An Analysis of Reaction Time in the Perception of Korean and English Words Utilizing the E-Prime Program

Kyung-Whan Cha* · Young-Chul Youn · Hyeon Yu*** · Jaehwang Shim******

ABSTRACT

In this study, the researchers evaluate the hypothesis that the reaction time (RT) in the brain is largely dependent on age and gender. The researchers tested English and Korean words using two types: reading as visual stimuli, and listening as auditory stimuli. The E-Prime program installed in functional magnetic resonance imaging (f-MRI) was used. There are 136 Korean subjects in three groups: 30 children (5th and 6th grade elementary school students), 76 young adults (college students), and 30 adults (35-53 years old). In the listening test, the variation for the two languages was different among the three age groups, regardless of gender, whereas the data did not show meaningful differences in the reading test. The findings will provide some meaningful information regarding perception and acquisition of a foreign language.

Keywords: decision-making, f-MRI, E-Prime software, language perception, English-Korean words comparison, listening, reading

1. Introduction

Language researchers have studied components of systems including language reception, verbal reasoning, and speech production (Allen et al., 1991; Edwards & Lahey, 1993; Thapar et al., 2003) based on objective data. Most studies focus mainly on RT and its application to scientific language research in order to show age-related changes in regional brain structures (Haier et al., 2005; Tisserand & Jolles, 2003; Van Petten et al., 2004). Hence, the objective of this study is to find out the perceptional timing of listening and reading functions of the brain. Our hypothesis is that the RT might correlate with age groups, gender, and individual language learning history within the Korean educational environment. To conduct the data initiated, we use a different design and evaluation procedures. The input stimuli as a trial setting are Korean

* Department of English Education, Chung-Ang University
** Department of Neurology, Chung-Ang University
*** Department of Radiology, Chung-Ang University
**** The Research and Development Institute of English Education, Chung-Ang University

and English words, and visual and auditory tasks. We also experiment with three groups comprising 136 participants in order to compare results to our hypotheses.

Unlike people who become bilingual after childhood, those who learn a second language at an early age rely on the same critical patch of brain tissues when speaking either tongue (Hirsch et al., 1997). Studies show that adult learners apparently make use of the brain cells of nearby group. Thus, the sensitivity to language exposure in Broca's area is different from the ways that children and adults learn languages (Hirsch et al., 1997).

A study of lexical tone was conducted in learning Mandarin (Wang et al., 2003), which was employed before and after six native English speakers completed lexical tone training as part of a program to learn Mandarin as a second language. It showed that language-related areas including Broca's area, Wernicke's area, the auditory cortex, and supplementary motor regions were active in all subjects before and after training (Wang et al., 2003).

In research on the RT, structural brain imaging studies show large individual differences in brain size and morphometry in normal subjects (Allen, Damasio & Grabowski, 2002; Good et al., 2001). Studies on some morphometric differences have been examined as they relate to performance on cognitive tasks, but they argue that little is known about morphometric differences as they relate to individual differences in speed processing tests in response time (Haier et al., 2005).

2. Method and Procedure

2.1 Subjects

All procedures in this study were conducted by the Department of English Education and the Department of Neurology, College of Medicine, Chung-Ang University, Seoul, Korea. We selected 136 volunteers who were in good health, with right-handedness, and had not had any brain disease or brain operation. In essence, they had no medical history of head injury or psychiatric disorder, and no indication of dementia or mild cognitive impairment at the time of the experiment. All subjects completed questionnaires relating to personal background on language learning. There were 86 men and 50 women (mean age 24; range 11-53). The subjects were originally selected from three groups: children (n=30, mean age 11.6; range 11-12), young adults (n=76, mean age 21.8; range 19-29), and adults (n=30, mean age 43.4; range 35-53).

In the process of setting the tasks, we used computer simulations as decision-making strategy in order to judge the RT deliberately (Volz, Schubotz & von Cramon, 2006). The purpose for choosing the method was to investigate relevant subjective data regarding language recognition on a language educational basis.

2.2 Procedure

E-Prime, developed by Psychology Software Tools (PST), is a set of applications that fulfills many research needs in the fields of psychology and neuroscience. The program can be used to create diverse behavioral and cognitive psychology research experiments (Schneider, 2002), and offers users control over almost every aspect of paradigm creation, especially in language input material (Shim, 2006). In addition, it is temporally accurate within a few milliseconds, which is a crucial aspect of control for many research needs (Schneider, 2002; Schneider, Eschman & Zuccolotto, 2002).

Researchers utilized the E-Prime program by developing a wide variety of paradigms implemented with randomized or fixed presentation of texts such as vision and hearing. The sense of vision can be stimulated with words, faces or any other visual stimulus, which can then be presented on a computer screen in order to investigate visual information processing. The sense of hearing can be stimulated with words or any other kind of acoustic stimulus to investigate acoustic information (Schneider, 2002).

After a tutorial on each test, the subject completed a practice and then completed the experimental trials. The first test was a visual stimulus-response task: After a delay of five seconds, a cross stimulus (+) was presented in the center of a computer screen for two seconds. The subject would respond by pressing a button when he/she was presented with each visual trial. The visual stimuli were shown on the screen for two seconds in the form of a simple word (animal or non-animal). There were 24 trials: 12 Korean words and 12 English words with the same meaning. They were presented twice randomly in each procedure.

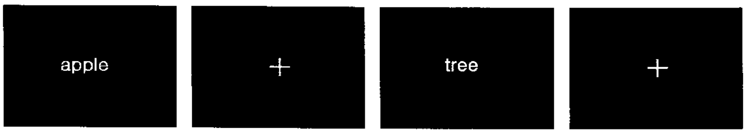

Figure 1. The order of stimuli display

The second test was an auditory stimulus-response task. The subject had the same procedures and trials as used in the first test. Stimuli were presented by the sound of the words after two seconds of a plus symbol (+). They consisted of simple words that represent common objects and were taken from elementary school textbooks such as animals, fruits, or objects. For the first test, trials were made into a *bmp* file with a white letter on black background. The same stimuli were transferred into a *wav* sound file for the second test. *MagicEnglish Plus* software (2005) was utilized for the text-to-sound program in order to produce the same voice and volume for each word. This program was also used to check the time of sound interval for each word. In other words, all words were the same length regardless of how many letters there are (e.g., cat, church, watermelon).

During the test, one of the stimuli would be presented in the center of the screen, and the subject would press the button "1" on the keyboard if it meant an animal, while pressing the button "2" if the stimulus was a non-animal. A subject took the test for eight minutes: four minutes for each trial in reading and listening, respectively.

2.3 Data Analysis

The researchers stored the data and used the E-Prime analysis program in order to identify the RT of the brain. It provided appropriate information relating to the test, especially for individual and group correlation. E-DataAid was also used to create study-specific results that met requirements in the research. E-Merge program processed the data to classify and preserve it (Schneider, 2002). As a result, these programs provided sufficient statistical analysis to test whether the results showed similar or different correlations among the groups. Furthermore, SPSS 10.0 and the One-way ANOVA test were also used.

3. Results

3.1 Listening in English

There were three basic analyses for each group (children, young adults, and adults) of the RT task. In the stimulus-response task for English listening, the total number of the subjects is 127 because there were some errors in the course of the experiment: two for children, four for young adults, and three for adults. The data show that two groups, children and adults, have a slightly different variation, while young adults show a wide-range in variation. This means variations between low and high level subjects in their English listening, which may be largely due to the listening ability, or partly due to other stimuli, such as concentration.

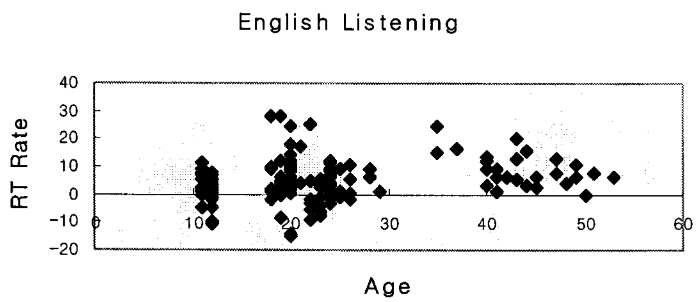

Figure 2. RT rate in groups (English listening)

The RT rate is the relative reaction time of English listening, obtained by dividing the Korean listening RT after extracting the Korean listening RT from the English listening RT. The result is extracted by 100 to reduce the figure: { (English listening-Korean listening)/ Korean listening } -100.

Table 1. Deviation analysis in English listening

Subject	No.	Mean	SD
Children	28	1.3	30.4
Young adults	72	4.3	63.9
Adults	27	9.3	35.0

In <Table 1>, the deviation analysis of listening for each group shows statistically significant differences in a One-way ANOVA test (df=2, f ratio=8.88, p=0.0002: p<0.0001). <Figure 2> points out that the first group (children) is almost the same age group, while the third (adults) has a wide-range. The second group (young adults) is apparently different from the others in each RT.

In <Table 2>, listening variation in each gender indicates that two groups, children and adults, do not show a meaningful difference (df=2, f ratio=0.43, p=0.65). However, young adults reveal a wide-range of variation between genders.

Table 2. Listening in each gender

	Male		Female	
	Mean	SD	Mean	SD
Children	0.3	5.6	3.0	4.6
Young adults	4.3	6.9	-1.2	9.9
Adults	9.6	7.2	10.6	6.0

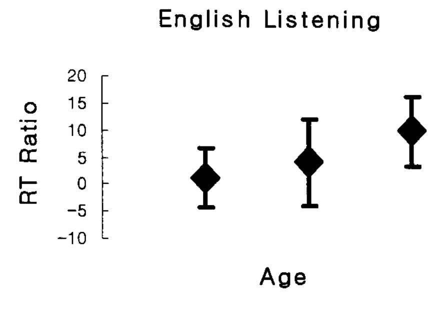

Figure 3. Deviation of each group (English listening)

The diamonds indicate the average RT, and the bars connected with the diamonds indicate the standard deviation in <Figure 3>. The three groups show the different RT for English listening ($p<0.001$). The first (children) and the third (adults) groups have short bar RT results compared to the second group (young adults); these are children (30.4), young adults (63.9), and adults (35.0). In the RT, the first (children) and the third (adults) group suggest the similar results, while the second (young adults) group shows a significant difference. They suggest that the hypothesis that the RT may not be necessarily affected by the age but be dependent on the personal factors.

3.2 Reading in English

One error of the young adults occurs in the English reading stimuli-response task. The variation in the three groups does not show a meaningful difference in this test, which means the age does not have influence on reading English. The data also indicate that genders in the same group do not show a variable factor.

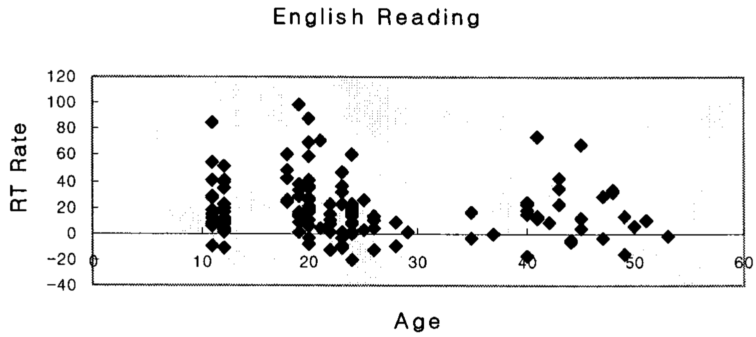

Figure 4. RT rate in groups (English reading)

The RT rate is the relative reaction time to English reading, obtained by dividing Korean reading RT after leaving out Korean reading RT from English reading RT. The result is extracted by 100 to reduce the figure: {(English reading-Korean reading)/Korean reading}-100. The subjects in each group represent quite a similar range of the RT in <Figure 4>, though the minor subjects are a little skewed. <Table 3> supports the figures in detail. The RT of reading English rarely shows statistically meaningful variation in the three groups.

Table 3. Deviation analysis in English reading

Subject	No.	Mean	SD
Children	30	19.5	413.9
Young adults	75	19.7	537.8
Adults	32	15.5	429.9

In <Figure 5>, the positions of diamonds are similar in the first and the second groups (19.5: 19.7) in average RT, whereas the third (adults: 15.5) has a little lower position than the other two groups. On the other hand, children and adults are similar in deviation as indicated by the length of bars (413.9: 429.9), while the bar of young adults (537.8) is longer than the others. The data overall, however, indicate that the RT in English reading does not have statistically meaningful difference within the three groups, compared to RT in English listening.

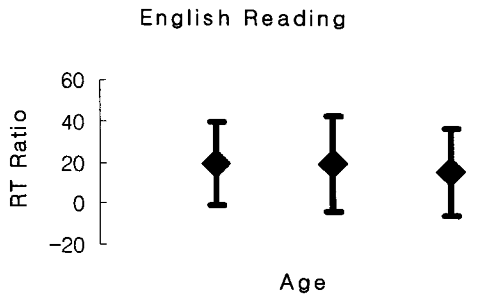

Figure 5. Deviation of each group (English reading)

3.3 English and Korean Listening in Each Group

The RT of English listening ranges from 1.911 to 3.398 seconds in the three groups (average: 2.373), while the RT of Korean listening ranges from 1.881 to 2.933 seconds (average: 2.258). The difference between the two tasks is approximately 0.1 seconds (average: 0.151). The data suggest that the subjects are faster in response when listening to Korean words than to those in English. The difference also appears slightly in age-based groups. Each group is not the same in number since the data come from volunteers. However, the analysis of the figure can be treated using averages.

Table 4. Average RT in each group (English and Korean listening, unit: sec.)

	Male		Female		Mean in Age
	English	Korean	English	Korean	
Children	2.222	2.218	2.360	2.292	2.273
Young adults	2.265	2.178	2.431	2.336	2.302
Adults	2.565	2.334	2.622	2.368	2.473
Mean in groups	2.351	2.243	2.472	2.332	2.349

Interestingly, <Table 4> indicates that on average male subjects respond slightly faster to listening in both target languages than females. Though the RT does not have a significant correlation, the result has meaning in that males in each age group are more dominant in all trials of tasks. Other studies conclude that the RT generally shows age-related slowing, and there are well-known age-related changes in regional brain structures (Haier et al., 2005; Tisserand & Jolles, 2003; Van Petten et al., 2004). The result in this research agrees with their studies, except for the male group in the Korean listening task: males in the young adult group are faster than in any other group.

4. Conclusion and Implications

This research offers the hypothesis that the reaction time (RT) is largely dependent on age and gender. The E-Prime program was used to examine 136 subjects in three groups using English and Korean words in two tests: reading as visual stimuli, and listening as auditory stimuli. The participants are 30 children (5th and 6th grade elementary school students), 76 young adults (college students), and 30 adults (35-53 years old).

Results indicate that age is a crucial factor in RT, regardless of gender. First, the RT in English listening is different among the three groups. The deviations of children and adults do not show a meaningful statistical difference, while young adults show significant variation in each RT.

Second, the RT in English reading does not produce a significant difference in the three groups. That is, they have almost the same deviation in English reading, although young adults are a little faster than the others.

Third, in this data, the RT in English listening increases with age and the age students start to learn English. While lexical decision RTs are shown to be affected by age, relative RT to English in listening is dependent on the time that objects acquired (Youn et al., 2006). Other factors, such as the period of learning or concentration, might be crucial features. Therefore, the researchers suggest that language learning does not necessarily depend on the time when the learners start to learn English. Learners should also be concerned with the ways they study or overcome the variables in listening as well as reading.

Finally, the researchers also propose that following-up studies be conducted to obtain more detailed information regarding language perception. In particular, the correlation between the RT and the duration of learning English can be studied by relating to the testee's ages. These tests will better explain whether early learners of English are consistently faster than later learners in EFL educational settings. The RT generally slows down with age, but the contribution of structural brain changes to this decline is unknown (Haier et al., 2005). Further study should also contribute to enhanced knowledge concerning the problems of early and late bilingual learners in EFL contexts.

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▲ Kyung-Whan Cha
Department of English Education, Chung-Ang University
221, Heukseok-Dong, Dongjak-Gu, Seoul, 155-756, Korea
Tel: +82-2-820-5395 Fax: +82-2-814-2193
Email: kwcha@cau.ac.kr

▲ Young-Chul Youn
Department of Neurology, College of Medicine, Chung-Ang University
224-1, Heukseok-Dong, Dongjak-Gu, Seoul, 156-755, Korea
Tel: +82-010-7190-5404
Email: neudoc@cau.ac.kr

▲ Hyeon Yu
Department of Radiology, College of Medicine, Chung-Ang University
224-1, Heukseok-Dong, Dongjak-Gu, Seoul, 156-755, Korea
Tel: +82-010-6299-2671
Email: hyeonyu@cau.ac.kr

▲ Jaehwang Shim
The Research and Development Institute of English Education, Chung-Ang University
221, Heukseok-Dong, Dongjak-Gu, Seoul, 155-756, Korea
Tel: +82-31-398-5610
Email: julyshim@hanmail.net