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Implications for English Education Based on an ERP Experiment*

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The main purpose of this study was to offer pedagogical implications for English education based on the results of an ERP (Event-related Brain Potential) experiment. The experiment was conducted at a laboratory at Y university and both high and low proficient university students participated in the experiment. ERPs were recorded from 17 students with high English proficiency and 14 students with low English proficiency as they read sentences that ended with the same words used literally and metaphorically. Their ERPs were compared with those of native speakers of English in Coulson's and Petten's (2002) study to understand how they differed and were similar. It was shown that ERPs from high proficient students were similar to those of native speakers but it was noticeable that ERPs from low proficient students were different from those of native speakers of English. Based on the results, some valuable implications were offered for English education: revisiting CPH (Critical Period Hypothesis), rejecting the use of terms, native and nonnative speakers of English, implementing multicultural and multilingual education, and focusing on strategies-based instruction.

[ERP/CPH/proficiency/native speakers of English/nonnative speakers of English/ strategies-based instruction]

I. INTRODUCTION

Whether there is an absolute CP for acquiring a language has been a matter of continuous debate in the field of SLA (Second Language Acquisition). If it is true, it is impossible for late learners (i.e., learners who start learning a SL after puberty) to obtain

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nativelike proficiency in a SL. On the other hand, if it does not exist in the process of learning a second language, late learners can reach a level of nativeness.

In fact, the idea of CP is derived from first language acquisition. For instance, Lenneberg (1967) first proposed that there was a CP for language acquisition and he makes a similar claim about SLA and emphasized that SLA might be difficult after puberty.

In the field of SLA, there are different CPs for different parts of a SL. Several researchers claim that there are CPs for some linguistic components of a language, not all (Fathman, 1975; Dunkel & Pillet, 1957; Scovel, 1988). For instance, Dunkel and Pillet (1957) first proposed that there was a CP for adults in the areas of phonology and phonetics and it was later linguistically refined by Fathman's (1975) and Scovel' (1988) studies in which they claimed that pronunciation was the sole linguistic capacity which showed age effects. Likewise, Long (2005) claimed there was an early sensitive period (i.e., between 6 and 12) for phonology. However, CPs for lexical and collocation abilities as well as morphology and syntax differ (i.e., as early as 6 and in the mid teenage years, respectively). Recently, some researchers have addressed the questions of whether native likeness is attainable for late second language learners (Hyltenstam & Abrahamsson, 2003; Ioup, Boustagui, Tigi, & Moselle,1994). Some of their participants performed like natives on certain tests.

As discussed above, there has been a debate about whether there is a CP for a SL in SLA research. Likewise, neuroimging research on age and proficiency in L2 acquisition shows that some late learners with high level of proficiency process a SL like native speakers of English and that there is a challenge for a CP. For instance, the largest N400 and P600 were observed when advanced SL learners read metaphorical and joke sentences like native speakers of English (Ardal, Donald, Meuter, Muldrew, & Luce, 1990). If late learners with high level of proficiency are shown to process a SL like native speakers of English, it is cautiously suggested that CP hypothesis be revised and more attention be paid to strategies-based instruction which is designed to improve learners' proficiency in a SL.

Therefore, this study investigated if the largest N400 was observed when SL learners with high and low proficiency read metaphorical sentences like native speakers of English and compared the results of the experiment to those of Coulson's and Petten's (2002) experiment in which ERPs were recorded from 18 adult native speakers of English when they read literal, metaphorical, and literal mapping sentences. Instead of delineating the results of the experiment in great detail, this study sought to offer implications for SLA and English education based on the results of the experiment. In what follows, the definition of critical period hypothesis and a debate on critical period hypothesis in SLA were introduced and neuroimaging research on age and proficiency in L2 acquisition was also reviewed.

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II. LITERATURE REVIEW

1. What Is Critical Period Hypothesis?

Lenneberg (1967) first introduced that there is a critical period for language acquisition, biologically determined period of life when language can be acquired more easily and beyond which time language is increasingly difficult to acquire and this proposal was based on different types of evidence: evidence from abused children who grew up without being exposed to human language in childhood and who did not acquire language normally after they were found, and evidence from deaf children whose development in spoken language stopped after puberty. Likewise, he also made a claim about SLA:

> Most individuals of average intelligence are able to learn a second language after the beginning of their second decade, although the incidence of language-learning-blocks rapidly increase after puberty. Also automatic acquisition from mere exposure to a given language seems to disappear after this age and foreign languages have to be taught and learned through a conscious and labored effort. (p. 176)

Later on, Pinker (1994) refined this notion and stated that "acquisition of a normal language is guaranteed for children up to the age of six, is steadily compromised from then until short after puberty, and is rare thereafter" (p. 294).

2. A Debate on Critical Period Hypothesis in SLA

In the field of SLA, much research has been conducted to understand the role of age since the 1960s. Johnson and Newport (1989) focused on 46 adults Chinese and Korean SL learners of English to understand the relationship in between AoA (Age of Arrival) and proficiency. All the participants in this study were given a grammaticality judgment test designed to assess twelve morphosyntactic rules. The results showed that there was a significant relationship between AoA and test scores. The AoA 3-7 group was the only group which was similar to native controls. Thus, it was concluded that there was a determined critical period for SLA, which closes after puberty.

Flege, Yeni-Komshian, Grace, and Liu (1999) also administered the similar test used in Johnson's and Newport's study (1989) and tested 240 Korean learners of English with AoA ranging from 1 to 23, divided over 10 AoA groups. It was found that there was a significant relationship in between AoA and test scores.

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In a similar way, DeKeyser (2000) studied Hungarian second language learners of English with AoA from 1 to 40 to see the relationship in between AoA and scores on the grammatical judgment test. It was revealed that there was a significant correlation in between AoA and test scores, which constituted evidence in favor of a CP.

Contrary to the aforementioned studies, the following studies are not in favor of CPH. Bialystok and Miller (1999) administered the similar grammaticality judgment test used in Johnson's and Newport's (1989) study and studied 28 Spanish and 33 Chinese second language learners of English and a control group of 38 native speakers of English. Unlike Johnson and Newport (1989), they did not find significant differences for accuracy among the three oldest learner groups and thus they concluded that there was no evidence for a CP for second language acquisition. Similarly, Coppieters (1987) tested 21 adults with high proficiency of French and compared their performance on a grammaticality judgment task with that of native speakers and the results revealed that adults learners' performance was similar to that of natives.

In the area of pronunciation, Neufeld's (1978) study is often used to refute the CPH. In this study, adult native speakers of English were rated as native for Japanese and Chinese and it was suggested that adults can achieve native ability pronunciation under the right conditions. Similarly, some researchers found it was possible to obtain native like proficiency for advanced learners under optimal learning conditions (Birdsong, 1992; Bongaerts, 1999; Moyer, 1999). For instance, Birdsong (1992) compared performance of English speaking learners of French with that of native speakers of French on a grammaticality judgment test and found out that there was no evidence of any dramatic differences in the judgments of the two groups.

3. ERP Research on Age and Proficiency in SLA

It seems suitable to use neuroimaging techniques when researchers address if there are neurophysiological changes in the brain before puberty that can explain the general tendency that early learners attain a higher level of proficiency. In fact, aspects of the brain's electrophysiological activity can be recorded from the scalp. In ERP research, participants' electrical brain activity is measured by a number of electrodes on their heads when they read or listen to tokens of the L2 and certain linguistic manipulations elicit robust effect in the ERP. For instance, syntactic and semantic anomalies elicit distinct ERP effects and researchers mainly focus on three important linguistic ERP components found for native speakers, the N400, the P600, and ELAN (Early Left Anterior Negativity). The N400 is a negative deflection in the brain waves at around 400 milliseconds after the presentation of a semantically anomalous word (i.e., the dog will bake the food.) (Kutas & Hillyard, 1980; Osterhout & Nicol, 1999). By contrast,

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syntactic anomalies (i.e., The dog will eating the food.) elicit a large positive wave that onsets at about 500ms after presentation of the anomalous word and persist for at least half a second (i.e., the P600 effect) (Osterhout & Holcomb, 1992; Osterhout & Mobley, 1995; Osterhout & Nicol, 1999). The ELAN is an early negative deflection on the left front side of the brain often found in syntactic conditions.

Some ERP related studies suggest that proficiency is more important as a determinant of cortical representation than age of onset of L2 acquisition. Ardal et al. (1990) tested the three groups, early proficient learners of French, late proficient learners of English, and English monolinguals, to understand their brain waves when they responded to incongruent and congruent sentence final words. The N-400 effect occurred earlier in the monolinguals than in bilinguals and later in the bilinguals' L2 than in their L1 and there was no differences for the L1 or the L2 between early versus late bilinguals. The results of this study suggested that the differences between the monolinguals and the late bilinguals were caused by the differences in having one versus two languages and in proficiency rather than age of onset of acquisition.

In a similar way, Weber-Fox and Neville (1996) compared syntactic and semantic anomalies in an ERP experiment focusing on 61 Chinese English bilinguals with at least five years of immersion divided into five AoA groups (i.e., 1-3, 4-6, 7-10, 11-13, and >16). For the semantically incorrect sentences, all the participants who arrived before the age of eleven were shown to perform like native speakers. For instance, the N400 was later for the highest AoA group and the remaining groups had a normal N400 pattern. However, the delay of the P600 was observed in the group (i.e., AoA 11-13) and the P600 was absent for the group (>16).

Hahne and Friederici (2001) also focused on syntactic and semantic processing in late Japanese learners of German (AoA 18-31) in comparison with native speakers of German. The participants were asked to read four different types of sentences, correct sentences, semantically incorrect sentences, syntactically incorrect sentences, and sentences that were semantically and syntactically incorrect. For the semantically incorrect sentences, the N400 was later for the highest AoA group but the remaining groups had a normal N400 pattern. For the syntactically incorrect sentences, the P600 effect was delayed for the group (AoA 11-13) and was not observed for the oldest learners.

To understand how advanced late learners of Dutch process gender and gender agreement in an ERP experiment, Sabourin (2003) compared a control group of 23 native speakers of Dutch with 14 native speakers of German, 8 native speakers of a Roman language, and 9 native speakers of English. To assess how well participants understand grammatical gender, the following four conditions were used: an NP definite condition (i.e., occurrence of right or wrong definite article), an NP indefinite condition

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(i.e., occurrence of adjective with or without inflection for gender agreement), an RP definite condition (i.e., agreement or disagreement between relative pronoun and definite antecedent) , and an RP indefinite condition (i.e., agreement or disagreement between relative pronoun and indefinite antecedent). The German group had a P600 effect for all conditions, the Roman group had a P600 on the finiteness condition, and the English group had a P600 for the finiteness and subject-verb agreement conditions and thus it was concluded that the participants performed like natives when they processed grammatical features similar in the L1 and the L2.

In the experiment conducted by Ojiman, Nakata, and Kakigi (2005), the three groups (i.e., native speakers of English, Japanese speakers with high proficiency, and Japanese speakers with low proficiency) were compared to understand the cortical process of post childhood L2 learning. They found that differences in ERPs between Japanese speakers with high proficiency and Japanese speakers with low proficiency. Specifically, a clear N400 component was observed in all three groups when they read English sentences with semantic anomalies. However, syntactic anomalies evoked a P600 in the two groups, native speakers of English and Japanese speakers with high proficiency. Thus, they concluded that they did not find concrete evidence for an absolute CP effect on SLA.

As discussed above, the results from ERP studies have shown an interesting perspective, age of onset of L2 acquisition is not a sole determinant of successful SLA, with respect to the CPH for SLA. Thus, it is suggested that CPH require further inquiry.

III. METHODS

1. Setting and Participants

The experiment was conducted at a laboratory at Y university in Seoul, Korea from July, 2010 to June, 2011. The laboratory was equipped with an ERP and computers and a research professor and several assistants were stationed to carry out experiments.

17 students (7 females and 10 males) with high proficiency (over 850 on the TOEIC) and 14 students (6 females and 8 males) with low proficiency (in between 450 and 550 on the TOEIC) voluntarily participated and were paid for their participation. They officially started learning English in Korea at around 13 years old, had normal visual acuity, and none had any reported history of neurological or psychiatric disorders. All of them were students of Y university, aged from 21 to 27, and studied varying majors (i.e., accounting, business, chemistry, education, engineering, English language & literature, history education, international trade, etc.)

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2. Materials

The researcher made 110 sets of the materials. The sets were divided into two lists (i.e., 55 literals and 55 metaphors) so that each word occurred in every condition across participants while a given participant saw sentence final word in one of its two possible sentence frames.

As shown in Table 1, each set has a one literal sentence followed by a comprehension question and a one metaphorical sentence followed by a comprehension question. Each type of sentence has a similar number of words in it and the same ending (critical word). The purpose of using comprehension questions was to see how well the participants understood the given sentences.

TABLE 1

A Sample Set of the Materials

Types & CQs	Examples
Literal (11words)	The stone we saw in the national museum is a **gem.**
Literal CQ (T/F)	We did not see a gem in the national museum (F).
Metaphor (11words)	After some thought, I realized the new idea was a **gem.**
Metaphor CQ (T/F)	I felt that the new idea was brilliant after deep consideration (T).

All the materials were reviewed by a native English speaking professor to check how appropriate and natural they were and revised based on his opinion.

3. Procedures

To recruit participants, the research assistants posted flyers on the bulletin boards in several buildings at Y university and the researcher acquired consent forms from the participants before each experiment. To prepare for the experiment, the research assistants injected gel into rods in an elastic cap and had the participants wear the cap. The participants sat in a comfortable chair and read what appeared on the monitor. The sentences were presented one word at a time for a duration of 200 msec each. The sentence final words were presented for 200 msec before the onset of the true/false questions and the questions were shown for 6 sec and the participants responded through a buttonpress. Sentences followed by incorrect answers were not included in the analysis. There were 2 sec of blank screen followed by each question before the beginning of the next trial. Each experiment was carried out at a laboratory at Y university and lasted approximately 60 minutes.

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4. Electrophysiological Recording

Participants' electroencephalogram (EEG) was recorded from 32 electrodes mounted in an elastic cap. Midline frontal (Fz), central (Cz), and parietal (Pz) recording sites were used along with parietal (P3 and P4) and occipital (O1 and O2) scalp. Each scalp site was referred to the left mastoid and later re-referenced to an average of the left and right mastoids. To monitor blinks and eye movements, electrodes were also placed under the right eye and at the outer canthi. EEG was digitized online with a sampling rate of 250 Hz and stored on a hard disk for subsequent averaging. Trials with eye movement, muscle or amplifier saturation artifacts were rejected offline prior to averaging. ERPs were time-locked to the onset of sentence-final words in each condition.

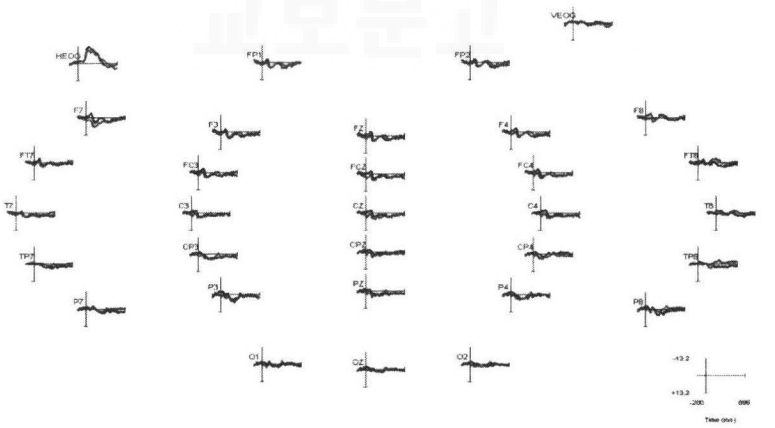
IV. RESULTS AND DISCUSSION

1. Results from an ERP Experiment

Figure 1 displays the ERPs elicited by sentence-final words in the two conditions (i.e.,

FIGURE 1

Grand Average Event-related Brain Potentials Elicited by the Sentence-final Words from High Proficient Learners



literals-solid lines and metaphors-dotted lines) from high proficient English language learners from all the 32 channels. As shown in Figure 1, metaphors elicited larger N400

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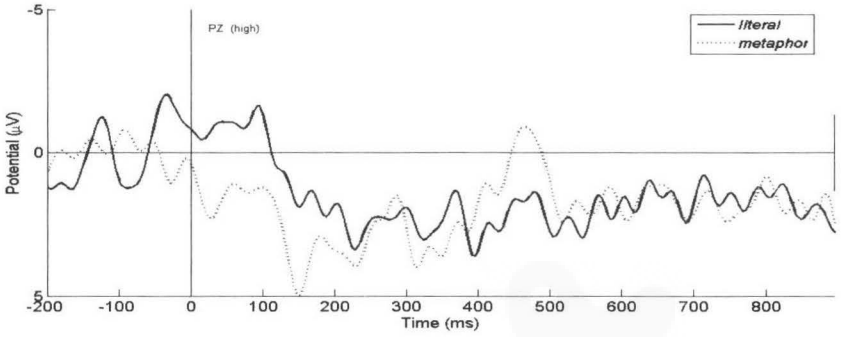
than did literal sentences at Fz, Cz, Pz, and Oz sites. Specifically, as shown in Figures 2 and 3, metaphors elicited a larger late positivity than did the literal condition.

FIGURE 2

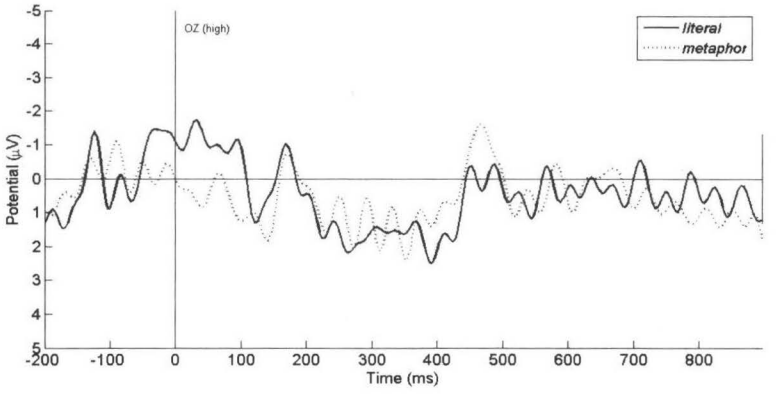
Grand Average Event-related Brain Potentials Elicited by the Sentence-final Words at Pz from High Proficient Learners



It is interesting to see that the results of the study was similar to those of Coulson's and Petten's (2002) study in which N400 was visible at all scalp sites and metaphor elicited larger N400s when adult native speakers of English read metaphorical sentences.

FIGURE 3

Grand Average Event-related Brain Potentials Elicited by the Sentence-final Words at Oz from High Proficient Learners



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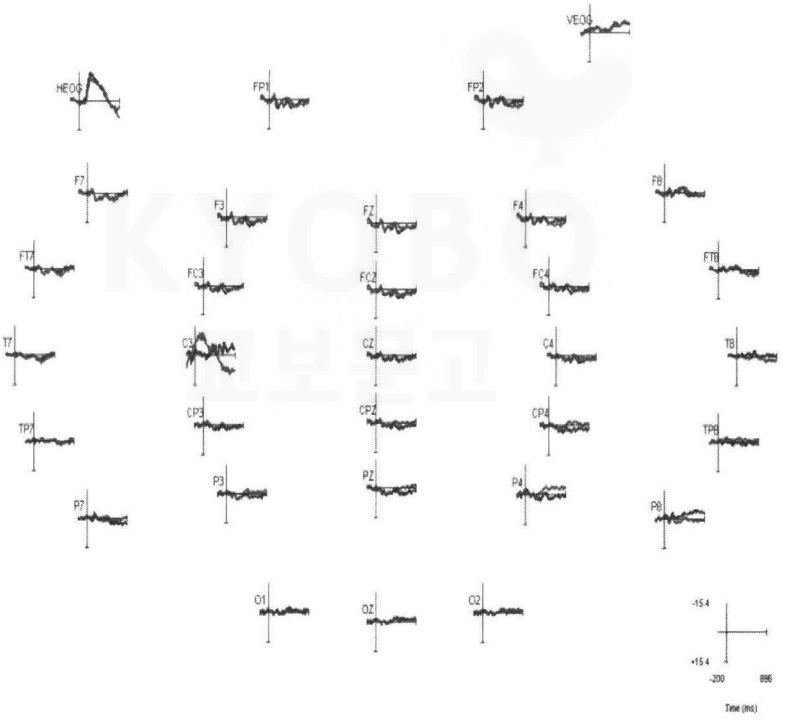
In fact, metaphors elicited larger N400s than did the literal and literal mapping conditions at posterior scalp sites (i.e., parietal and occipital) in their study, which is similar to the results of the study shown in Figures 2 and 3. Based on the comparison, it is noticeable that adult native speakers of English and advanced English language learners process language (i.e., literal and metaphorical sentences) in quite a similar way.

Figure 4 shows the ERPs elicited by sentence-final words in the two conditions (i.e., literals-solid lines and metaphors-dotted lines) from low proficient English language learners from all the 32 channels. Unlike the results of high proficient English learners, N400 was larger than literal condition at Fz site but not at Cz, Pz, and Oz sites.

FIGURE 4

Grand Average Event-related Brain Potentials Elicited by the Sentence-final Words from Low Proficient Learners



Unlike N400 at Fz, no N400 amplitude difference was observed in literal and metaphoric sentences at Pz and Oz, which is shown in Figures 5 and 6.

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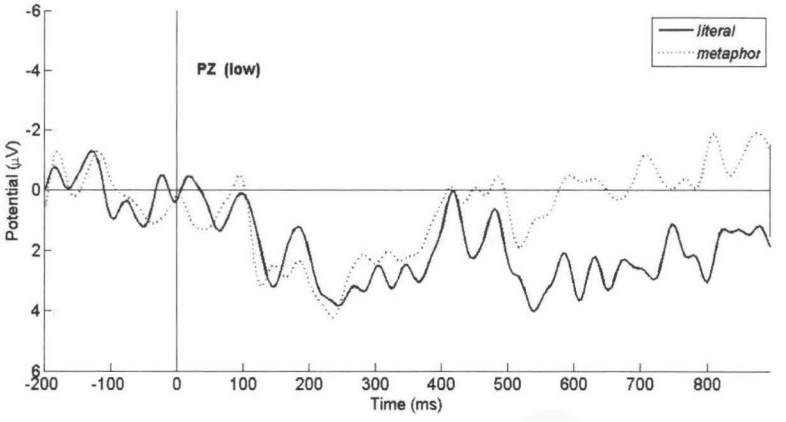
FIGURE 5

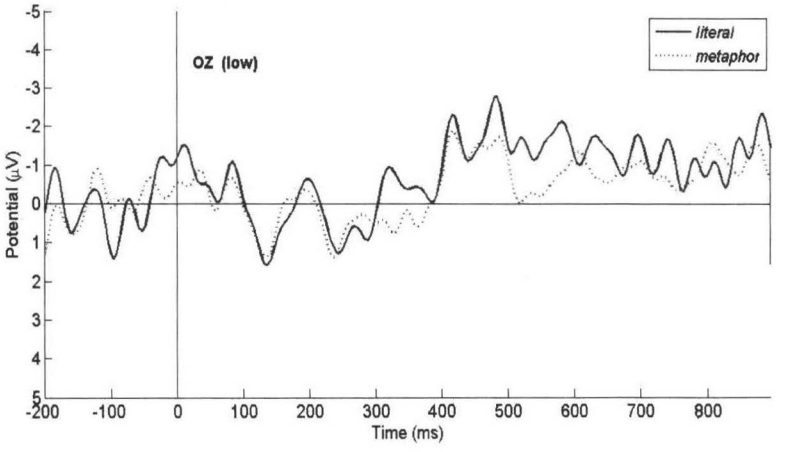
Grand Average Event-related Brain Potentials Elicited by the Sentence-final Words at Pz from Low Proficient Learners



It was shown in Figures 5 and 6 that both literal and metaphoric sentences from low proficient learners did not elicit N400, which was different from ERPs of high proficient learners.

FIGURE 6

Grand Average Event-related Brain Potentials Elicited by the Sentence-final Words at Oz from Low Proficient Learners



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Based on the comparison of the results of the study and those of Coulson's and Petten's (2002) study, it was shown that high and low proficiency English language learners processed the same language condition in a different way. However, there was a similarity in the way of processing the similar langauge conditions among adult native English speakers and high proficient English language learners.

2. Implications for English Education

According to CPH, the ability to learn a language seems to degrade with age. However, the causes of age effects on L2 proficiency are controversial and the hypothesis seems to be inconsistent with accumulating evidence that the brain remains remarkably plastic throughout much of life (Van Praag, Kempermann, & Gage, 2000). Likewise, the results of the study revealed that unlike late second language learners with low proficiency, those with high proficiency processed a SL like native English speakers.

Based on the results of this study, the following suggestions were made for SLA and English education. First, CPH needs further inquiry. According to the hypothesis, language learning is constrained by brain maturation that circumscribe a CP for native-like attainment, which implicates that around or beyond puberty, people seem to be incapable of acquiring a SL. In a sense, it makes sense that younger learners tend to achieve higher levels of success than older learners, but despite the popularity of this view, it must be understood in the light of what it means to be native-like in learning a SL (Brown, 2007). In fact, the use of the terms, native and nonnative speakers of English, is somewhat obsolete because people use English as a tool to communicate in a globalized society (Choi, 2012). It eventually produces a new term, EIL (English as an International Language) and more and more people use English to communicate with other people all over the world (Kachru, 2006). Thus, what is important is comprehensibility not native-like perfection in communicating with other people. In addition, like other researchers have argued, it is hard to define when puberty occurs because puberty is getting younger compared to that defined earlier (Geschwind, 1970; Krashen, 1973; Lenneberg, 1967; Scovel, 1988).

For spreading this idea among people, multicultural and multilingual education should be implemented in the curriculum of English education. It should offer courses where students come to realize that there is no dichotomy, such as standard and nonstandard English or native and nonnative speakers of English, and English plays an important role as a communication tool in many fields of activity, such as business and banking, industry and commerce, transportation, tourism, sports, international diplomacy, advertising, and so on.

This rather huger concept can be applicable to EMCs (English Medium Course) here

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in Korea. In fact, one distinctive feature of EMCs is teachers talking and students listening. To create a more interactive classroom atmosphere, many teachers have made tremendous efforts to make students actively participate in class by using innovative classroom activities, materials, and procedures (Yang, 2011). In addition to this, teachers in EMCs can make students actively participate in class by disseminating the idea that they are part of a globalized society and language is a tool to communicate with other people. Through this, it is hoped that students will be able to transform their identity from passive language learner to active language users and this kind of ownership of English will make them invest more in studying English conducive to their English language proficiency.

Moreover, the results of the study revealed that late SL learners with high proficiency were shown to process a SL like native speakers of English. Based on this, it is suggested that strategies-based instruction (Chamot & O'Malley, 1986) which can refine learners' skills (i.e., self-monitoring, note-taking, question for clarification, etc.) in a SL receive more attention. For instance, more constructivist approach (Vygotsky, 1978) to English education is needed. Teachers should provide an active learning environment in which students can have the opportunity to work with other students, to explore a problem, and try out solutions. Students should be encouraged to draw, discuss, and write about what they are learning.

V. CONCLUSIONS

The results of the ERP experiment revealed that unlike SL learners with low proficiency, high proficient SL learners and native speakers of English processed linguistic information in a similar way, which suggests that there is a possibility of late SL learners' reaching a level of native-like attainment. Based on it, the researcher suggested that CPH be redefined by including how English is defined nowadays, addressed the necessity of including courses related to multiculturalism and multilingualism in English education curriculum, and finally emphasized the importance of refining students' language skills by adopting more strategies-based instruction.

This study is valuable in that the researcher made efforts to produce practical implications for English education based on a neuroimaging experiment but there are some limitations of this study. First, the way of defining the term, late language learners, is somewhat problematic. Second, it might be said that the researcher overgeneralized the results of the study because she focused on only one language area, semantics.

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Example in: English
Applicable Languages: English
Applicable Levels: All

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