

<論 説>

A Survey of Second Language Acquisition Studies from Neurobiological Perspective

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ABSTRACT

In the first section, major approaches to Second Language Acquisition (SLA) are described, and some examples are given, in order to show the situation and problems of research in this field. The first four approaches focus their attentions on language alone. The fifth and sixth approaches look at SLA from a different perspective, i.e. from the learners' side. Interesting data and hypotheses about SLA have been produced under these approaches. However, once it comes to the matter of second language acquisition mechanisms, the proposed explanations lack biological reality. Therefore in the second section, another approach from the learners side, i.e. the learners brain, is proposed. Three issues in SLA, Krashen's Monitor Theory, bilingualism, and differential success among late second language learners are discussed from the neurobiological perspective.

Key Words : Second Language Acquisition (SLA), Neurobiological Perspective

I. MAJOR APPROACHES TO SECOND LANGUAGE ACQUISITION

Since ancient times, people, laymen and scholars, have investigated the ways a second language is acquired. As a result, an enormous amount of hypotheses and findings have been presented and debated. In this section, the present paper does not attempt to provide a comprehensive review of the past investigation. Instead it describes and gives some examples of the recent major second language acquisition research to show the situation and problems in the field.

1. Contrastive Analysis

Contrastive analysts begin their investigation by comparing mother language (L1) with the target second language (L2), for example Japanese with English. Through the comparison they find phonetic, morphological and syntactical similarities and differences that exist between the two languages. Then they predict that those similarities help the learners acquire

L2 and this is often referred to as positive transfer from L1. On the other hand, the differences between the two languages are to cause difficulties and errors in L2 acquisition. Therefore, this is referred to as negative transfer or interference from L1. Contrastive analysts claim that those interference from L1 will be overcome by drawing learners attentions to the differences and by creating a new set of L2 habits through intensive practices.

Unfortunately, language acquisition mechanism is not so simple. For example, Japanese do not have articles (the, a) and Japanese word orders are also different from English. However, many researchers report that English word orders are fairly easily mastered by Japanese learners whereas even advanced learners have problems with articles¹⁾. Another difficulty for Japanese students is the differentiation of English [l/r]. While some students may master it faster than the other students, some taught by the same teacher in the same class may never learn. These

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acquisition variances among L2 learners with the same L1 background indicate that there are more factors involved in L2 acquisition than just the phonetic, morphological or syntactical differences between the two languages.

2. Error Analysis

Unlike the contrastive analysts who first compare L1 and L2 languages in order to predict the nature and problems with L2 acquisition, error analysts make direct observations and recordings of the errors actually made by L2 learners. Then they analyze those collected errors speculating the causes of the errors and also the nature of language acquisition. They have traced some errors to L1 interference as contrastive analysts predicted, but they have also found that L2 learners with different mother languages (L1s) commit similar types of errors, which seem to require other explanations than L1 interference. For instance, Japanese beginners of English sometimes make such errors as 1b) or 2b) below:

- | | | | | | |
|-----|------|--------|-----|-------|----------|
| 1a) | work | worked | 1b) | speak | *speaked |
| 2a) | book | books | 2b) | foot | *foots |

Chinese learners of English or even children learning their mother tongue, English, are also reported to commit similar kinds of errors²⁾. So, the error analysts attribute these errors to learners' overgeneralization rather than to L1 interference. Other sources of errors suggested by error analysts besides L1 interference and overgeneralization are simplification, developmental error, communicative strategies, learning strategies, transfer from training, etc. One of the major problems with this approach is the ambiguous explanation of these errors. For example, are all Japanese English learners under L1 influence when they omit plural marker -s and say, *"I studied English for two year"? Could it be possible that some of the learners are exhibiting simplification or a transfer from training? Sometimes even analysts themselves are unable to decide which

is the true cause of errors and they enumerate several sources as possibilities.

3. Interlanguage Approach

Among the error analysts there are some researchers who direct their attention not so much on the causes of errors but look at the errors from a different perspective. They consider language as a set of rules. Therefore, language learning is a process of acquiring the rules of the target language and the errors are the indication of the active processing in the learners' minds, such as making hypotheses and testing the rules of the target language. They call such temporal stage of language Interlanguage. By studying Interlanguage, those researchers hope to find language acquisition mechanisms. For example, Dickerson reports that there exist certain observable rules in acquisition of English pronunciation by Japanese students³⁾. She analyzed the pronunciation of 10 Japanese students who were studying in the US. She recorded their pronunciation three times over 9 months on three tasks: (1) free speech (2) reading dialogue aloud (3) reading word lists aloud. Her findings are as follows. 1. Pronunciation is conditioned by phonological environment. For example the correct /r/variant was used most frequently before a low vowel like /rack/ (rock) and least frequently before a high vowel like /ru:l/ (rule). 2. Correct pronunciation is produced most frequently when learners are reading word list and least frequently in free speech. 3. Acquisition of English pronunciation as a second language is achieved very slowly as target-like pronunciations gradually increase in learners' Interlanguage. Tarone, who conducted similar research, explains the variation according to given tasks as summarized in Dickerson's finding 2 above as the result of learners' attention paid to the language form. She also predicts that target language-like acquisition first occur in the most careful utterance and gradually moves to the casual utterance with less or no attention to language form⁴⁾. There is, however, some research

including a later study by Tarone that gives opposite results,

Some other investigators approach Interlanguage from a different angle. Being influenced by L1 researchers who study the acquisition orders of mother tongues by children, some L2 investigators make longitudinal and cross-sectional studies on L2 acquisition orders. In longitudinal studies, utterances of one or two L2 learners are recorded for certain period of time to be analyzed mainly for tracing acquisition order of morphological elements. In cross-sectional studies, utterances of numerous L2 learners with similar L1 background are collected as data for analysis. These investigators claim that they have discovered some degree of similarity between L1 and L2 acquisition orders. Ravem, for instance, studied the development of English negation in his Norwegian children⁵⁾. Milton also studied English negation by a seven-year-old Japanese speaker⁶⁾. Both reported that negative utterances orders produced by those children were very much like those of children acquiring English as L1. The following is the developmental order for ESL (English as a Second Language) negation summarized by Larsen-Freeman⁷⁾.

stage	sample utterance
Stage 1 no+X	No you playing here.
Stage 2 no/don't V	don't have job.
Stage 3 aux-neg	I can't play the guitar.
Stage 4 analyzed don't	She doesn't drink.

At stage 1, negation is made by putting "No" at the beginning of an utterance. At stage 2, internal pre-verbal negations occur very commonly. Not only "no" but "not" and "don't" are also used. "Don't" at this stage is used as an unanalyzed negative particle as in "He don't like job," "I don't can play good." At stage 3, again unanalyzed chunk of "can't" and often "wasn't" are used, which soon leads to stage 4 in which the learners use analyzed Aux. + neg. and analyzed "don't", i.e. correct negation. Learners with different L1 backgrounds have been observed to pass

through these four stages. According Larsen-Freeman, a striking feature of this negation finding is the commonality of initial pre-verbal construction. Not only the speakers of L1s with pre-verbal negation but also the speakers of L1s with post-verbal negation such as Japanese and Turks are also found to use the pre-verbal negation structure. But here again, there are many studies which report different acquisition orders. Different results may be partly due to task variation since L2 learners perform differently according to the task given, such as picture description test or grammaticality judgment test, and also due to L2 learners' cultural, educational and personal background including different L1. Even though Interlanguage researchers observe some commonality and systematicity in Interlanguage, there are still many variations in their results that require explanation. Perhaps it is time to incorporate a new perspective, such as a neurobiological approach in order to account for those variations.

4. Universal Grammar-based Approach

Contrastive analysts and error analysts focus their attention on the differences between the languages. On the other hand, those who take up a common acquisition order approach as mentioned above and those who advocate this Universal Grammar (UG) as their perspective, focus their attention on the similarities among the languages. What underlies UG based research is Chomsky's idea that a human infant is born with ability to learn language and universal language-specific knowledge, UG. UG consists of certain syntactic principles and parameters. These principles include syntactic categories such as subject, object, noun, verb and distinctive phonological features. Parameters in UG are abstract rules which account for the minor differences among the languages. UG approach is very different from other research which study L2 learners' actual utterances. Instead, the aim of UG-based L2 acquisition research is to construct abstract rules (grammar) that govern the human languages in

general. Therefore, it has no way of accounting for the individual differences in language acquisition we so often notice especially among L2 learners.

5. Socio-Psychological Factor Approach

All the approaches mentioned above are the same in the point that they study language to speculate about L2 acquisition mechanism. But some researchers try to get insight about the L2 acquisition by studying learners' problems, sometimes referred to as *learner's factors*.

Various studies suggest there is a relationship between learners' motivation and learners' success in L2 acquisition/ proficiency, while all children with normal faculties universally acquire their mother tongue (L1) without being conscious of their motivations. Most studies in this approach are carried out in survey form but with mixed results. So, Gardner and Lambert, for example, proved by their earlier survey conducted in Canada that "integrative motivation" (i.e. learners have strong desire to identify themselves with the speakers of the target language) is superior to other motivations. But their later survey on learners of English as a foreign language in the Philippines showed "instrumental motivation" (i.e. learners study the target language for utilitarian purposes such as career, social status, grades, and etc.) highly correlates with the students' English proficiency. On the other hand, Stong's survey on Spanish-speaking children learning English in an American classroom reports that it is not motivation that enhances language acquisition but "the student's intensity of integrative motivation increased relative to their English language proficiency"⁸⁾.

6. Cognitive Factor Approach

Various studies report that cognitive factors like memory, learning strategies, aptitude, personalities, sex, age, etc., all of which are involved with learners processing stimuli, are responsible for differential success in L2 acquisition. Learners are reported to use such learning strategies as deduction, transfer,

inference, selective attention, auditory representation, etc. McLaughlin found that experienced language learners switch strategies according to the tasks⁹⁾.

Caroll postulates that language aptitude accounts for the individual variance in foreign language learning. He made statistical analysis of correlational data obtained from his well known Modern Language Aptitude Test results and proposed four abilities as components of aptitude: 1. grammatical sensitivity 2. phonetic coding ability 3. associative memory 4. inductive language learning ability¹⁰⁾. Neufeld, Oller, and Perkins dispute the existence of a special aptitude for language, arguing that general intelligence accounts for the individual variance in foreign language acquisition. Skehan and McLaughlin found out in their surveys that family variables such as family-background, parental education or literacy influence child's aptitude and ability to use strategies¹¹⁾.

As for the age, it has been a big issue in L2 acquisition: Is there such thing as critical period after which the native like mastery of L2 is impossible? It is noticed by many parents, teachers and researchers that children learn L2 better than adults. Especially those early starters who began learning before the age of five speak L2 without accent and their syntactical usage is just like the native speakers. However short term research, in which observations of the learners were made for a short period of time like from a few minutes to a few months, often reports older children and adults do better than those younger children except in pronunciation.

II. INCORPORATING THE NEUROBIOLOGICAL PERSPECTIVES

In the previous section of this paper, major approaches adopted by SLA researchers have been discussed briefly. Accumulated data, a wealth of findings and detailed results from various experiments on SLA phenomena are very informative and valuable. However, when the researchers try to infer principles and mechanisms that are operating behind the

observed phenomena, their explanations strike us inadequate. They say “x” phenomenon is due to either L1 interference, overgeneralization or simplification, but overgeneralization and simplification are in fact descriptions of learners’ behaviors. What we need to find out is the mechanism underlying those behaviors. As for the interference of L1, it is not a behavior but it is still a phenomenon. We need to find out how it happens. They also say grammatical sensitivity and motivations are important. What is grammatical sensitivity? Motivations are mental conditions but what is the mechanism that tie mental conditions and learning? Another typical example of unsatisfactory explanations is the reference to innate language acquisition mechanisms specific to human beings. The most frequently used of such mechanism is Chomsky’s ‘Language Acquisition Device’ (LAD). As mentioned in the first section of this paper, Chomskian researchers claim that human infants must be endowed with UG and with highly sophisticated innate ability to learn the rules of its mother tongue from natural speech. But what is this innate language acquisition device specific to human beings? One knows human beings are born with ability to see but thanks to doctors and neurobiologists we know how the optical system works. According to Jacobs and Schuman, “this theoretical linguistic assertion that there is an innate, wholly distinct ‘language organ’ seem to be default metaphors that reflect our ignorance about how language is acquired”¹²⁾. They also state,

Unlike the formal linguistic perspective, a neurobiological approach does not consider human language acquisition to be fundamentally different from learning of any other type of knowledge (in other species). Learning, in its most general sense, involves alteration of the microanatomical and molecular neural structure to the point where information can be retained and retrieved so as to be able to effect behavior. Although different species do not learn the same things,

it is the same type of neural issue, following the same natural laws, which makes this learning possible¹³⁾.

We all agree that cognitive processes underlie language acquisition for anybody whether they are adults, children or infants. In order to understand cognitive processes we need to understand the brain. Therefore, the above cited claim from neurologists who study the brain should not be ignored. The study of the brain has made a great progress during the past decade and there are now many findings of relevance to language acquisition available to us. Let us apply the brain science perspective to SLA studies in order to view them in a different way.

1. Krashen’s Monitor Theory

Krashen was an influential figure in Second Language Acquisition research during 1970’s and 1980’s. He is famous for his Monitor Theory in which he claims that two separate and independent systems are involved in second language acquisition: *acquisition* and *learning*. By *acquisition* he means the unconscious process, for example used by children when they develop their first language, whereas *learning* is a conscious process resulting in knowledge about the target language or simple easy grammar, such as the rule for plural morphemes. According to Krashen, second language acquisition is largely the result of unconscious process and the consciously learned system at school, for example, serves little but only to monitor the production by the acquisition system¹⁴⁾.

Robinson conducted an experiment to check the plausibility of Krashen’s Monitor Theory¹⁵⁾. His subjects were 60 Japanese university students. They were divided into 4 groups according the training conditions they received: (1) Implicit condition, in which subjects were encouraged to remember instances of input (2) Incidental condition, in which subjects were encouraged to process input for meaning (3) Enhanced condition, in which subjects were encouraged to process input for meaning while

simultaneously noticing selected features of the form (4) Instructed condition, in which subjects were taught rules regulating the input and were encouraged to apply them to examples. Then all the subjects took a grammaticality judgment test immediately following training. After the test, all subjects answered a debriefing questionnaire in which they were asked whether they had noticed any rules during the training session, whether they had been looking for rules, and if they could say what the rules were.

Robinson found through his experiment that Instructed learners are clearly superior to learners in other three conditions in their ability (i.e. in accuracy and speed) to judge grammaticality of new sentences because they acquired generalized knowledge through instruction. As for the learners in all other conditions, decisions about previously encountered sentences are faster than decisions about new sentences, suggesting that rule-based knowledge is developed through conscious effort. Thus Robinson's experiment gives a counter proof against Krashen's theory that second language development is the result of unconscious process.

However, one sees in Robinson's report on Questionnaire Response (Fig.1) that the subjects in Implicit and Incidental conditions looked for rules and some of them noticed rules even though they could not verbalize them. Isn't this the phenomenon Krashen meant by unconscious acquisition even though it was proved by Robinson's study that it is less powerful than conscious learning?

iv. Questionnaire Responses.			
	Noticed rules	Looked for rules	Verbalized rules
Implicit	4	8	0
Incidental	5	6	0
Enhanced	10	8	0
Instructed	13	14	13

Fig. 1 Peter Robinson,
JACET Lecture, October, 1996

On the other hand one finds a very informative study from the cognitive perspective made by Posner and Keel¹⁶⁾. They conducted an

experiment to find out if one learns by generalization or by experience. They prepared patterns composed of 9 dots, each pattern was slightly different from the others. Before the experiment, subjects went through a session to practice classifying a set of 9 patterns (referred to as old patterns from now on) into 4 categories until their performance was 100% correct. Then they were given a new set of patterns including prototypes and were asked to decide which categories they belong to as fast as possible. The accuracy and response time of classifying the prototype patterns, even though they are new to the subjects, was almost comparable to the response time and accuracy needed to classify the old patterns. Also, the identification of the prototype patterns was much faster and accurate than the new patterns.

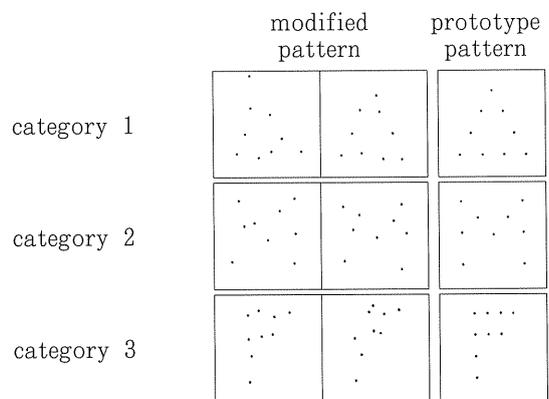


Fig. 2 Ichikawa,S., Itoh,Y., et al.
Kiokuto gakushu (The science of memory).
Iwanamishoten, p33, (1994)

As one can tell from Fig.2, the prototype patterns are standard or average of all other slightly different patterns. Posner and Keel, therefore, conclude that their subjects were developing prototypes or standards in their mind during the practice session. Though this experiment is on the recognition of visual patterns and not on language rules, there is no reason to believe that the fundamental cognition principle operating behind is not the same. The results of this experiment provide a plausible evidence for Krashen's vague notion of unconscious learning of language rules.

However, what is the brain mechanism underlying the phenomena like the pattern

recognition introduced above or language-rule acquisition proposed by Krashen? One finds a very interesting neurobiological principle mentioned by Tachibana in his book¹⁷⁾ and discussed in Pulvermüller and Shumann's study¹⁸⁾. The principle is called Hebb's Law. Hebb's Law states that the more frequently neurons A and B are activated simultaneously, the stronger the synaptic connections between them become. According to Pulvermüller and Shumann, individual content word is neurobiologically represented by a strongly connected set of neurons (cell assembly). Suppose a learner has already learned the content words, *swimmer* and *diver*. Those words are stored in the brain as the connection between cell assemblies as represented by circles in Fig.3. The overlap

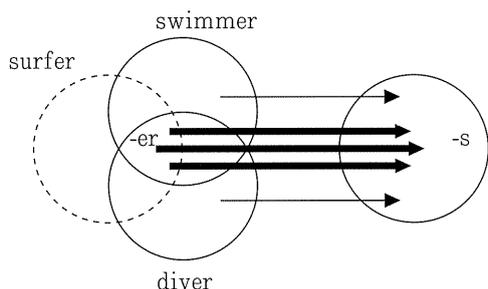


Fig. 3 Modified from Pulvermüller, F.,
What neurobiology can buy language theory.
SSLA, 17, P75, (1995)

part indicates that the two words share some neurons in common, for example neurons for *-er* and semantic features. Each time the learner encounters either of the two nouns with a plural suffix *-s*, the overlapped region (shared neurons) is activated. Consequently the connection between the overlap and the plural *-s* assembly becomes the strongest as indicated by strong arrows in the figure, which means the synaptic transmission efficiency becomes higher and smoother and quicker. So when the learner encounters a word entirely new to her/he, for example, *surf* (represented by dotted circle in the figure), the overlap network will activate the *-er+ -s* connection as soon as the semantic association is recognized by the network. According to Pulvermüller, this process can be considered the neurobiological equivalent of a rule developing as a consequence of associative

learning¹⁹⁾. One may also expect the same neurobiological process is lying under learners' behavior so called generalization or over-generalization.

In Fig.3 the neuron assemblies were represented by circles and overlaps for explanation sake, but actually neurons in each assembly need not be necessarily located side by side so long as they are connected with each other by dendric trees and axon with multiple branches. According to Pulvermüller and Schumann²⁰⁾, a content word cell assembly network has neurons in language area for sounds and syllables as well as neurons scattered over various parts of cortex for sensory or motor information, while grammatical words and affixes (functors) are likely to have neuron networks in the language areas only, i.e. Broca's and Wernick's areas.

Evidence supporting the neurobiological explanation cited above is found in various studies. One evidence is Watanabe's report²¹⁾ on a Japanese aphasiac whose spontaneous speech was characterized by semantically empty neologistic jargon. The patients speech contained newly created meaningless content words while it retained functors such as particles (*ga*^が, *wa*^は, *ni*^に, etc.) and inflectional suffixes. Watanabe also refers to neologistic jargons found among English aphasics by Caplan, Kellar, and Locke: "I can't believe that she *adsers* anyway but the thing." / "They will have to *presite* me." / "Yes, I know what the *presite* is." (Italics indicate neologistic jargon). These three sentences sound grammatically correct but they are meaningless. Broca's aphasia is another type of aphasia typical symptoms of which are agrammatism: the patient's speech is very simple and brief, mainly nouns or main verbs, and functors such as prepositions, auxiliaries, and determiners tend to be omitted. The symptoms of these different types of aphasia, one type showing semantic impairment while grammar is kept intact and another type showing grammatical impairment while content words are kept intact though they tend to be short, strongly indicate the existence of

independent cell assemblies for content words and functors respectively.

More evidence comes from an experiment with event-related brain potentials (ERP). Kutas & Hillyard discovered that one particular component of ERP called N400 appear when words that are semantically irrelevant to preceding context are presented to their subjects²²⁾. Of particular interest is that Kutas and Hillyard also discovered that N400 did not appear for grammatical errors. This finding also indicates that the brain is processing functors and meanings differently in its different areas.

There is also an experiment conducted by Tumoto in 1979 proving the strengthening of synaptic transmission efficiency by simultaneous activation of the connected cell assemblies²³⁾. He first gave repeated electrical stimulation only to the optic nerve of the left eye of a cat for an hour. Then, he gave electric stimuli to both left and right optic nerves. An amazing result was observed. The supremacy of synaptic transmission efficiency between left eye optic nerve and visual cortex to that of right eye lasted for more than 9 hours.

Pulvermüller and Schonle also argue that Hebb's law was the neurobiological mechanism underlying the remarkable recovery of their patient with mixed transcortical aphasia²⁴⁾. When the patient came to them for treatment five years after the onset, the patient retained good repetition performance compared to all other language abilities. Therefore, during the intensive 3 week therapy (5 sessions of 60 minutes each per week) to improve the patient's communicative abilities, the therapists used "a paradigm that allowed the patient to *perform speech acts by repetition*" (see pp 144-147 Pulvermüller & Schonle, 1993 for method and procedures in detail). The remarkable changes in adequacy and reaction time scores at the beginning and end of the treatment demonstrates that speech production and comprehension abilities improved. Pulvermüller & Schonle explain the improvement as the result of (a) patients adoption of a strategy to repeat

and monitor words, which enhanced (b) the neuronal changes in the patients brain, "in particular, the connection within assemblies corresponding to content words may have strengthened due to simultaneous activity of phonological and semantic sub-assemblies²⁵⁾", (Hebb's law). They think, "Significant parts of these assemblies are located in the patient's right hemisphere, which had not been used much for language before the brain damage."

2. Bilingualism

It is not just content words and functors that have their own cell assemblies, but some researchers believe the second and the third language of bilinguals and multilinguals have their own localities, in other words cell assemblies, in their brain. Their arguments are mainly grounded on the findings by Ojemann & Whitaker²⁶⁾. With the consent of their bilingual patients with epilepsy, Ojemann & Whitaker studied the brain of two patients by the technique of electrical stimulation mapping sites during a naming task. They report as follows:

Within the center of the language area for each patient, there appear to be sites common to both languages. Peripheral to this, in both anterior and posterior language areas in both cases, are sites with differential organization for the two languages. There is a tendency for those sites concerned with a given language to cluster together.....²⁷⁾

Then what about the site of English in the brains of Japanese university students, even though they are usually not considered bilinguals. Is there any neurological difference between their brains and bilingual brains? Here, before we go on, we must take a note of what is meant by the word bilingual. A bilingual person is usually thought to be equally and fully fluent in two languages. Grosjean, however, defines bilinguals as "those people who use two or more languages in their everyday lives" and points out that the vast majority of people who use two languages in their everyday lives do not have the

same competence as monolinguals²⁸⁾. One of the bilingual patients of Ojemann & Whitaker seemed one of such people: he was 37 years old, spoke only Dutch as a youth and acquired a "working command of spoken English" after he emigrated to the United States at age 25, "although his comprehension of written English remained somewhat limited." Coming back to the question of the site of the second or third language in the brain, Watanabe, Uejima et al. reported they had a non-fluent type aphasia patient, a 54-year-old auto-mechanic, who responded in English instead of in Japanese, when he was asked to name a desk, a chair and a few everyday items, numbers from 1 to 10 and names of months, even though his English education was just like other Japanese, six years of school English²⁹⁾. His responses seem to suggest that differential localization of the second language occurs even in the nonbilingual brain in fairly early stage of language acquisition. However, Uemura warns no differential localization will occur as long as students learn English through Japanese translation only and he suggests students begin their study by listening to English extensively and immersing themselves in the language as much as possible in order to create English site in the brain³⁰⁾.

According to Grosjean, bilinguals often mix their two languages in several ways: involuntary mixing (so called interference), code-switching (the complete shift to the other language for a word, a phrase, a sentence, or an utterance), and borrowing (borrowing a word from the other language and integrating it phonologically into the language they are using at that moment)³¹⁾. As mentioned earlier in this study, L2 learners also suffer from interference from their first language (L1 interference) and they also borrow words from their L1 when they are unable to find an appropriate word in L2, and some of them switch from L2 to their L1 and vice versa depending whom they are talking to. As for borrowing, unlike when bilinguals borrow, L2 learners do not integrate the word into L2 phonologically but pronounce it as it is

pronounced in their L1. Moreover, they usually borrow only content words and not functors. For example, suppose a Japanese student is speaking with an American friend and is unable to find a word meaning *persimmons*, "I bought two _____, yesterday." Then he will substitute in the blank his native word *kaki*, but he is most likely to say *kaki* without plural ending *-s*. As we saw in the first section of this paper, this phenomenon used to be interpreted either as interference of L1 or as simplification. From a neurobiological viewpoint, Hebb's law may be one of the mechanisms underlying such phenomenon. In the Japanese student's brain the cell-assembly for word *kaki* has no connecting neurons to English plural morpheme *-s*. Therefore *-s* was not activated. At the same time, such differential treatment of content word and functor (in this case suffix *-s*) as this supports the hypothesis that content words and functors have different cell assemblies. As for borrowing and code-switching, studies must be made on the brain mechanisms that switches on and off the activities of cell assemblies located on different brain sites. But there is one study of particular interest to us on this subject. That is a finding by Miller & Wickmen. They say neurons of the neostriatum exhibit strong lateral inhibition so that they prevent neighboring cells from becoming active³²⁾. This finding may explain why speakers do not confuse L1 and L2 and use them inappropriately, yet are able to borrow and code-switch.

3. Differential Success among Late L2 Learners

Late learners are those who started to learn their second languages after the so called critical age and they are generally believed to have some degree of impaired grammaticality. For example their performance scores in a grammaticality judgment task decreased with the age of learners and their scores showed a large variation while native speakers and early second language learners performed almost perfectly doing the same task³³⁾. Pulvermüller and Shumann consider motivation or positive emotional associations as the main factor of the

variance among the late learners. Judging from language disorders of some aphasics, they assume that a cell assembly of a linguistic element is composed of not only cortical neurons but also of subcortical neurons. Strengthening of the connections between those cortical and subcortical neurons, i.e. dendric growth, cannot take place without dopamine input from midbrain. And it is the amyglada that links cortical neurons to midbrain neurons and controls the activity of dopaminergic neurons in the midbrain. Amyglada is also known to play a significant role in emotion. So, Pulvermüller and Shumann claim as follows:

If the language learner positively evaluates aspects of the learning situation, the linguistic elements of the language to be acquired become associated to the positive emotional state. Sounds, words, or larger syntactic structures cooccur frequently with positive evaluation of a teacher, the teaching setting, the learning materials, or, for naturalistic language learning, with native speakers and aspects of the cultural context³⁴⁾.

They also say that this amygdala-midbrain associations mechanism is working when "the human baby suck when its lips touch a nipple" or when the bell alone elicits in the Pavlovian dog "the positive emotional state (eagerness)" and saliva. Tachibana reports Ono's studies on the relation between emotion and memory³⁵⁾. Ono's studies are restricted to rats and monkeys but his findings indicate the close association of cortex (stimuli), amyglada (emotion), and hippocampus (memory). Therefore, one may expect the variance of success in second language acquisition among late learners is due to their appraisal of learning situation which triggers the enhanced hippocampus-midbrain-amygdala-activity and consequetly leads to strong connections in the cell assemblies, even though more neurobiological information and more refined experiments and data from Second Language Acquisition research are needed to prove it.

CONCLUSION

Under various approaches and methodologies, researchers have accumulated a tremendous amount of data and hypotheses on Second Language Acquisition. However, the obtained data are often contradictory, interpretation of data also varies, and the explanation of acquisition mechanism is vague and not plausible. Researchers used to excuse themselves saying they must speculate because language learning is an internal process and they cannot observe it directly. Neuroscientists, however, have been studying the brain directly using electrical stimulation method (Ojemann), event-related brain potentials (Neville, Kutas & Hillyard), dendritic analyses (Jacob), and synaptic density measurement (Huttenlocher et al.), measurement of local cerebral metabolic rates for glucose (Chugani), and etc. If SLA researchers are seriously interested in understanding (not interpreting) the language acquisition process, they cannot ignore the findings from brain science. They should incorporate neurobiological perspectives so that their findings will not only advance their field but also will contribute to enhance the study of the brain by researchers of other fields such as neurobiology or aphasia.

【References】

- 1) Kinoshita, K. Dainigengoshutokuni okeru ayamarino bunseki (Error analysis in second language acquisition). [Koike, I.] Dainigengoshutokuni motozuku saishinno eigokyouiku (New English education based on SLA). Taishukanshoten, Tokyo, 109(1994).
- 2) Larse-Freeman, D., Long, H.L. An introduction to second language acquisition research. [4.] Longman, New York, (1992).
- 3) Dickerson, L. The learner's interlanguage as a system of variable rules. TESOL Quarterly, 9, 401-408 (1975).
- 4) Tarone, E. On the variability of interlanguage systems. Applied Linguistics, 4, 142-63 (1983).
- 5) Larse-Freeman, D., Long, H.L. An introduction to second language acquisition research. [4.] Longman, New York, 92-96, (1992).

- 6) Larse-Freeman,D., Long,H.L. An introduction to second language acquisition research. [4.] Longman, New York, 92-96, (1992).
- 7) Larse-Freeman,D., Long,H.L. An introduction to second language acquisition research. [4.] Longman, New York, 92-96, (1992).
- 8) Larse-Freeman,D., Long,H.L. An introduction to second language acquisition research. [4.] Longman, New York, 173-175, (1992).
- 9) McLaughlin,B. The relationship between first and second language: Language proficiency and language aptitude. Harley,B., Allen,P., Cummins,J. et al. The Development of Second Language Proficiency. Cambridge, (1990).
- 10) McLaughlin,B. The relationship between first and second language: Language proficiency and language aptitude. Harley,B., Allen,P., Cummins,J. et al. The Development of Second Language Proficiency. Cambridge, (1990).
- 11) McLaughlin,B. The relationship between first and second language: Language proficiency and language aptitude. Harley,B., Allen,P., Cummins,J. et al, The Development of Second Language Proficiency. Cambridge, (1990).
- 12) Jacobs,B., Schumann,J. Language Acquisition and the neuroscience: Toward a more integrative perspective. Applied Linguistics, vol.13(3), 282-299 (1991).
- 13) Jacobs,B., Schumann,J. Language Acquisition and the neuroscience: Toward a more integrative perspective. Applied Linguistics, vol.13(3), 282-299 (1991).
- 14) Larse-Freeman,D., Long,H.L. An introduction to second language acquisition research. [4.] Longman, New York, 240-249, (1992).
- 15) Robinson,P. Generalizability and automaticity of L2 learning under implicit, incidental, enhanced and instructed conditions. JACET Lecture, Aoyama Gakuin University (Oct. 1996).
- 16) Itoh,Y. Kiokuto gakushuno ninchishinrigaku (Cognitive psychology of memory and learning). Ichikawa,S., Itoh,Y., Watanabe,M., et al. Kiokuto kagaku (The science of memory). Iwanamishoten, Tokyo,(1994).
- 17) Tachibana,T. Nouwo kiwameru-Noukenkyusaizensen (Studying the secrets of the brain-the most recent developments in brain research). Asahishinbunsha, Tokyo, 215-225 (1996).
- 18) Pulvermüller,F., Schumann,J. Neurobiological Mechanisms of Language Acquisition. Language Learning, 44. 4, 681-734 (1994).
- 19) Pulvermüller,F., What neurobiology can buy language theory. SSLA, 17, 75
- 20) Pulvermüller,F., Schumann,J. Neurobiological Mechanisms of Language Acquisition. Language Learning, 44. 4, 681-734 (1994).
- 21) Watanabe,M. Goihanchuto kinouhanchuno kairi (Dissociation between lexical category and functional category). Gengo, 23(4), 50-55 (1994).
- 22) Kutas,M., Hillyard,S. Event-related brain potentials to grammatical errors and semantic anomalies. Memory & Cognition, 11(5), 539-550 (1994).
- 23) Tachibana,T. Nouwo kiwameru-Noukenkyusaizensen (Studying the secrets of the brain-the most recent developments in brain research). Asahishinbunsha, Tokyo, 217 (1996).
- 24) Pulvermüller,F., Schonle P.W. Behavioral and neuronal changes during treatment of mixed transcortical aphasia: A case study. Cognition, 48, 139-161 (1993).
- 25) Pulvermüller,F., Schonle P.W. Behavioral and neuronal changes during treatment of mixed transcortical aphasia: A case study. Cognition, 48, pp 159-160 (1993).
- 26) Ojemann,G.A., Whitaker.H.A. The bilingual brain. Archives of Neurology, 35, 409-412 (1978).
- 27) op. cit. p.412.
- 28) Grosjean, F. Neurolinguists, beware! The bilinguals is not two monolinguals in one person. Brain and Language, 36, 3-15 (1989).
- 29) Watanabe,S., Kamijima,G., Suzuki,M. et al. Nihongo-eigowo shutoshita takokugoshutokushano shitugoshouno ichirei (A case study of a multilingual — Japanese-English — aphasia). Shitugoshoukenkyu, 10(3) 217-223 (1990).
- 30) Uemura, K. Nouwo kasseikasaseru gaikokugo kyouiku (Foreign language education that

- stimulates the brain). *Gengo*, 24(7) 62-70 (1995).
- 31) Grosjean, F. Neurolinguists, beware! The bilinguals is not two monolinguals in one person. *Brain and Language*, 36, 3-15 (1989).
- 32) Pulvermüller, F., Schumann, J. Neurobiological Mechanisms of Language Acquisition. *Language Learning*, 44. 4, 681-734 (1994).
- 33) Johnson, J., Newport, E. Critical period effects in second language learning: The influence of maturational state on the acquisition of English as a second language. *Cognitive Psychology*, 21, 217-248 (1989).
- 34) Pulvermüller, F., Schumann, J. Neurobiological Mechanisms of Language Acquisition. *Language Learning*, 44. 4, 708 (1994).
- 35) Tachibana, T. Nouwo kiwameru-Noukenkyusaizensen (Studying the secrets of the brain-the most recent developments in brain research). *Asahishinbunsha*, Tokyo, 164-176 (1996).

第2言語習得に関する神経生理学的研究—文献考察

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要旨

母国語(第1言語)の他に習得あるいは学習する言語を第2言語と呼ぶ。第1章では、第2言語習得についての研究をそのアプローチによって6タイプに分類し、それぞれの研究成果と問題点について述べる。第1～第4のアプローチは、言語そのものを研究の対象とする。第5、第6のアプローチは学習者の認知的および社会的側面から第2言語習得を観察する。どのアプローチに於いても興味深い研究結果が報告されているが、その背景にある第2言語習得のメカニズムの説明となると裏付けのない仮説に止まり、相反する研究結果や反対意見も多い。そこで第2章では、この2、30年の間にめざましく進んだ神経生理学からの情報を取り入れ、学習者の脳の仕組みから第2言語習得を見ることを提案する。そして、試みに、KrashenのMonitor Theory、バイリンガル現象、学習者間に見られる習熟度の違いという3点を例にとり、神経生理学的観点からどのような説明が可能であるかを論ずる。

キーワード：第2言語習得、神経生理学的視点