describe the color of the sentences (red or blue) by pressing shift keys with red or blue stickers on them while they were translating the given English sentence into Korean orally.

As for vocabulary presented through the sessions, the same words introduced in the training phase were used, but six new words were introduced in sessions 10 through 14 to exclude the possibility of word knowledge affecting the result of the study.

The researcher participated in session 1 through 4 to ensure that everyone acquired the knowledge of Korean sounds, vocabulary and three grammatical rules. Except some comments of the researcher to manage the experiment, all instructions, practice and test activities in session 5 through 14 were done through software programs installed in the local computers. As for the software programs, the study employed Microsoft Word for the training phase. For treatment phase, DMDX was used to present practice and testing materials and to measure all participants' performance that did not involve their oral speech. To record and analyze participants' oral speech, the study employed Audacity and Cool Edit.

## 2.6. Analysis

The data obtained during the treatment phase consisted of reaction time, error rate, and length of time of speech. Reaction time and length of time of speech were measured in milliseconds while error

rate was measured in terms of the number of errors. Performance on the color identification task was also scored in terms of accuracy, with one point given for each correct answer.

Reaction time was measured as the length of time between the appearance of target sentences and the beginning of their speech. The length of time of speech was the time period between the beginning and the end of the utterance. If there was a correction, the end of speech was the end of the correction.

## III. Results

The results of vocabulary and grammar tests showed that the participants had firm knowledge about the target vocabulary and grammar points before they started the treatment sessions. They showed 99% accuracy on the vocabulary test and 98.9% accuracy on the grammar test. The color identification task during the treatment sessions also showed that the participants were doing the given tasks actually in a dual-task condition. They showed 99% accuracy.

The results of the test activities during the treatment phase indicated that automatization of L2 acquisition through practice occurred overall in a power law of practice pattern. In terms of reaction time, as shown in Figure 2, the average score decreased fairly rapidly from 2365 ms at session 5 to 1981 ms at session 9. Although there is a high peak in session 10, this may be because the study started employing new words in session 10. The graph shows another rapid decrease of average from 2786

ms at session 10 to 2334 ms at session 11.

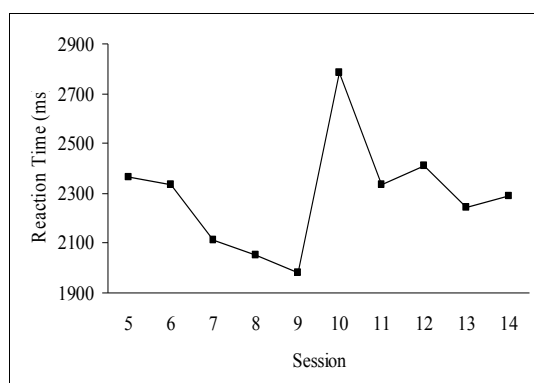


그림 2. 자동화와 반응시간  
Figure 2. Automization and Reaction Time

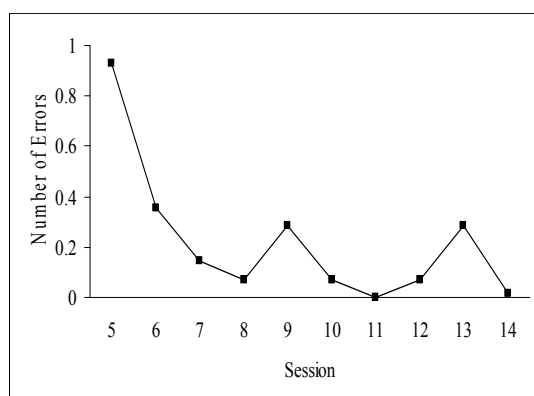


그림 3. 자동화와 실수율  
Figure 3. Automization and Error Rate

Then it is followed by a gradual decrease over time. In terms of error rate, as shown in Figure 3, the average score decreased rapidly from .93 at session 5 to .07 at session 8. After that although there are two small bumps, the overall picture of average shows gradual decrease or asymptote over time. In terms of length of time of speech, as shown in Figure 4, the average score decreased rapidly from 5674 ms at session 5 to 4629 ms at session 6. It is followed by a

gradual decrease at sessions 6-9. Next, as in reaction time data there is an increase in session 10, where new words started being employed. After the increase, the average score decreases again fairly rapidly over time.

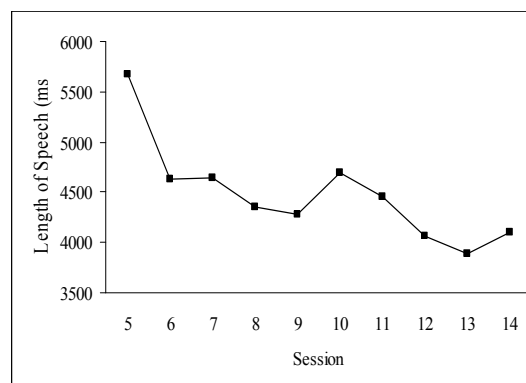


그림 4. 자동화와 총 발화 시간  
Figure 4. Automization and Length of Time of Speech

#### IV. Discussion

The findings of the study have shown that the power law of practice, which has been discussed in relation to skill acquisition, is highly likely to apply to the acquisition of automaticity in second language acquisition. This helps raise teachers' and learners' awareness about the process of second language development at the skill knowledge level. Learners may experience rapid changes in the initial stages as seen in the power law pattern. The rapid drop-off means that when second language learners begin practicing a target structure, it is already a big step forward in their second language development at the skill knowledge level. Therefore, learners need to be

encouraged to start practicing a variety of target structures, remembering the rapid drop-off of the power law pattern. Unfortunately, however, it is often observed that second language learners give up practicing a target structure after some trials because they think that the automatization of the target structure does not occur without knowing that actually automaticity of the target structure is being acquired, especially relatively rapidly at its early stage. Sometimes the learners may try practicing no other structures because of their false idea of skill knowledge acquisition from their previous experience. Again, here the learners need to be encouraged to continue to practice various target structures because they will make a great progress in skill knowledge development whenever they start practicing what they learn.

The gradual improvement at its later stage in the pattern also gives learners important information about their second language development. The gradual improvement pattern means that learners are likely to reach more gradual levels of change fairly quickly and the automatization process will be very slow. Therefore, when their improvement slows down fairly quickly and seems to be stuck at the later stage of their second language development, they do not need to be frustrated. For it is exactly what the latter part of power law pattern shows. Since second language development reaches its ultimate state very gradually at its later stage through a large amount of practice, second language learners need to be encouraged to continue practicing target structures, being assured that their second language competence is improving and approaching a native speaker's competence of the target language at the skill

knowledge level. However, since this was a lab-based study, classroom-based research is necessary before specific pedagogical applications can be identified.

#### 참고문헌

- [1] R. DeKeyser, Automaticity and automatization. In P. Robinson (Ed.), *Cognition and Second language instruction* (pp. 125-151), Cambridge: Cambridge University Press, 2001.
- [2] H. Aoki, P. Hansen, and K. Itoh, "Learning to interact with a computer by gaze." *Behavior and Information Technology*. Vol. 27, pp. 339-344, 2008.
- [3] G. Logan, "Toward an instance theory of automatization." *Psychological Review*, Vol. 95, pp. 492-527, 1988.
- [4] A. Newell, and P. Rosenbloom, Mechanisms of skill acquisition and the law of practice. In J. R. Anderson (Ed.), *Cognitive skills and their acquisition* (pp. 1-55). Hillsdale, NJ: Erlbaum, 1981.
- [5] R. DeKeyser, "Beyond explicit rule learning: Automatizing second language Morphosyntax," *Studies in Second Language Acquisition*, Vol. 19, pp. 195-222, 1997.
- [6] J. Byun, (2009). "Skill-specificity in the acquisition of automaticity in L2," *The Linguistic Association of Korea Journal*, Vol. 17. No.3, pp. 57-78, 2009.
- [7] C. Kwon, *Han'gugo t'ongsaron [Korean Syntax]*. Seoul, Korea: Mineumsa, 1992.
- [8] H. Sohn, *The Korean language*. New York, NY; Cambridge University Press, 1999
- [9] J. Greenberg, "Numerical classifiers and substantial number: Problems in the Genesis of a linguistic type," *Working Papers on Language Universals*, Vol. 9, pp. 1-39, 1972.

The early version of the present paper was presented at the annual conference of the Second Language Research Forum, University of Seattle, in 2006.

---

### 저자소개

#### 변진석(Jin-Suk Byun)



2000년 University of Illinois at Urbana-Champaign (TESOL 석사)  
2001년 University of Illinois at Urbana-Champaign (언어학 석사)  
2006년 University of Illinois at Urbana-Champaign (언어학 박사)

2007년~현재 University of North Florida TESOL 교수  
※ 관심분야: SLA, 응용 언어학, TESOL 프로그램 개발