THE HISTORICAL DEVELOPMENT OF JAPANESE PSYCHOLINGUISTICS

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1. INTRODUCTION

The history of Japanese psycholinguistics, like that of Western psycholinguistics, is a relatively recent one and can be linked to psychological interests in language behavior over this century. Like Western psycholinguistics, the field has been confined largely to the discipline of psychology (See, for example, Haga: 1988), although more recently attempts have been made to incorporate current linguistic theory into the core of research directions (See, for example, Otsu: 1989). But Japanese scholarship has often followed an independent line of development in certain areas of scientific endeavor, and the analysis of language is an excellent example of unique perspectives on intellectual inquiry. For example, both traditional phonological analysis, as evidenced by the phonological elegance of the two *kana* syllabaries, and traditional grammatical analysis, as embodied in the discipline of *kokugogaku* 'the study of national language' are certainly derived from specifically Japanese perspectives. Some disciplines, like Japanese psycholinguistics, have also been influenced by European or Anglo-American theoretical concerns, with the resultant outcome that some focal areas in Japanese psycholinguistic research have been complemented or even enriched by these influences. Among these may certainly be counted the point-counterpoint status of the long-standing Japanese interest in *kana/kanji* processing, and the later Western parallels in lexical access, word recognition, and the structure of the mental lexicon. Similarly, recent neurolinguistic claims for hemispheric specialization in the comprehension and production of the syllabic *kana* versus the logographic Chinese-derived *kanji* characters are enhanced by the current medical technology found in PET scans, CT scans, and Magnetic Resonance Imaging techniques which pinpoint tissue damage for aphasic syndromes. Lastly, modern aspirations to harness even more clever generations of computational devices which can parse, make inferences as well as decisions, and even translate between languages, intersect with the boom in psycholinguistic work in sentence and text processing.

The history of Western psycholinguistics over the past century is well-known to interested linguists, but Japanese psycholinguistics is not. This paper attempts to fill this lacuna by illustrating the modern development of Japanese psycholinguistics by citing these four topics, namely, *kana/kanji* processing, hemispheric specialization and laterality differences, sentence processing, and text processing, and summarizing how these four areas have been approached and synthesized. One could, of course, take a strictly historical approach in listing dates and events,[1] but we believe that an issue-oriented approach will be far more enlightening. We do not, as a result, pursue the distant past too vigorously. For example, we are aware that the psychology of Leipzig's Wilhelm Wundt set the intellectual paradigm at the end of the 19th Century. We could have written on the likelihood that the general post-war decline of Wundtian psychology in favor of American behaviorism was slowed in Japan as a result of the influential purchase of Wundt's entire library by Sendai's Tohoku University after Wundt's death in 1920. But we instead choose to focus on the modern issues that psycholinguistics is currently pre-occupied with, and suggest that

this approach may be more informative of the recent historical development of Japanese psycholinguistics.[2]

2. KANA AND KANJI PROCESSING

Japanese employs a unique orthographic system which relies on two *kana* syllabaries and a large inventory of logographic *kanji* characters derived from several historical periods of Chinese influence. The *hiragana* syllabary is relatively cursive in character, and is used for writing non-kanji words and grammatical devices, such as function words and inflectional endings; as a result, it figures prominently in the normal presentation of written Japanese. The *katakana* syllabary, on the other hand, is relatively crisp and angular in nature, and is reserved for transliterating foreign words, proper names, borrowings into Japanese, and neologisms; it often serves as a form of marked writing system in the way that italics do in English, and it also appears frequently in some genres like advertising or signs presenting brand names and their qualities.

The received opinion is that the kana syllabaries evoke a phonological recoding in lexical access procedures, in that they are based on the relatively straightforward kana-to-syllable correspondences based on the V/CV canonical shapes found in Japanese phonology and morphophonemics. In contrast, the received opinion in respect to kanji processing is that their semantic values are directly accessed without special reference to their phonological readings, and is based on a word-specific strategy derived from visual shape.

However, recent psycholinguistic work has challenged whether such a simplistic view of kana-kanji processing can be upheld. For example, Osaka's work (See Osaka: in press, for a convenient summary) with eye-movements in reading Japanese texts calls for a reconsideration of the role of kanji vs. kana in processing text longer than a single word, and thus for understanding the cognitive processes in reading. The basic eye movements found in reading consist of a series of fixations and saccades, or movements until the next fixation point. The results from experiments using Japanese texts show that kanji-based texts are both easier and faster to read than kana-only texts. In kanji-based texts, the eye skips from kanji to kanji, using them like stepping stones to organize the text in a top-down processing strategy (Osaka: 1987). Moreover, the peripheral vision for kanji-based texts is wider (with a range of 6 words) than for kana-only texts (with a range of only 4 words). When Japanese subjects read English alphabetically-written texts, Osaka (1989) found that these subjects had the same eye movements as for kana texts, suggesting that phonologically-based writing systems (such as the kana syllabary and the English alphabet) and logographic writing systems (such as in kanji writing) elicit different processing strategies in reading. The implication is that kanji are accessed directly in the mental lexicon (See Osaka: 1990).

Contrary to popular beliefs about ease of reading horizontal and vertical texts, Osaka and Oda (1991) found no difference between these two modes of reading, as measured by both eye-fixation durations and saccade lengths. The effective visual field for both vertical and horizontal readings were found to be the same, namely, about 5 to 6 character spaces. Hirose and Hatta (1988) have also noted that reading disabilities are as common in Japan as they are in many Western countries, laying to rest the complementary belief that reading disabilities are extremely rare in Japan.

Work with lexical access and word recognition for isolated words also suggests that some kana shapes present immediate lexical access in the mental lexicon. For example, Besner and Hildebrandt (1987) found that visually and orthographically familiar words written in katakana were named faster than both non-words and visually unfamiliar words, suggesting that lexical access for such katakana words is achieved without reference to phonological recoding. Feldman and Turvey (1980) did, however, find that response latencies in naming color words that were written in kana were consistently faster than the words written in their familiar kanji counterparts. Their conclusion was that such phonologically-based kana forms support greater facility in naming, because the phonologically-based nature of kana supports greater facility in verbally naming the form. Lastly, some distinction between content words and function words should also be made, for it is unlikely that phonological recoding is needed in accessing all lexical items. Japanese, like English and alphabetically-based orthographies, probably elicits whole-word access for the configurational shape of function words, but word recognition studies have typically focussed on lexical access for content words.

Content words in Japanese are typically presented in text by the Chinese-derived *kanji* characters. Kanji have a special place in Japanese education, aesthetics, and consequently, in popular notions about the psychology of language; it is thus not surprising that this orthographic system has enjoyed an enormous interest in a large variety of psycholinguistic studies. A typical example of this focus can be seen in Kaiho and Inugai's (1982) attempt to rate the Gestalt characteristics of kanji, by using the *semantic differential* technique with 881 kanji. Indeed, there was overall high reliability among Japanese subjects for the 8 scales of complexity, compactness, elongation, openness, straightness, roundness, stability, and symmetry, and a subsequent factor analysis classified the kanji into 4 tighter groupings based on these Gestalt characteristics.

Current psycholinguistics is quite preoccupied with the structure of the mental lexicon, and the processes underlying lexical access and word recognition. And so also is the Japanese psychological literature, although through the medium of kanji processing. Kanji have been probed with semantic priming tasks, with the results often supportive of a spreading activation model of lexical access (See Kawaguchi: 1987; Naka: 1984). And Naka (1984) has paralleled Western findings with ambiguous lexical items, namely, that both meanings of an ambiguous homograph are activated (up to 0.6 sec) before one of the meanings is selected as the one linked to a context word (after 1.2 sec). Lastly, the logographic nature of the orthographic kanji unit has a shape which evokes both the phonological and semantic referent in an arbitrary way. Not surprisingly, Wang (1988) has found that the phonological and semantic processing of kanji are performed in a parallel mode rather than a sequential mode.

Priming experiments which examine lexical access procedures for words written in kanji offer some interesting perspectives on the full-listing vs. decompositional/affix-stripping positions on how word recognition is supposed to take place (See Kess: 1992, *Chapter 4*, for a fuller explanation of psycholinguistic experimentation in morphology and word recognition). Sakuma *et al.* (1989) examined whether kanji characters or word units are the recognition units in lexical access for vocabulary items written in kanji characters. A first experiment had two-kanji target words preceded by primes which consisted of a single identical kanji, two-kanji words which shared one identical kanji, or an identical two-kanji word. A priming effect was observed only when the primes were the identical two-kanji words. A second experiment examined whether priming effects appeared with single-kanji words. Once again, priming effects were observed only when the primes preceding the targets were the identical kanji characters. Simple kanji characters which corre-

sponded to the radicals of the target characters also failed to elicit any priming effect. Sakuma *et al.* concluded that lexical access for Japanese words written in kanji utilizes word units as the basic element in searching the mental lexicon, and not the kanji character units or analyzable parts thereof.

Psycholinguistic experiments which examine the difference in memory recall between kanji and kana words have not found dramatic differences for low-imagery and high-imagery words in recall tasks. When the task is an unexpected recall, high-imagery words do not exhibit a difference in the rate of recall between kanji and kana words; however, for low-imagery words, kanji words were better recalled than kana words. When the semantic task of free associations was required, however, there were no differences in the rate of recall between kana and kanji words (See Yokoyama and Imai: 1989). Delayed recall showed that both high-imagery and low-imagery kanji words were better recalled than kana words, and Yokoyama *et al.* (1991) suggest that there are differential recall processes for words presented in kanji and kana formats.

Lastly, to give some idea of the unique role accorded to kanji, we might note that some psycholinguists have even examined the knowledge that the congenitally blind have about kanji. Kaiho and Sasaki (1984) charted the possible correspondence between spoken words and written kanji, asking sighted and blind subjects which words that they expected to have corresponding kanji characters. Subjects produced as many kanji as possible, based either on the sound or on the radical (*bushu*) for the kanji.[3] The blind subjects did exhibit some sensitivity to the correspondence between words and kanji, though to a lesser degree than the sighted; in fairness, it should be noted that this is probably due to their naive, but accurate, grammatical assessment of words into part of speech classes which have a statistical probability of receiving kanji assignments. Although the blind do have some kanji knowledge, that knowlege of actual form is extremely poor; however, once form is acquired, it has a long residence in memory for the blind. The point to be made is that kanji are felt to be uniquely Japanese, and researchers apparently expect even the blind can have some psycholinguistic knowledge of their form and function.

3. HEMISPHERIC SPECIALIZATION AND LATERALITY DIFFERENCES

The received wisdom in the matter of kana vs. kanji processing is that kana recognition exhibits a right visual field (and thus left hemisphere) superiority, while kanji recognition for single kanji exhibits a left visual field (and thus right hemisphere) superiority. As a typical example, we may cite the findings by Hatta (1977b; 1978) that the logographically-based configurational shapes of kanji are mainly processed in the right hemisphere, while kana are processed in the left hemisphere, as well as Hatta's (1981a) finding that the Stroop test elicits greater interference in the left visual field while Japanese subjects are responding to kanji stimuli.[4]

But one must also discriminate between tasks which attempt to illustrate word recognition and lexical access procedures. For example, two favorite methodologies have been the *lexical decision* and the *naming* tasks, and they have often elicited different types of response. The *lexical decision* task requires subjects to decide whether a kanji is in fact a word, while the *naming* task requires subjects to articulate the word that a kanji stands for. Not surprisingly, the results may be different, and the typical finding is a reported left visual field (and thus right hemisphere) superiority for kanji naming, but either no visual field superiority or a left visual field superiority (and thus again right hemisphere) superiority for lexical decision tasks with kanji. This seems to

square with the general assumption that the left hemisphere analyzes linguistically-based patterned stimuli, while the right deals with visuo-spatial stimuli. This is what must explain the earliest findings by Endo *et al.* (1978) that responses to the left visual field were faster for random shapes, while responses to the right visual field were faster in nonsense word recognition.

But there are also reported differences in hemispheric involvement in specific tasks, and the matter may not be as simple as a binary left-right opposition in processing tasks. For example, Elman *et al.* (1981a) found a right hemisphere advantage in word recognition for high imageability kanji nouns, but a left hemisphere superiority for low imageability kanji See also Hayashi: 1985). Elman *et al.* (1981b) also report a right hemisphere advantage in identifying concrete kanji nouns, but a left hemisphere superiority in identifying abstract kanji. An earlier study by Hatta (1977a) did find that concrete kanji were more correctly identified than were abstract kanji, but he did not find a significant interaction between visual fields and concrete/abstract classes.

In investigating different aspects of kanji processing (for example, pattern matching vs. lexical decision vs. semantic comparison tasks), Hatta (1981b) found differential hemispheric involvement. For example,, in the first stage of kanji processing, i.e., pattern-matching, there is a predominant contribution by the right hemisphere. In the second stage of the processing, i.e., lexical decision, both left and right hemispheres contribute to the processing. At the last stage of the processing, i.e., semantic comprehension, the left hemisphere is predominant in the processing.

Similarly, Hatta (1981c) also found that kanji recognition is sensitive to differences in processing level as well as processing strategy. For example, different processing strategies are found in matching physical identity and matching phonological identity, while matching physical identity and matching semantic category differs in processing level. The first matching task showed no significant difference in laterality effect, but the second task did show a significant difference in laterality effect. Thus, the physical identity matching task did not show laterality differences, but category matching demonstrated a significant superiority for the right visual field (and left hemisphere). Sasanuma *et al.* (1980) also investigated whether it is the type of stimuli or the type of task involved that determines hemispheric asymmetry. In a phonological experiment, they found a shift of laterality for kanji, but in a visual experiment, they found a shift of laterality for kana, suggesting that both (namely, the type of stimuli as well as the task involved) contribute importantly to hemispheric asymmetry results reported. These findings challenge the received view that kanji recognition automatically invokes right hemisphere superiority, in that the factor of processing level is strong enough to supercede right hemisphere superiority. Hatta in fact concludes that processing level must be taken into account as a significant factor in any discussion of hemispheric specialization. In an experimental presentation of simple words in congruent and incongruent positions, Hatta (1985) also found that kanji, hiragana, and pictographs are processed faster when they appear in semantically congruent positions than in semantically incongruent positions. Such differences are not found, however, for English words and katakana, leading Hatta to suggest each of the five types of orthographic presentation invoke specific processing mechanisms.

Most recently, Hatta (In press) has demonstrated that the various kanji attributes will affect kanji processing differently, depending upon the level of processing. Rather than focus on a single attribute, Hatta wisely examined the mutual relationship of various attributes, as well as their relative contribution to a left or right visual field advantage. A multiple regression analysis, as applied to three distinct experimental tasks, revealed the relative relationships of kanji attributes

like familiarity, concreteness, hieroglyphicity, stroke number, and regularity. The prediction was that such attributes will differentially affect left and right visual field processing, as they interact with different tasks like lexical decision, naming, and semantic classification. Hatta, like many other researchers, assumed that such tasks map onto a continuum of kanji processing, so that different levels of processing invoke different degrees of cognitive analysis, and thus differ in depth of processing. For example, lexical decision requires a lower level of processing than naming, which in its turn invokes a lower level of processing than semantic classification of kanji into concrete or abstract semantic classes. And indeed, Hatta found that in the early stages of processing (e.g., lexical decision) certain perceptual attributes, such as the number of strokes for kanji characters, was a strong factor; but in later stages of processing (e.g., semantic classification), both perceptual and imagery-related attributes are contributing factors.[5] Nishikawa and Niina (1981) have also investigated the claim that the left, or linguistic, hemisphere employs a serial processing mechanism, in contrast to the right hemisphere which is said to display a simultaneous or parallel processing mechanism. Their subjects judged similarity for upper and lower case alphabetic letters, hirakana, katakana, and kanji, presented in either a normal upright mode or a physically inverted mode. Measurements of reaction time showed functional similarities for both hemispheres, depending on the stimulus type. Processing of the upright/inverted kanji and inverted kana and alphabetic symbols invoked linear processing; the rest of the stimuli types involved parallel processing, leading them to conclude that neither linear processing nor parallel processing is exclusively assigned to the left or right hemispheres. Each hemisphere may be specialized for stimulus type (linguistic vs. visuo-spatial), but each hemisphere also employs both types of processing.

Recent neurolinguistic work has also challenged whether such a simple view of kana-kanji processing and production can be supported in the face of recent aphasic diagnoses. In examining the relationship between localization and symptomatology for over two dozen cases of pure alexia, pure agraphia, and alexia with agraphia, Kawamura (1990) reports that the common sites for lesions causing these impairments are localized in the left parietal or temporal lobes, or the left angular gyrus. According to Kawamura, alexia is caused by the disconnection of visual information **to** the left angular gyrus, while agraphia is caused by the disconnection of visual information **from** the left angular gyrus; alexia with agraphia is caused by the disconnection of both incoming and outgoing information. Kawamura and Hirayama (1991) admit selective impairment in kanji and kana reading, and that the neurological routes involved in processing kanji and kana are partially different. But their physical examination of the functional role of the occipital, temporal, and parietal lobes in the visual recognition of kanji and kana, and their interaction with the left angular gyrus, suggests that the relationships between the two hemispheres, as well as within the left hemisphere, are somewhat more complex than has been suggested. A variety of other reports on pure agraphia (Kawamura *et al.*: 1984) and alexia (Kawamura *et al.*: 1981); Kawahata *et al.*: 1987) which employ CT or PET scans, also place both kana and kanji impairments in the left hemisphere, but not always in the classical lesional sites. An early paper by Sugishita *et al.* (1978) had already pointed in this direction in reporting on the reading capability of three patients who had undergone a partial commissurotomy. For a period of three years, these patients were examined for their abilities in the areas of oral reading, visual comprehension, and visual perception of nouns in kanji and hiragana. They exhibited no problem when individual nouns were exposed in the right half-field, whereas mistakes were made with exposure in the left-half field. Comprehension impairment was less severe than oral reading impairment, and word-matching tests were performed correctly irrespective of the type of script, indicating that the visual perception of words itself was intact. Sugishita *et al.* concluded that the the most noteworthy effect of commissurotomy in Japanese patients is unilateral dyslexia, which is more marked for kana than for kanji.

The clinical evaluation of symptomatology for aphasics, and more recently, the detailed results provided by enormous progress in advanced imaging devices, show the situation to be somewhat more compex than has been suggested by neuropsychological tests, and is far from being the simple left-right hemispheric split hypothesized by some neuropsychologists.

4. SENTENCE PROCESSING

The psycholinguistic study of sentence processing is a relatively new area of inquiry in Japanese psycholinguistics, and the number of studies on Japanese is limited. It has been the one area in which considerable influence from linguistics is evident, and this may be exemplified by the current preoccupation with issues like the role of empty categories in sentence processing and the cognitive consequences of parsing left-branching or right-branching sentence structures. Empty categories are of interest because they are postulated in at least one major grammatical theory; psycholinguistic experimentation is obviously able to provide evidence as to their psychological reality, and whether empty categories require any processing cost.

There have been to date a small number of studies concerning the psycholinguistic evidence for empty categories in Japanese. Nakayama (1990a; 1990b; 1991a) has tested whether empty categories have a processing effect by using a probe test (See Bever and McElree: 1988). The test measures whether a probe word is better recognized than other words in sentence comprehension; the reasoning is that a probe word is an antecedent of an anaphoric expression later in the sentence, and is better recognized because it is processed twice, once at the antecedent position and then in its anaphoric position. Nakayama has shown that when a probe word is an antecedent of *pro*, *PRO*, or the trace of an NP-movement in passive and unaccusative sentences, that probe word is better recalled than other words. The conclusion that Nakayama draws is that such empty categories are not simply theoretical constructs in a syntactic theory of *Government and Binding*, but also psycholinguistically real.

Nakayama (1991b) has, however, also examined the NP-movement caused by scrambling, but has been unable to demonstrate support for empty categories in this area of grammar. Nakayama admits that this lack of experimental support suggests a discrepancy between the syntactic theory of *Government and Binding* (See also Saito: 1985) and psycholinguistic reality. In contrast, Sakamoto (1989; 1991) has provided some theoretical support for the psycholinguistic validity of empty categories. Apparently, an empty category can function as an antecedent of another empty category, so that an empty category created by NP-movement can be a legitimate controller of another empty category.

In respect to the processing cost of empty categories, we can only report conflicting claims, rather than unanimity. Mazuka (1991) claims that the activities of processing empty categories and detecting their antecedents do not impose any processing difficulty. She examined the reading times for empty categories postulated as subjects of temporal adjectival clauses, but found no increase in reading times for any of her stimulus materials. In contrast, Yamashita *et al.* (1991) report the opposite finding when gapped and gapless relative clauses were used as stimuli. Reading times showed a localized time increase when subjects were processing empty categories in relative clauses which contained gaps.

The main theoretical issue underlying sentence processing differences for Japanese vs. English involves the psycholinguistic effects of processing right-branching languages (like English), as opposed to processing left-branching languages (like Japanese). Simply stated, is it the case that Japanese, as a left-branching language, is harder to process than English, a right-branching language? Since Yngve (1960), it has been generally assumed that left-branching sentences are harder to process than right-branching sentences, mainly because in the former the verb which provides subcategorizational information occupies a sentence-final position.

Besides being left-branching, Japanese has other grammatical characteristics which might suggest difficulty in sentence processing. Japanese has free word order, an abundance of empty categories, and there are typically no complementizers or relative pronouns which mark the beginning of a clause. All these features contribute to parsing indeterminacy, the on-line impossibility of knowing where a clause begins. Until a processor encounters a sentence-final matrix verb, there is no way of knowing how deep the embedding is; the result is that the processor constantly entertains the possibility of ambiguity and re-analysis. The above is also what simple computationally-based metaphors of language processing would predict. However, the possibility that Japanese, and languages like it, impose severe constraints in respect to processing, is obviously not a tenable position. Japanese subjects parse left-branching Japanese structures just as easily and efficiently as English subjects parse right-branching English structures.

Part of the answer to this conundrum may be found in the origins of theoretical models of sentence processing. One important bias found in modelling has been the tendency to apply English models to Japanese, possibly because the main preoccupation of psycholinguists in respect to sentence processing has been English. For example, Marcus *et al.* (1983) and Abney (1987) both present theoretically-based sentence-processing models which postulate right-branching advantages; given the Japanese findings, both must fail as a universal models of sentence processing (See Mazuka and Lust: 1990).

Another bias in Japanese work has been its almost exclusive reliance on the syntactic theory of Government and Binding, as a theoretical framework upon which to base both linguistic and and psycholinguistic formulations. As a result, GB-proponents typically ignore elucidating the boundaries between *competence* and *performance*, as well as the difference between branching *per se* and the structural complexities caused by branching. As Hasegawa (1990) points out, the processing difficulty often cited for English speakers in dealing with English sentential subjects in left-branching structures should be defined not only by the nature of left-branching *per se*, but also by the structural complexity caused by the fact of branching.

If we expect a model of sentence processing to be universally valid, serious theoretical consideration must be given to determining which types of models best characterize the processing of these two language types. We would reasonably expect a theoretical model of language processing to be as universally applicable as our model of language structure, and so far there is a gap between the two. Our main goal in a psycholinguistic sense is, therefore, to come up with a universal model which accounts for the ease in processing of both left-branching and right-branching languages. A plausible psycholinguistic model will have to consider the combination of top-down and bottom-up processing, coupled with serial (depth-first) and parallel (breadth-first) processing. Such combinations have in fact been tested as possible computational models (See Sato: 1988). A plausible psycholinguistic model will also have to resolve whether parsing models are commital or non-commital, and such have been debated in the study of *garden path* ambiguous sentences (See Gorrell: 1987; Frazier and Fodor: 1978).

Despite the variety of proposals, there is a general consensus that the configurational advantages of a top-down model make it more appropriate in explaining English sentence processing, while a bottom-up model might be more appropriate for explaining Japanese sentence processing. Because of its right-branching nature, the English sentence processor can construct a structural tree starting from a top-most S, attaching the sentence-initial NP to this S node. In contrast, because of the indeterminacy of embedding in Japanese sentences, the Japanese processor cannot perform this assignment until much more information has been added. Instead, the processor has to construct a tree from the bottom, attaching the sentence-initial NP to the most deeply embedded tree.

It is obvious from the foregoing discussion that the nature of Japanese, and the psycholinguistic results with sentence processing in Japanese, will continue to forcefully remind us of our theoretical responsibilities in constructing a truly universal theory of sentence processing.

5. TEXT PROCESSING

Much psycholinguistic research on text processing in Japan has investigated the role of story grammar and its analogues in the comprehension and recall of text. A text is not merely a collection of independent sentences. It is structured in such a way that several component sentences form a small information unit, and such small information units cohere as larger information units. The concepts of *story grammar* and *schema*, as proposed by Western scholars such as Rumelhart (1975), Mandler and Johnson (1977), Thorndyke (1977), Kintsch and van Dijk (1978), have been influential in the study of text processing in Japan. Though the details vary depending on the particular model, it is generally agreed that an text has an overall or *macro-structure*, which in turn consists of several components (*episodes* or *micro-structures*) which are related to each other in causal or temporal terms. Text comprehension thus involves discovering the macro-structure of a text, and interpreting each sentence in respect to this overall structure, as well as to other sentences in the text.

Much work in text comprehension has been devoted to formulating an adequate model of story grammar, and to chart the way in which story grammar affects text processing. A number of experiments, typically using memory tasks, have convincingly demonstrated that narratives are actually processed in units proposed by models of story grammar (See Masui and Kawasaki: 1980, 1981; Takahashi and Sugioka: 1988, 1991; Taniguchi and Kawamura: 1986).

Some researchers have criticized story grammar for its emphasis on the structure of the text, as opposed to the interaction between the processor and the text (See Norman and Bobrow: 1975). The claim is that attention should also be paid to the available processing resources, that is, the cognitive skills and space available for text processing. Kuwabara *et al.* (1983) did in fact find that the amount of available processing resource affects text memory independent of the structure of the text. Indeed, the process of constructing an apppropriate macro-structure out of the text requires inferential ability, and Ikeda (1981b) found that the inferential ability of individuals affects both text comprehension and recall.

Different presentation modalities involve different types of processing (e.g., visual vs auditory), suggesting that the process of text comprehension may also be different. The received opinion is, however, that differences in presentation modality do not lead to a significant differences in

comprehension (See Kintsch *et al.*: 1975; Kintsch and Kozminsky: 1977). This observation is confirmed by Yoshida *et al.* (1981) and Takai (1989) for story comprehension, as well as for the comprehension and recall of TV cartoons (See Takahashi and Sugioka: 1988, 1991).

Other data suggest that recall of expository texts is sensitive to the presentation modality, though the results are at times equivocal (See Sannomiya: 1982, 1984; Yoshida *et al.*: 1981). As a result, psycholinguistic work which finds its origins in educational psychology has been particularly active in elucidating facilitating factors. The experimental results have shown that activities which require the processor to respond to a specific goal, such as inserting questions, analogies, and examples, or imposing a summarizing task, definitely enhance the comprehension of expository texts (See Akita: 1988; Ikeda: 1981a; Mitsuda: 1986, 1990; Yonezawa: 1989; Otomo: 1991; Fushimi: 1991; Taniguchi: 1988; Kuwabara: 1985; Kirigi *et al.*: 1981). Facilitating text comprehension means facilitating the construction of an adequate macro-structure in a mental model of the text (See Taniguchi: 1988). Providing analogies, setting specific goals, asking questions, and eliciting summaries can all be interpreted as aids which reduce the cognitive expenditure necessary for text processing. The processor is supported in its quest for an adequate schema for the text, and the ensuing construction of an appropriate mental model for that text.

NOTES

1 One could cite, for example, the following as the first textbook with the term *psycholinguistics* in its title: Ichiro Sakamoto, Keiroku Okamoto, Shozo Muraishi, and Yasumasa Sato, *Gengoshinrigaku ['Psycholinguistics*], Tokyo: Gakugei-Tosho, 1956. Or the following as the first psychological text dealing with the matters *psycholinguistics* in its modern sense: Ichiro Sakamoto, *Kotoba no Shinri ['The Psychology of Language']*, Tokyo: Kaneko-Shobo, 1952. We are grateful to Professor Jun Haga of Tsukuba University for both of these references.

2 Our future plans, however, do include the presentation of historical descriptions of such unique and influential scientific episodes in the chronological development of Japanese psycholinguistics.

3 It should be noted that in Japan the blind do receive some training in kanji.

4 The above is true for single-kanji words; the reverse seems to be true for two-kanji words. That is, there is a reported tendency for the right visual field or left hemisphere to be superior in word recognition for two-kanji words.

5 For those who are interested, Hatta (1991) presents a useful historical overview of research on the relationship between laterality and kanji recognition by normal subjects, summarizing the pertinent literature on the subject, drawing from *Neuropsychologia, Cortex, Brain and Language, Brain and Cognition, Shinrigaku Kenkyu Japanese Psychological Research, Kyoiku Shinrigaku Kenkyu*, and *Psychologia.* The overview is laid out according to major topics, such as reseach methodology, the relationship of laterality to kanji recognition in normal subjects, processing strategies in kanji recognition, the processing level at which kanji recognition takes place, and a survey of explanatory models that attempt to account for the laterality effect. The overview concludes with an insightful summary of what has been achieved and suggestions for the direction of future research.

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