
3-2 Language Learning in the 21st Century

Reiko AKAHANE-YAMADA and Keiichi TAJIMA

Advanced Telecommunications Research Institute International

With the globalization of human activities, it has become increasingly important to improve one's ability to communicate in a second language. To better understand how human beings process spoken language and to help develop better technology for human-computer interaction and effective instructional tools for second-language education, Spoken Language Acquisition Project is studying how language learners develop listening and pronunciation skills in a foreign language, through three research themes: (1) basic research on underlying mechanisms, (2) advancement of core technology, and (3) diversification of learning environments. Furthermore, as a powerful tool for collecting extensive research data and for putting our research findings to practical use, we have started to develop an individualized, long-distance language-learning system called "ATR CALL (computer-assisted language learning system)".

Keywords

speech, second language, acquisition, training, computer assisted language learning

1 Introduction

There are thousands of mutually unintelligible languages in the world, of which typically only one is acquired as the native language. While one's native language is acquired quite effortlessly, once the native language is established, it is often difficult to master a second language. With the globalization of human activities, the necessity to overcome such difficulties has become increasingly important, particularly in Japan where improving communicative skills in English has become a top priority for many. This has brought about a surge in the number of language learning tools available in the market. However, this has also led to considerable variation in the degree of effectiveness of one tool to the next, and has trivialized the importance of finding techniques that are most helpful for learners. In light of this, we propose that effective language learning tools can be developed only after a better understanding of the mechanisms that underlie human spoken language process-

ing capabilities.

In our project, we have been undertaking basic research on native-language and second-language acquisition by human learners, through experiments investigating such issues as the link between speech production and perception, the effect of native language on second-language speech perception, and neural mechanisms associated with learning non-native speech sounds. We have also been devising ways to incorporate recent advancements in speech signal processing and telecommunications technology to the development of language-learning tools. Specifically, our project has been focusing on: (1) basic research on underlying psychological mechanisms, (2) advancement of core technology, and (3) diversification of learning environments, in an effort to develop an individualized, long-distance language-learning system called ATR-CALL (ATR computer-assisted language learning system). Details of the three sub-themes above and the ATR-CALL system are described below.

2 Basic research on underlying psychological mechanisms

To obtain second-language speech learning data from learners in a variety of settings and age groups, training studies were administered at various sites, in collaboration with the National Institute of Multimedia Education (elderly learners), Waseda University Media Network Center (college students), and Osaka Shin-Ai Jogakuin (elementary and junior/senior high school students). Experiments are being conducted to investigate the effect of age, the effect of native language, and the link between speech production and speech perception in learning phonetic contrasts, speech rhythm, as well as vocabulary of the second language.

2.1 Age and language learning

To investigate the effect of age on acquisition of second language speech, training studies are being conducted with learners of various age groups, from elementary school children to elderly subjects. Results demonstrated that even subjects in their 60's can improve their ability to identify difficult nonnative speech contrasts such as English /r/ vs. /l/, although the time required to achieve the same level of improvement in performance increases with age (see Fig.1) [1].

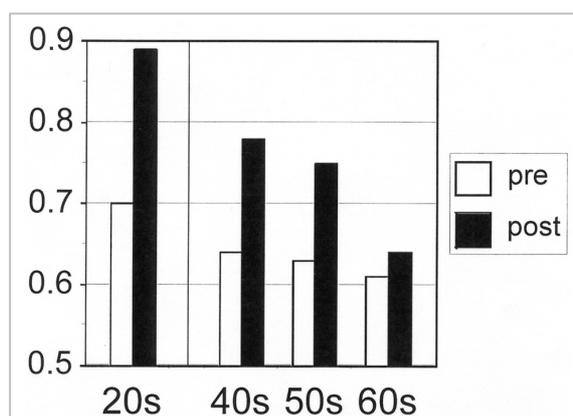


Fig. 1 Comparison of subjects' performance in pre-training and post-training tests.

The labels "20s", "40s", etc indicate subjects in their 20's, 40's, etc [1].

2.2 Acquisition of second-language rhythm

The English word "Mac-Do-nald's" becomes "ma-ku-do-na-ru-do" when borrowed into Japanese. Focusing on such rhythmic differences across languages, we have been conducting experiments on native Japanese speakers' tendency to insert extra vowels when pronouncing English words, as well as training studies on improving their ability to perceive syllables in spoken English words.

2.3 Effect of native language

When comparisons were made between native Japanese and native Korean listeners in their perception of the English /r-/l/ contrast, significant differences were found between the two groups (see Fig. 2) [2], suggesting the effect of native language on how second-language speech sounds are perceived. Analogous results were also found in production of English /r/ and /l/. These results suggest that language-learning tools must be designed with the learners' native language in mind.

2.4 Neural mechanisms

As a first step in exploring possible neural mechanisms associated with acquisition of second language speech sounds, brain activity before and after perceptual training of English /r/ and /l/ was recorded using fMRI as well as MEG (magneto-encephalography). Significant differences were found before and after training in brain activity and in MMF (mismatch field) response, providing encouraging results for future investigations of neural processes that may be associated with the acquisition of second-language speech.

3 Advancement of core technology

In order to develop a system that provides objective and useful feedback to second-language learners about the quality of their pronunciation, we are developing an automatic English pronunciation scoring system that capitalizes on latest speech recognition tech-

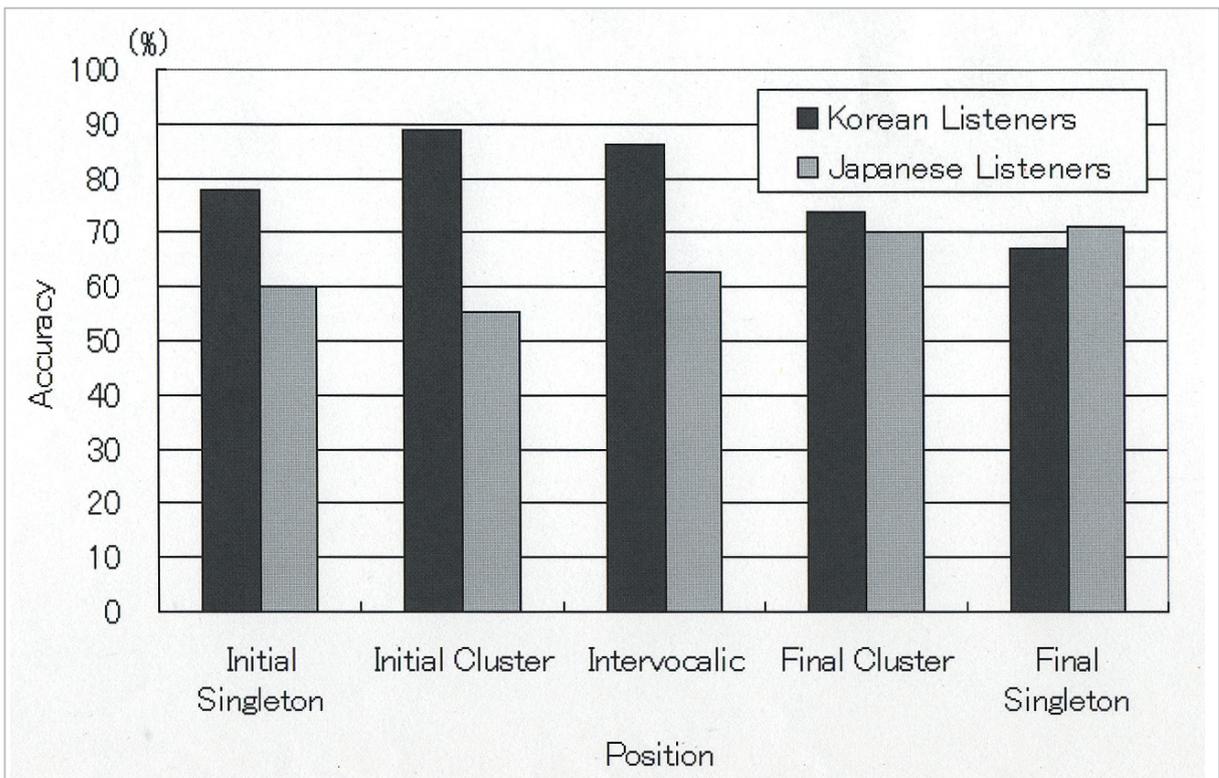


Fig.2 Perception of English /r/-/l/ by native Korean and native Japanese listeners.

The two groups vary with respect to the easiest and hardest positions in the word for identifying /r/ vs. /l/ [2].

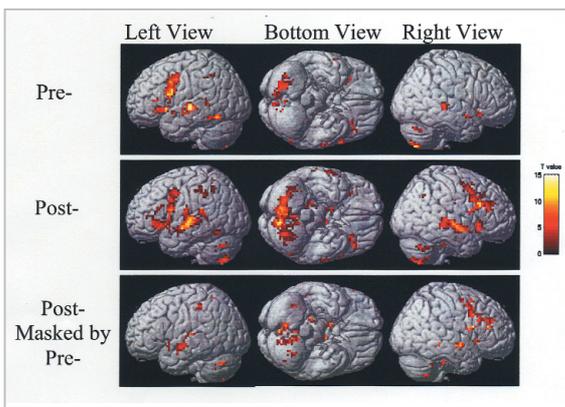


Fig.3 Brain activity recorded using fMRI before (pre-) and after (post-) the /r/-/l/ perception training [3].

nology as well as high-quality speech analysis-synthesis methods such as STRAIGHT [4]. To develop a system that can cope with speech produced by speakers with various characteristics (gender, age, and dialect), a large-scale speech corpus of American English is also being constructed.

4 Diversification of learning environment

Perceptual training of English /r/ and /l/ was conducted with subjects of various age groups (30 - 60 years old) by modifying software programs that were originally used in laboratory experiments and installing them on laptop computers to be taken home by the participants. Although many participants were novice users of personal computers, all of them successfully completed the training program, and the participants as a group showed significant improvement in performance. These results suggest that even “digitally challenged” learners who may face difficulties using computers could benefit from multimedia language-learning systems. In addition, training studies were carried out on-site at elementary and junior/senior high schools and universities by developing a system that utilizes the schools’ server-client LAN (local-area network) environment. At elementary and junior high schools, we implemented a

system that is better suited for the population by, for example, simplifying the interface and using more graphics. We also developed a convenient interface for teachers to keep track of student records and their progress. Results from these on-site studies confirmed that students ranging from 4th graders to undergraduates can effectively learn under the LAN-based environment.

Finally, in order to facilitate management and maintenance of software programs and acquired data, we have developed a Web-based language-learning system in which data management is handled solely by the server. On-site evaluation of the system is currently underway.

5 ATR CALL (ATR Computer-Assisted Language Learning System)

Our project has been conducting extensive training on various domains (listening, pronunciation, vocabulary, etc.) under various training environments (in the laboratory, at home using a personal computer, at school with a LAN environment, over the internet, etc). As a way to systematically carry out all these experiments and acquire data from many

participants efficiently, we have developed the "ATR CALL" system, and have utilized it in our studies. The ATR CALL system allows us to collect data in various experimental settings; the acquired data are then analyzed and used as feedback to further improve the ATR CALL system in a timely manner. By doing so, we have established a link between basic research and real-world users, whereby the two contribute to each other in a "spiral" manner.

6 Conclusion

During fiscal year 2000, an experimental regime for systematically collecting training data from various target populations and learning environments was established. In fact, experiments were carried out in the laboratory, at home, or at school, using LANs or the Internet, with almost 2500 participants including native Japanese and native English speakers between 6 and 70 years of age. Results from these experiments not only reveal facts about human speech processing and learning, but they also suggest ways to build practical tools for language learning.

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Reiko AKAHANE-YAMADA, Ph. D.
*Project Leader, Spoken Language
Acquisition Project, Information Sci-
ences Division, ATR International
Human Science*



Keiichi TAJIMA, Ph. D.
*Spoken Language Acquisition Project,
Information Sciences Division, ATR
International
Cognitive Science*