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《Abstract》

Reading comprehension processes are assumed to have ambiguous and complex relationships with human cognitive processes as modules or interactions. Therefore, interdisciplinary cognitive science-based research concerning theoretical linguistics, psycholinguistics, cognitive psychology, and neurolinguistics, etc. is essential for exploring and elucidating reading comprehension processes.

How are Japanese EFL learners inclined to process and comprehend sentences which are difficult to parse, syntactically ambiguous, or complex, such as garden path sentences? What sorts of principles and strategies are Japanese EFL learners apt to use at that time? What are these cognitive processes and mechanisms? How are these processes and mechanisms appropriately activated? In addition to that, if more discourse information is added to the syntactically ambiguous or complex sentence, can the prior or subsequent discourse contexts resolve the ambiguity of such sentences? The present study is an attempt to elucidate the cognitive mechanism, processes and strategies regarding sentence processing and the significant effects of prior or subsequent discourse contexts on resolution of ambiguity or complexity of garden path sentences.

It principally aims at exploring and reconsidering the validity of the

previous studies closely-related to the above-mentioned research fields. It mainly deals with significant problems with mechanisms and functions of the syntactic parser, immediate processing, delayed processing, serial processing, parallel-distributed processing, top-down processing, bottom-up processing, syntax-based approach, constraint-based approach, referential approach, etc. as a prerequisite for further experimental research into the principal effects of different types of discourse contexts on resolution of ambiguity of garden path sentences.

I. Introduction

It is evident that reading comprehension processes are assumed to have complex relationships with human cognitive processes as modules or interactions. Therefore, interdisciplinary research concerning theoretical linguistics, psycholinguistics and cognitive psychology, etc. are essential in order to explore reading comprehension processes.

Moreover, research into lexical processing, sentence processing and discourse processing, etc. are essential to the understanding of reading comprehension processes.

How should Japanese EFL learners process a sentence or sentences which are difficult to parse, and syntactically ambiguous, such as garden path sentences? What sorts of principles and strategies do Japanese EFL learners adopt at that time? What are these processes and mechanisms and how are they activated? In addition to that, if more discourse information is added to the syntactically ambiguous or complex sentences, can the subsequent discourse contexts resolve the ambiguity or complexity of such sentences? In the present study, we would like to elucidate the processes and strategies regarding sentence processing and the significant effects of

subsequent discourse contexts on resolution of ambiguity of sentences.

II. Previous studies regarding second language sentence and discourse processing

This section principally illuminates some of the significant problems with cognitive processes, strategies, and mechanisms underlying second language (hereafter, we will refer to second language as L2, or sometimes ESL; English as a Second Language) reading comprehension in terms of L2 sentence and discourse processing. Since cognitive mechanisms underlying L2 reading comprehension have a close relationship with our human cognitive mechanisms, there are subordinated aspects of complicated cognitive processes and activities required for effective and efficient reading comprehension. At the first stage, the series of simultaneously-driven and linear cognitive processes and activities essential for reading comprehension can also be briefly described as follows:

As soon as a reader assumes to start with L2 reading comprehension, a series of cognitive activities react simultaneously and interactively in our human cognitive processing mechanisms, with a view to making L2 reading comprehension more effective and efficient. These subordinated cognitive activities also perform in an interactively compensatory manner as follows: For instance, in the initial stage of L2 reading comprehension, a reader is required to start with lower level processing such as rapid word recognition and lexical access. And at the next stage of L2 reading comprehension, he or she proceeds to the cognitive processes closely related to sentence level processing, such as syntactic parsing through at phrase level based on syntactic and semantic chunks, mainly in terms of syntactic information and semantic plausibility. At the next stage following this series of lower level

processing, the reader proceeds to a higher level of processing such as discourse processing, semantic and contextual processing.

In addition to that, in these series of cognitive activities, there are three major aspects of cognitive components functioning efficiently and effectively in a simultaneously-driven and interactively complementary way.

- (1) logical and critical thinking abilities to examine the validity of logical consistency
- (2) efficient and appropriate inferences and inferential abilities based on textual and contextual information
- (3) proper activation of various types of schemata, such as content, formal, linguistic schemata, and so on, stored in a reader's long-term memory

(Grabe & Stollers, 2001; Grabe, 2002)

The efficient and effective cognitive processes in reading comprehension, can be typically divided into the following two different levels of processing: on the one hand, the lower level of processing, which mainly deals with units at the sentence-level, or clause-level of processing units; and on the other hand, the higher level of processing, which principally handles larger information units that is discourse semantic and contextual level of processing units, and so on. Both the two major levels of processing can be described and considered in more detail in the following section.

2.1.1 Lower level of processing in L2 reading comprehension

The lower level processing includes the following three major factors:

- (1) rapid and automatic letter and word-level recognition and lexical

access

- (2) syntactic parsing based on syntactic information and principles of syntactic attachment and association
- (3) semantic proposition formation required to combine word meaning and syntactic information

Furthermore, in order to make these three major components work effectively and efficiently in the natural course of cognitive processes and activities in reading comprehension, it is definitely necessary for them to perform appropriately in a simultaneously-driven and interactively-complementary manner in the working memory. In this way, reading comprehension works most efficiently and effectively in the lower level of processing (Grabe & Stoller, 2001:24-25; Grabe, 2002).

As for the distinguished and effective functions of lower level processing, Segalowitz (1991) strongly argues for the significance of automaticity in the lower level of processing on the foundation of significant and well-known research into differences in reading comprehension processes of bilingual and L2 participants. To sum up, this research clearly shows that compared to L1 learners, L2 learners don't exhibit automaticity especially at the lower level of processing, such as rapid word recognition and lexical access. Therefore, the interactively-compensatory effects Stanovich (1980) has advocated in his well-known theoretical interactively-compensatory model fails to work properly and effectively, and L2 learners are inclined to depend on contextual information too much. As a result, they tend to be slower readers compared to L1 learners.

Furthermore, Eskey (1988) also strongly claims that an efficient and effective higher level of processing is principally based on the automaticity at the lower level of processing such as automatic bottom-up processing of

discourse markers, cohesive ties, and so on.

The higher level of processing is described and examined in more detail in connection with the lower level of processing in the next section.

2.1.2 Higher level of processing in L2 reading comprehension

The higher level of processing is assumed to include sentence, or syntactic parsing, discourse processing, and text comprehension through the syntactic and semantic association, or attachment of sentence, discourse, and whole text-level information, which chiefly deals with the information units larger than sentence-level information. It is also assumed that higher level processing includes various aspects of a reader's cognitive processes and activities such as the proper activation of different types of schemata, the adequate inferences principally based on textual and contextual information, the appropriate monitoring of a reader's comprehension processes as well as his or her meta-cognitive processes.

Moreover, this processing is supposed to include a so-called 'text model' of reading comprehension. This model asserts that a reader takes in, as a sort of 'basic text representation', semantic information he or she has obtained by utilizing different types of schemata and textual and contextual information. In the following stage of reading comprehension, the L2 reader associates the main ideas with supporting ones, and in the final stage of reading comprehension, integrates this information as semantic units into his or her long-term memory in human processing mechanisms for the purpose of constructing 'a meaning representation of the text'.

Furthermore, the higher level of processing also includes 'a situational model' of interpretation. This model requires the following significant components such as a reader's view of the writer's intentions, his or her attitude toward the genre and material of the text, the various types of

experiences he or she has made through reading texts with similar contents and topics, and the interpretation he or she has made in order to satisfy his or her own evaluation of the text itself.

In both a text model and a situational model, proficient readers are required to make appropriate inferences based on textual and contextual information of a text. In addition to that, in the final stage of reading comprehension, they are also required to appropriately monitor their own reading comprehension processes and strategies with a view to testing and confirming whether they have attained their goals of reading comprehension hypothesized at the initial stage, or whether they are making valid adjustments for the purpose of getting a more proper interpretation of the text when the necessity arises (Kitch, 1988; Grabe, 1999; Grabe & Stollers, 2001; Grabe, 2002: 52-53).

It follows from what has been considered above, that the higher level of processing is closely related to the lower level of processing. To sum up, both levels of processing are not completely independent, but have mutually-dependant and compensatory components and functions, and as a result are conducive to rapid and automatic sentence level and discourse level processing. As examined above, the automaticity of various aspects of processing has a close relation to both levels of processing, and it will be considered in more detail in the following section as one of the significant problems of sentence and discourse processing.

2.1.3 Automatic processing in L2 reading comprehension

What should be noticed in this chapter is that the lower level of processing is in principle, supposed to precede the higher level of processing. That is, efficient and effective processing at the higher level is based on the foundation of the lower level of processing. Since human

working memory is assumed to have quite a limited capacity, it is next to impossible to pay attention to and process large amounts of information at a time. It is presupposed that a rapid and unconscious processing of incoming information be made automatic in order to make parallel-distributed processing function effectively and efficiently in the natural course of reading comprehension. In particular, now that automatic processing is assumed to facilitate efficient and effective processing on the basis of 'associative connections' that are supposed to exist in the long-term memory, a great amount of continual practice is essentially required for effective and efficient automatic processing. For example, a large amount of time has to be spent in achieving automatization of rapid and efficient processing of syntactic parsing as well as word recognition (Grabe & Stoller, 2001: 20-24).

Moreover, Perfetti (1985) advocates Verbal Efficient Theory, on the basis of a theoretical paradigm of an interactive processing model, and points out the significance of lexical access and local processing required for the lower level of processing, or that of syntactic processing of the basic meaning units in the textual comprehension. Furthermore, he argues that it was definitely significant in reducing the cognitive loads of processing resources through more rapid and appropriate lexical access and local processing in order to make effective use of limited processing resources for the integration of propositions and construction of 'a text model' (Kadota & Noro, 2001:20).

In addition to that, McLaughlin (1990) claims that the higher level of processing is made possible and feasible through efficient execution of automatization in the lower level of processing, such as word recognition and syntactic parsing, after a great amount of continuous practice. This also asserts that the proceduration of declarative knowledge, that is, the

cognitive shift from controlled processing to automatic processing is required as a prerequisite for acquiring fluent and efficient reading ability, or automatic and rapid processing.

2.2 Cognitive architectures and mechanisms in L2 sentence processing and comprehension

Sentence processing, which is composed of various sorts of subordinated cognitive activities and behaviors, occurs principally on the basis of cognitive architecture, mechanisms and processes at the kinds of different levels and stages. Research into sentence processing has been a central focus and major concern in psycholinguistics, computational linguistics, artificial intelligence, and neurolinguistics, or neurology (Clifton, Frazier, & Rayner, 1994; Pickering, Clifton, & Crocker, 2000; Harrington, 2001). Significantly enough, sentence processing research is completely different from research into language structure and function, in that it is principally concerned with illuminating and elucidating cognitive architectures, mechanisms, and processes responsible for language as a dynamic, real time entity (Harrington, 2001:91). One of the major concerns of sentence level processing is how the two major different sources of linguistic and extra-linguistic information function, in an interactive and compensatory manner in real time to construct a valid syntactic analysis for a string of words or sentence fragments, and assign it a semantic interpretation with a view to yielding the most appropriate meaning of sentences.

As has been considered above, it follows that it is necessary to illuminate and elucidate the architectures, mechanisms and processes of sentence processing in the context of cognition in general and in connection with cognitive science as a whole (Pickering, 1999; Pickering, Clifton, and Crocker, 2000, 1-2).

Pickering (1999) refers to the definition and workings of sentence comprehension as follows:

Sentence comprehension is concerned with how people obtain a particular syntactic analysis for a string of words and assign an interpretation to that analysis. Thus, it is not principally concerned with word recognition, morphological processing, anaphoric resolution, figurative language, discourse coherence, in general. Fundamentally, it concentrates on those aspects of language comprehension that draw upon the rules and representations that are studied within generative grammar (Pickering, 1999; 123).

Moreover, Pickering (1999) prefers to use the term 'sentence comprehension' rather than 'parsing' in that it is more significant to emphasize that the ultimate goal of the cognitive process is to construct a semantic interpretation for a string of words, or sentence fragments. In short, it is to determine the most appropriate meaning of a sentence as a whole on the basis of a sequence of words, not simply to construct syntactic analysis for them.

In addition, as has been examined above, it is next to impossible to investigate and illuminate the general nature of the cognitive mechanisms and processes responsible for sentence level processing by adopting a single particular research method. Therefore, it is essential to make an appropriate and plausible attempt to adopt more than one effective and efficient research method at the same time, or in parallel in accordance with the proper nature of the target research theme, to combine these research methods in an interactively compensatory manner in order to conduct adequate experimental research, and to analyze the research findings and results obtained from such research in terms of the theoretical linguistic

and related applied linguistic fields, such as generative grammar, lexical functional grammar, formal semantics, psycholinguistics, cognitive neuroscience, information processing and so on.

This section aims at considering and elucidating the underlying cognitive mechanisms and processes responsible for comprehension of sentences, as well as architectures and functions of a sentence processor, or syntactic parser, in terms of different aspects of relevant research findings available.

The next section is going to deal with architecture, mechanism, and function of a sentence processor.

2.2.1 Three contrastive pairs of architectures, mechanisms and functioning of sentence processor, or syntactic parser

It is generally acknowledged that since a sentence processor, or syntactic parser is supposed to have a large number of the dynamic workings and functions underlying the sentence level of processing, it is difficult to explain the significant differences in their architectures and mechanisms in a rigid manner. However, Sakamoto (1998) tactfully explicates the fundamental sentence processing architectures and significant functions of a syntactic parser on the foundation of the following three contrastive pairs of characteristics.

- (1) Immediate and delayed processing
- (2) Serial and parallel distributed processing
- (3) Top-down and bottom-up processing

In brief, the first issue of ‘immediate and delayed processing’ is regarded as the one closely related to ‘when and at what time’ a sentence processor is required to obtain, or construct a particular sentence

processing analysis. The second issue is the one closely related to ‘the processing route concerning sentence processing’, such as ‘from which way to which way; from top-down processing to bottom-up processing, or from bottom-up processing to top-down processing’, a sentence processor is supposed to proceed, and develop sentence processing. Last but not the least, the third issue is the one closely related to how many types of sentence processing analysis; a single, or more than a single type of sentence processing, a sentence processor is endowed with, or capable of adopting at a time, or in parallel.

The significant relationship between these three contrastive pairs and sentence level processing is considered in the following sections.

2.2.2 Immediate processing and delayed processing

This section principally explicates the first issue related to immediate and delayed processing. Immediate processing is regarded as one of the most efficient sentence processing strategies to construct a particular syntactic analysis for incoming information in a lineal and temporal manner. In short, in accordance with this immediate processing strategy, a sentence processor is required to construct a particular syntactic analysis for incoming information, and associate that analysis with currently constructed syntactic structure immediately after it encounters the newly-inputted string of words, or sentence fragments (Sakamoto, 1998; Pickering, 1999; Pickering, Clifton, and Crocker, 2000; Harrington, 2002).

On the other hand, the delayed processing can also be described as one of the most efficient sentence processing strategies to construct syntactic analysis for incoming information in a lineal and temporal manner, although it adopts the contrastive sentence level of processing strategy that is quite different from that of the immediate processing one. To sum up, in the

case that in accordance with the delayed processing strategy, a sentence processor encounters syntactic ambiguities and complexities in the natural course of sentence processing, it is required to delay or reserve adopting a possible syntactic strategy; and continued to read to the end of the sentence without backtracking at the problematic point until it meets with definitive incoming information sufficient to resolve the syntactic ambiguities and complexities (Mazuka & Itoh, 1995; Pickering, Clifton, and Crocker, 2000).

What has to be examined here is to consider the following issue: The significant issue regarding whether sentence processing is principally based on “immediate processing” or “delayed processing”, and can lead to one that “when and at which point” a syntactic parser is required to be determined to perform a syntactic processing analysis and semantic interpretation of a sentence, or sentences. In other words, it can also lead directly to the significant issue regarding whether a syntactic parser is required to obtain syntactic analysis for one piece of information after another at the same time that a series of incoming information such as a string of words, or sentence fragments is newly inputted in accordance with a temporal and linear order, regardless of various sorts of syntactic ambiguities and complexities that fundamentally exists in sentence level, or syntactic processing and semantic interpretation, or it is required to delay the sentence level of processing of a problematic part of a syntactically ambiguous and complex sentence, such as a garden path sentence, that poses more than one possibility of syntactic analysis and semantic interpretation, without determining to adopt a ‘tentative’ syntactic processing strategy and keep a syntactic processing reserved or delayed, until it encounters plausible information to make it possible and feasible to resolve that sort of syntactic ambiguity and complexity and reconstruct the

more valid syntactic analysis for the problematic point, which in turn, leads directly to the most appropriate and adequate syntactic processing and semantic interpretation.

Concerning this issue, there is the work of Frazier & Rayner (1982), which has been described as one of the representative and well-known studies in that classical sentence processing research field, and on the foundation of their research results, they point out that there is a possibility of the precedence or preference of immediate processing over delayed processing (Just & Carpenter, 1980; Mazuka & Itoh, 1995; Sakamoto, 1998).

Their research is conducted as follows:

To sum up, Frazier & Rayner (1982) illuminates the processes of the readers' eye movements including gaze and regression in the natural course of syntactic parsing of the garden-path sentences mainly by measuring their reading time and average gaze time. Their research findings showed that there was statistically longer gaze time especially at the problematic point such as syntactically ambiguous sentence fragments in which the readers consider it difficult to decide to conduct a proper syntactic analysis in the natural course of syntactic parsing, so it can lead directly to the conclusion that the immediate processing was predominantly adopted principally in accordance with 'immediacy principle' (Just & Carpenter, 1980).

In addition to that, Just, Carpenter, and Woolley (1982) conducted similar research in order to investigate the relationship between a readers' gaze time and syntactic parsing. The result indicated that the readers participated in the research started with obtaining a particular syntactic

analysis for a string of words, sentence fragments as quickly as possible when they met with newly-inputted information. Therefore, this research result also supported the precedence of immediate processing over delayed processing in the natural course of syntactic parsing.

The significant point to be noticed here is that the subjects who participated in the research conducted by Frazier & Rayner (1982), were regarded as L2 learners whose proficiency level of English was extremely high and who had much more natural exposure to English than those of average level Japanese EFL learners. Therefore, the present study is conducted in an attempt to illuminate and elucidate what sort of syntactic parsing, or sentence processing strategy Japanese EFL learners are inclined to adopt and utilize, or in particular, whether Japanese EFL learners also follow the syntactic parsing principle of the precedence, or preference of immediate processing over delayed processing as in Frazier & Rayner's research result in cases that they encounter a syntactically and semantically ambiguous and complex sentence or sentences.

2.2.3 Serial processing and parallel-distributed processing

This section principally illuminates the significant issue regarding serial and parallel-distributed processing. Before explicating the general nature of the issue, the major theoretical and logical premises are briefly considered mainly on the basis of Pickering's framework as follows:

In the case when a newly inputted string of words or a fragment of a sentence is compatible with a single particular syntactic analysis in the natural course of sentence processing, the evidence for 'incremental' sentence processing suggests that a single particular analysis is computed and interpreted (Pickering, 1999; 126). However, it is assumed that there occur several aspects of the following significant problems with sentence

processing. What kinds of processing possibilities happen when a newly inputted string of words is compatible with more than a single particular syntactic analysis? For example, is a sentence processor capable of computing and obtaining all possible syntactic analyses at the same time, or in parallel? If so, is a sentence processor required to retain all possible syntactic analyses for certain possibly long period of time, or is it required to abandon some of them at that time? Is it required to foreground a single particular analysis, or some of the syntactic analyses and background others? Or alternatively, is it required to only compute and construct a particular syntactic analysis in the initial parsing decision, but to have the capacity to attempt a reanalysis for the target fragment of a sentence? These significant questions are required as fundamental to determine the syntactic strategy that a sentence processor is assumed to adopt in order to resolve syntactic ambiguity and complexity. However, unfortunately, these fundamental issues remain to be solved. (Pickering, 1999, 126-127; Pickering, et al, 2000, 10-11).

Serial processing is also regarded as one of the most efficient syntactic processing strategies to obtain where by a particular syntactic analysis for the incoming, or newly inputted information in a lineal and temporal manner is adopted at the expense of the other syntactic analyses and interpretations available immediately whenever it meets with the newly inputted information.

In a serial processing, a sentence processor is assumed to select a single particular syntactic analysis it attempted to adopt in the initial parsing decision out of some kinds of syntactic analyses. Therefore, if it attempts to adopt a serial processing, and as a result, it recognizes a particular syntactic analysis as impossible; as not compatible with currently being a constructed syntactic structure in the natural course of sentence

processing of the syntactically ambiguous and complex sentence, or sentences, it has to abandon the first-pass analysis immediately, and again attempt to construct a syntactic reanalysis for the target and problematic fragments of a sentence. For example, as for a well-known garden-path sentence discussed and considered by Bever (1970); *The horse raced past the barn fell*, in a serial processing, a sentence processor attempts to close a sentence structure that *the horse raced past the barn* as a complete sentence rapidly in the initial parsing decision. That is, it follows that on the basis of this initial parsing decision, *raced* is regarded as an active past-tense verb, and therefore, that the sentence that *the horse raced past the barn* is considered to be a complete sentence. However, when a sentence processor encounters the following word; *fell*, and it recognizes this initial syntactic analysis as not valid and impossible; or not compatible with currently being a constructed structure, and immediately it has to abandon the initial particular syntactic analysis. It then attempts to start again with attempting a syntactic reanalysis for the ambiguous string of words of the garden-path sentence, and as a result, reinterprets *raced* as a past participle in a reduced-relative construction (cf. The horse that was raced past the barn fell), and makes the syntactic ambiguity resolution successful, or if not, it fails to understand the syntactic structure of the garden-path sentence entirely, that is, it is 'led up the garden path' by this target sentence (Pickering, 1999; Pickering, et al, 2000; Harrington, 2001; Harrington, 2002). That is, in a serial processing model, a sentence processor is required to build a single particular syntactic structure and interpretation at the expense of the other syntactic structures and interpretations available, immediately whenever it meets with the newly inputted information. Therefore, it follows from these reasons that 'serial accounts are broadly compatible with data demonstrating the existence of

garden-path effects' (Pickering, 1999; 126).

In a parallel-distributed processing model, in contrast, a sentence processor is supposed to compute and consider more than a single particular syntactic analysis and interpretation at the same time, or in parallel, immediately when it encounters a syntactically and semantically ambiguous sentence such as the garden-path sentence, and then waits for the appearance of incoming disambiguating information for the purpose of yielding the most appropriate syntactic processing outcome. To sum up, on the basis of a parallel account, a sentence processor is supposed to be endowed with computing and considering multiple types of syntactic analyses at the same time, or in parallel (Sakamoto, 1998; Pickering 1999, 126; Pickering, et al 2000, 10).

It is evident that parallel-distributed models are different in themselves in various aspects, for example, depending on how many syntactic analyses are retained, or maintained at the same time, or in parallel, what types of ranking are adopted, or employed with a view to selecting the most compatible and plausible syntactic analysis out of the other multiple analyses, how long the different kinds of syntactic analyses are computed and considered for, and so on (Sakamoto, 1998, Pickering, et al, 2000).

There are five major parallel-distributed accounts briefly considered by Pickering (1999) and Pickering, et al (2000). These are as follows; pure unrestricted parallelism, a ranked parallel model, a constraint-based account, a beam-search mechanism, and referential or incremental-interactive account.

Firstly, pure unrestricted parallelism is considered as follows.:

In terms of pure unrestricted parallelism, a sentence processor is supposed to construct all possible syntactic analyses in parallel, or at the same time in the initial parsing decision, and require all syntactic analyses

as ‘being of equal importance’ (e.g., Forster, 1979). For instance, after a processor encounters the fragment of a garden path sentence such as *The horse raced* in Bever’s experimental sentence examined before, it is required to compute and represent all possible syntactic analyses, or both the main clause and the reduced relative analyses. In addition to that, after it meets with the garden path sentence *The horse raced past the barn fell* as a complete sentence, a sentence processor is required to abandon, the main clause analysis and continue with the reduced relative analysis. As a result, it leads to successfully resolving syntactic ambiguity and complexity of the garden path sentence. Nevertheless, this reduced relative analysis quite frequently causes a processor to be ‘led up the garden-path’, for the reason, this account cannot always be correct as an efficient parsing model to resolve syntactic ambiguity. Particularly, a lower proficiency level of L2, or EFL readers, including Japanese EFL learners, are frequently inclined to be led up the garden-path during parsing.

However, there assumed to be two possible kinds of hypothetical accounts to enable a sentence processor to yield efficient and successful sentence processing. The first possible account is based on a serial account. In a serial processing model, a single particular syntactic analysis is selected out of the other possible syntactic analyses. For instance, a syntactic parser attempts to adopt the main clause analysis. That is, *A horse raced past a barn* is required as a complete sentence in the initial parsing decision. If this particular analysis is considered to be impossible and not compatible with a currently constructed syntactic structure, then immediately it has to be abandoned or dropped, and after that a sentence processor is required to start again with backtracking, or attempting a syntactic reanalysis for the target part.

Another possible account is based on a rank-parallel account. In a rank-

parallel model, a single particular syntactic analysis is foregrounded, and as a result, any other analyses are backgrounded. In Bever's sentence considered above; *The horse raced past the barn fell*, the main clause analysis may be foregrounded, and the reduced relative analysis backgrounded. If the main clause analysis is considered to be impossible, or not compatible with currently being a constructed syntactic structure, then immediately, a sentence parser has to change its own ranking of all possible syntactic analyses. However, Pickering (1999: 127) claims that 'the most influential kind of parallel model is the constraint-based account' (Trueswell et al, 1994; Pickering, 1999; Pickering, et al, 2000). In accordance with this constraint-based account, different syntactic analyses are weighted on the basis of how compatible they are with a range of constraints. For instance, a single particular syntactic analysis will be foregrounded if it is highly frequent, highly plausible, and highly compatible with the prosody employed, and so on (Pickering, 1999, 127). When a sentence processor encounters a newly inputted string of words, or a fragment of a sentence in accordance as the sentence progresses in the natural course of syntactic processing, different syntactic analyses can be activated principally on the basis of new information. To sum up, incoming information can cause syntactic analyses to change their rankings, and therefore a different type of syntactic analysis may be foregrounded, and others backgrounded (Pickering, 1999; Pickering, et al, 2000).

An interesting alternative parallel-distributed account proposed by Gibson (1991) requires a beam-search mechanism "in which analyses which are close enough in syntactic complexity to the simplest analysis are retained. Analyses are then dropped if their complexity, measured in a way proposed by Gibson, exceed the syntactic complexity of the simplest analysis by some threshold value" (Pickering, et al, 2000, 11). However,

the unit Gibson originally proposed on the basis of syntactic complexity appears to have a flaw. That is, these kinds of parallel-distributed accounts assume that different kinds of syntactic analyses are retained for an extended period. However, other accounts such as ‘momentary parallelism’ can also be assumed. The referential or incrementally-interactive account of Altman and Steedman (1988) can safely be said to be categorized as ‘momentary parallelism’. According to this account, when a sentence processor encounters the target part of the ambiguous syntactic structure, and it computes and considers more than a single particular syntactic analysis at a time, or in parallel, it is required to resolve that kind of syntactic ambiguity on the basis of how felicitous these syntactic analyses are with respect to discourse context. That is, in this account, after the initial parallel stage, sentence processing utilizes serial processing, ‘Momentary parallel accounts are similar in spirit to many models of lexical ambiguity resolution (e.g. Swinney’ 1979), where all alternative meanings of a word are proposed, all but the most contextually appropriate (or frequent) meaning is rapidly abandoned’ (Pickering, 1999:128).

In addition to that, Pickering, et al (2000: 12) refers to the significant difference between two different types of parallel-distributed account.

However, there is an important difference between two different kinds of parallel account: the extended-parallel account, as in the constraint-based model (cf. Gorrell, 1989); and the momentary-parallel model, where different analyses are proposed in parallel, but evaluation between alternatives is effectively immediate. The referential or incrementally-interactive account of Altman and Steedman (1988) (cf. Crain & Steedman, 1985) is of this latter kind. Here, alternative analyses are proposed in

parallel, and contextual information chooses between them immediately, on the basis of how felicitous the analyses are with respect to discourse context (see the section on Referential Theory for more detailed discussion). This account involves momentary parallelism, but is otherwise serial. It is similar in spirit to many models of lexical ambiguity resolution (e.g., Swinney, 1979), where all alternative meanings of a word are proposed, all but the most contextually appropriate (or frequent) meaning is rapidly abandoned.

These different accounts of ambiguity resolution should be considered and explored in connection with the experimental data obtained from the present research in the later chapter.

What has to be considered here in the natural course of sentence processing is to elucidate the following issue. The significant issue regarding whether a sentence processing performs principally on the foundation of “serial processing or parallel distributed processing”, can lead directly to the one concerning whether a syntactic parser, which is supposed to be not capable of adopting more than a single particular syntactic processing strategy simultaneously at a time, or in parallel irrespective of all possible processing strategies available, it should continue adopting only a single particular structural analysis. That is to say, a parser is not capable of adopting more than a single particular structural analysis simultaneously at a time, or in parallel, until it regards as inadequate and inappropriate the specific syntactic processing strategy it attempted in the initial parsing decision (that is, serial processing). Assuming that it is also capable of processing more than a single particular syntactic structure, or adopting more than a single particular syntactic processing strategy at a time, or in parallel, a processor should conduct

multiple aspects of processing a garden path sentence in which it is capable of selecting the most plausible and appropriate syntactic processing out of all possible processing strategies if needs arise (that is, parallel processing). Hence, what is one of the most significant points to note is that in terms of a serial processing, unlike a parallel-distributed processing, a syntactic parser is required to start again with obtaining syntactic reanalysis immediately when recognizing the inadequacy of a specific structural and syntactic analysis it has attempted.

As is mentioned above, Frazier & Rayner (1982) argued for the possibility of the precedence of serial processing over delayed processing (Sakamoto, 1998; Fodor & Inoue, 1998; Pickering, 1999; Crocker, 1999).

What should be noted here is that the subjects participated in the representative study Frazier & Rayner (1982) conducted, were regarded as L2 learners whose proficiency level of English was much higher and had much more natural exposure to English than the average level of Japanese EFL learners were.

Therefore, the present study is conducted in order to explicate what sort of syntactic processing strategy

Japanese EFL learners are inclined to adopt, and in particular, to examine whether Japanese EFL learners also follow the syntactic processing principle, or strategy of the preference of serial processing over parallel-distributed processing when they meet with a syntactically and semantically ambiguous sentence, or sentences.

2.2.4 Top-down processing and bottom-up processing

As has been examined in the preceding chapters, it is quite evident that the major difficulty and complexity in syntactic parsing of so-called 'a garden path sentence' is based on the syntactic, semantic, and the other aspects of

ambiguity and complexity of the particular sentence, or syntactic structure. Furthermore, in order to deal with the principal syntactic ambiguity and complexity posing the major difficulty in syntactic parsing, it is a generally accepted-assumption that it is prerequisite to recognize that there are two distinct and contrastive syntactic parsing strategies. That is, a syntactic parser is either required to stop performing a syntactic analysis for the syntactically ambiguous input string of words, or sentence fragments, and backtrack with a view to conducting an efficient and effective syntactic reanalysis, or it is required to adopt a parallel-distributing processing such as performing more than a single particular syntactic analysis at a time, or in parallel. Here, we'd like to refer to Marcus(1980)'s argumentation for the purpose of elucidating the relationship between top-down processing and bottom-up processing from the opposite perspectives in Sakamoto. (1998: 18-19) .

On the other hand, Marcus (1980) argues against the generally-acknowledged assumption. He contends that the human language processor is not required to backtrack as well as conduct a parallel-distributed processing, and therefore, there exists a garden path phenomenon in syntactic parsing. However, he argues that since a garden path sentence is an exceptional case in the natural course of sentence processing, it is more significant to construct a sentence processing model to explicate the general nature of human language processing than to construct a model to explicate the special, or exceptional nature of language processing such as a garden path phenomenon, and that his model is principally based on 'the determinism hypothesis' that a sentence processor is supposed to construct a single particular syntactic analysis without backtracking in the natural course of processing. To sum up, his model asserts that once a single particular syntactic analysis is computed

and constructed, it cannot be easily cancelled, and that more than a single particular syntactic analysis is conducted at a time, or in parallel.

Moreover, on the basis of this hypothesis, he claims that a syntactic parser is requested to have three different fundamental functions, or dynamic workings such as bottom-up processing, top-down processing, and looking-ahead.

If a syntactic parser assumes to adopt a top-down processing strategy completely in a rigid manner, it attempts to perform sentence processing on the foundation of ‘the hypothesis driven strategy’ in a purified manner. In accordance with this hypothesis, if a particular syntactic structure based on an initial parsing decision is not applicable to the subsequent newly inputted syntactic structure, and as a result, a parser recognizes it as an inappropriate one. Clearly enough, this initial parsing decision is not compatible with the determinism hypothesis. For this reason, it is assumed that a parser has to be required to have a partially bottom-up processing function.

If a parser is supposed to adopt a bottom-up processing strategy completely in a rigid manner, it attempts to conduct a sentence processing on the basis of ‘the data driven strategy’ in a purified manner. By referring to the well-known pair of sentences such as (1) and (2), the validity of this hypothesis is examined as follows:

(1) I *called* [NP John] [S to make Sue feel better].

(2) I *wanted* [S John to make Sue feel better].

In order to obtain syntactic analysis for these pair of sentences, a syntactic parser has to make an efficient use of the syntactic information regarding these two main verbs. That is, the verb *call* is required to take

both the object and the complement as subsequent elements, while, the verb *want* is required to take only the complement. Consequently, this hypothesis is not compatible with the determinism hypothesis. Therefore, a syntactic parser has to be required to have a top-down processing function for the purpose of predicting the subsequent input string of words remaining to be processed, or the incoming information especially in a top-down processing manner.

In the end, if a parser is not supposed to have ‘a looking ahead function’, what sort of syntactic parsing problem occurs? Concerning these pair of sentences, one of the most significant issues is considered.

(3) *Have* [s the boys take the exam today].

(4) *Have* [NP the boys] [VP taken the exam today]?

As is evident, in (3) *Have* is regarded as the main verb working as an imperative form, on the other hand, in (4) *Have* is described as an auxiliary verb functioning as an interrogative sentence. However, a sentence processor doesn’t recognize the significant difference in grammatical function between (3) *Have* and (4) *Have* until it encounters the verbs such as *take* and *taken*. To sum up, assuming that a parser is not required to have ‘looking ahead function’, it adopts a wrong and inappropriate syntactic analysis for selecting either one of the grammatical usages from two different usages of *Have*, and as a result, it has to conduct a syntactic reanalysis. It follows from these reasons that the hypothesis is not applicable to the deterministic one (Marcus, 1980; Sakamoto, 1998).

2.3 Three major models of sentence processing, or sentence comprehension

One of the principal aims of sentence processing research can be defined as an attempt to elucidate when and how the various sources of information such as lexical, syntactic, discourse, semantic, pragmatic, contextual information, and so on, make a significant contribution to on line processing outcomes in sentence comprehension (Tanenhaus and Trueswell, 1995). In sum, sentence processing research mainly seeks to explicate how the different sources of linguistics as well as extra-linguistic information mutually interact in a compensatory manner on line to yield a meaning and interpretation of a sentence, or sentences. Moreover, various aspects of the influential models of sentence processing, or sentence comprehension have been presented and advocated until now. As a result of examining a large amount of the theoretical, or hypothetical models of on-line sentence processing, or comprehension, this wide variety of approaches to sentence processing or syntactic parsing can be briefly classified into the following three distinguishable types such as syntax-based (or principle-based) approaches, constraint-based (or interactive) approaches, and referential (or discourse-based) approaches, which combines the components and functions of these two approaches. There are significant differences in these three contrastive approaches in that ‘the respective approaches can be distinguished by assumptions they make concerning the role of syntax, its interaction with other sources of knowledge in real time interpretation, and the manner in which processing is carried out’ (Harrington, 2001:92).

2.3.1 Syntax-based approach or principle- based approach

As has been evident, syntactic processing research based on a

psycholinguistic paradigm has been developed especially on the basis of crucial and central effects of theoretical linguistic findings including generative grammar, or UG , LFG, and so on.

Harrington (2002) refers to the significant relationship between the syntax-based approach and syntactic processes in sentence processing as follows:

“Syntax-based approach to processing ascribes a central role to syntactic knowledge in the sentence interpretation process. Syntactic knowledge consists of an autonomous competence grammar, and a principled distinction is made between the mechanisms responsible for lexical processing (e.g., word recognition and lexical access) and syntactic processing. Often referred to as a two-stage model; ‘the sausage machine’ model (Frazier & Fodor, 1978), the syntactic parse is carried out rapidly using the minimal syntactic category information needed to complete the initial parse. The initial parse is then output to an interpretative mechanism that matches it against semantic, contextual, and real-world information, ultimately yielding an interpretation” (Harrington, 2002:128).

The above-mentioned two-stage model can be defined as one of the most influential and well-known principle-based models, that is, the ‘sausage machine’ model. It is assumed to be one of the syntax-based models composed of two different stages which deals with and explicates a series of operations for syntactic processing which range from newly-inputted information to sentence comprehension, and in this theoretical model, a syntactic parser is supposed to carry out syntactic analyses for the garden-path sentences in two major distinct stages where syntactic parsing proceeds step by step from the preliminary phrase packager (PPP) as a first stage, to the sentence structure supervisor (SSS) as a second stage. And

this model will be described and considered more in detail in the later section for syntactic principles.

Harrington (2002) also refers to the main characteristics, elements and functions of the syntax-based approach as follows:

“In the syntax-based processing approach, cognition and language are characterized as a symbol manipulation process (Newell, Rosenbloom, and Laird, 1989). The symbolic approach assumes that knowledge is represented in the mind directly in the symbols and that computations specified in rules, are carried out on these representations. In natural language computation, these symbols include phonemes, morphemes, grammar rules, and so on, and the processor works directly on these elements to yield an interpretation. The level of syntactic representation is assumed to be independent of semantics of the specific items involved, in the same way that the computation of an algebraic equation (e.g., $a + b + c$) is the same, regardless of the specific values of a and b .

An omission of a middle part of a passage

The role of syntactic structures is thus of primary concern, and from the outset the interest has been in how the sentence processor (or parser) builds a syntactic structure that ultimately leads to an interpretation of the sentence (Frazier, 1987). Fundamental insights into how this structure building proceeds have come from examining the processing of ambiguous language structures (e.g., visiting relatives), where structural alternatives are thrown into a sharp relief. Ambiguity resolution processes provide a window on processes that are difficult to observe otherwise” (Harrington;

2002; 127-128).

As has been considered above, in the syntax-based approach, the comprehension process of sentence processing is fundamentally required as the application of autonomous syntactic principles. To sum up, the syntactic parser is supposed to be modular, which means that syntactic information is applied prior to, independently of, the other types of linguistic information; semantic, pragmatic, or contextual information and extralinguistic information such as real world knowledge, or content schemata in the natural course of on-line sentence processing, or interpretation.

What has to be noted here is that these syntactic principles assume to function as the exclusive foundation for the selection of the most plausible parsing strategy in the first-pass syntactic analysis, and evaluate the adequacy of the initially attempted one subsequently in interpretative process and revise it if the need arises (Pritchett, 1992). Furthermore, in the syntax-based approach, other sources of information such as semantics, context and frequency are presumed to play not so significant role in performing a syntactic parsing particularly in the initial parsing decisions.

Some of the significant problems with the syntax-based approach will be considered and explicated in relation to the principles of syntactic parsing in the later section. Especially, greater insight into on-line processing by L2 learners will inform individual difference-based models of L2 development (Sawyer & Ranta, 2001), and provide a window on transfer in interlanguage (IL) development (Harrington, 2001:93).

Therefore, in addition to that, some problem with Participant's individual differences should also be considered in the later section. Furthermore, there is an contrastive approach with processing strategy on the basis of

the lexical information of Head, which is totally different from this traditional approach such as syntax-based approach.

2.3.2 Constraint-based approach, or interactive approach

As has been examined in the former section, it can safely be said that the syntax-based approaches of sentence comprehension offer a sharp and clear-cut contrast to the constraint-based approaches of sentence comprehension. The characteristics, elements and functions of constraint-based approaches are described and considered in this section.

In constraint-based approach, unlike in the syntax-based approach, text comprehension can be identified as the result of ‘mutually compensatory interactions’ by multiple types of information resources such as lexical information, syntactic information, semantic information, pragmatic information, contextual information and the real world knowledge. These different aspects of information are represented in a parallel-distributed way and contribute to serve wholly as probabilistic constraints on the comprehension of a sentence, or sentences. Therefore, in terms with the constraint-based approach, text comprehension is assumed to be characterized as a higher cognitive and interactive process and is constrained in real time, or on-line through integrated, compensatory interactions by lexical, syntactic, semantic-conceptual, and other information resources.

In addition, the following significant elements can be pointed out as the major differences between the syntax-based approach and the constraint-based one mainly in terms of Harrington’s theoretical framework (Harrington, 2001, 2002).

The principle-based approaches put an emphasis on the significant role of syntactic representations in the structure building process in the natural

course of sentence comprehension, whether as the foundation for syntactic complexity-based parsing decisions in the garden path models (Frazier, 1989), or as well-formedness conditions driving thematic role assignment. (Pritchett, 1992). On the other hand, the constraint-based approach defines syntactic and semantic ambiguity resolution process as a higher cognitive and interactive one on the basis of multiple, independent sources of probabilistic information, in which lexical, syntactic, and semantic-conceptual information interact to constrain on-line sentence comprehension in a compensatory manner. (Tanenhaus & Trueswell, 1995). Furthermore, sentence comprehension in terms of the constraint-based approach can also be regarded as an interpretative process of constraint-satisfaction (McClelland, Rumelhart & Hinton, 1986).

The principle of constraint satisfaction can be readily associated with connectionist perspectives on cognition, and also be closely related to the connectionist model. And the connectionist model is described as one of the most influential ones principally based on cognitive science as well as information science aiming at elucidating human intellectual and cognitive abilities through artificial neural networks; also known as the 'neural networks' or 'PDP (Parallel Distributed Processing)'.

Harrington (2001) refers to the following nature of the lexicalist' constraint-based model as one of the most influential constraint-based models.

Units corresponding to the various information types are activated in parallel, with the strength of activation of a particular unit or set of unit reflecting the type, number, and strength of the links it shares with other units in the system. Alternative structures are activated to differing

degrees, and the interpretation depends on which alternative the system ultimately settles on (Rumelhart, 1989).

A distinguishing feature of the lexicalist constraint-based model is the assumption that the principles governing lexical ambiguity resolution (and processing) are identical to those governing lexical ambiguity resolution (Kawamoto, 1993; MacDonald et al., 1994). Both processes are assumed to be the outcome of an interactive, constraint-satisfaction process in which multiple, independent sources of probabilistic information serve to interact to facilitate certain outcomes and inhibit others (Harrington, 2001:109).

As has been considered, in the constraint-based approach, the syntactic parser is assumed to draw on, and exploit multiple types of probabilistic information sources such as syntactic representation, semantic knowledge, pragmatic knowledge and real world knowledge in parallel with a view to resolving local ambiguities in garden path sentences. Next, we'd like to consider some of the stimulus sentences used for Experiment 1, 2, and 3 in relation to the multiple, independent sources of probabilistic information which have a significant effect on local ambiguity resolution and constraints made on these information sources within the theoretical framework of the constraint-based approach.

Trueswell & Tanenhaus (1994) investigated the significant effects of "sense-semantic" information regarding ambiguity resolution principally in terms of thematic relations.

- (1) a. The defendant examined by the lawyer turned out to be unreliable.
- b. The evidence examined by the lawyer turned out to be unreliable.

(Trueswell & Tanenhaus, 1994, p.158)

As sentence (1) indicates, it is evident that (1b) is easier to understand

than (1a) and that there is less syntactic complexity in parsing and less possibility of eliciting the garden path effects, although both of the two sentences have the same sentence structures. In addition, Trueswell & Tanenhaus (1994) indicated that (1a) took the subjects' reading time significantly longer than (1b).

The following reasons can be considered.

In (1a), there is local ambiguity in connection with thematic relations. For example, *The defendant* is very likely to be treated as a subject and assigned the thematic role Agent (this entity doing the examining), however, there can also be another possibility that *The defendant* is assigned the thematic role Theme (someone that was examined), whereas in (1b), there is no local ambiguity in connection with thematic relation, for example, *The evidence* is most likely to be assigned the thematic role Theme (the thing that was examined). Therefore, it follows from these reasons that (1a) is more difficult to parse than (1b), and that there is less possibility of eliciting garden path effects.

In addition, Crocker (1999) also referred to Trueswell & Tanenhaus (1994)'s research findings and claimed that "such '*semantic fit*' constraints will combine directly with syntactic constraints to resolve such ambiguities immediately" (Crocker, 1999: 219).

The fundamental principle of Constraint-based approach is described as one that sentence structure-based or syntactic ambiguity can be reduced to lexical ambiguity. As for lexical ambiguity regarding lexical information, for example, the transitive verb 'assume' can syntactically take both direct object and complement clause. However, a syntactic parser is supposed to prefer to take the complement clause than direct object on the basis of its lexical preference. Therefore, in such case, lexical ambiguity can also be

resolved more easily and immediately.

And other information resource can also have a significant effect on such type of lexical ambiguity and sentence level ambiguity. For example, in (1b) The evidence in *The evidence examined by the lawyer.....* cannot be the subject (semantically the agent of verb) of 'examine' .

(2) The gossiping neighbor heard the story had never actually been true.

If a sentence processor encounters sentence (2), and a parser is inclined to regard *the story had never actually been true* as the main clause, or the matrix clause. As a result, it can be led up to the garden path effects. In accordance with Garden path theory mainly based on linguistic analysis, or the syntax-based approach. This Garden path effects can be explained by one of the syntactic processing strategy; or Minimal Attachment.

We'd like to examine another similar type of the stimulus sentence used for Experiment 1, 2 and 3 in connection with thematic relations.

(3) As the woman edited the magazine amused all the reporters.

(Pickering, 1999, p.135)

In (3), one of the reasons for eliciting garden path effects can be based on the transitivity of the target verb; whether a particular verb is identified as a transitive verb, or an intransitive verb, the familiarity in semantic relations between the verb *edited* and NP *the magazine*. For example, in (3), it is assumed that there is a possibility of *the magazine* which can function as both the object of *edited* and the subject of *amused*.

If the sentence processor assumes to regard *the magazine* as the object of *edited* in the first-pass analysis, and misanalyses *edited* as a transitive verb,

not as an intransitive one in relation to lexical preference and frequency. And as a result, the parser is going to be led up to the garden path. That is mainly because in terms of the initial parsing decision, there is no subject in the main clause. Furthermore, there is a very close semantic familiarity in between the verb *edited* and NP *the magazine*. So, this familiarity in semantic relations between the former and the later might also have caused the garden-path effects on stimulus sentence (3).

Accordingly, the constrains of thematic relations have an influential effect on the local ambiguity resolution in sentence comprehension as a result of interaction of the other types of constraints such as familiarity in semantic relations.

2.3.3 Referential approach or discourse-based approach

As has been examined in the preceding section, the syntax-based approaches of sentence comprehension offer a clear-cut contrast to the constraint-based approaches of sentence comprehension. In addition to that, in terms of the referential approach, which shares the functions and features with the two contrastive approaches, both contextual information in the prior context and other resources of discourse context play a significant and central role in on-line processing, especially in the natural course of processing of syntactically and semantically ambiguous sentences.

Furthermore in this approach, syntactic information can be required as a sort of 'module', and as the basis for initial parsing decision, however, what should be emphasized here is that in the case that there are more than one possibility of syntactic parsing strategy, or strategy for interpretation of a sentence, or sentences, and it is difficult for a syntactic parser to select the most plausible one out of all possible ones, the final parsing decision

depends principally on discourse context. In sum, a parser is assumed to put more emphasis on the significance of the prior discourse context which can be conducive to success in local syntactic ambiguity resolution when a processor encounters the syntactic ambiguity in the natural course of parsing. It follows from this reason that this model can also be called 'the *discourse-based processing* model' .

Moreover, it can be safely said that referential or discourse-based approach is identified as a sort of compromise, or eclecticism between principle-based and constraint-based approaches. The referential approach seems to be confused with the constraint-based approach mainly in that both of the two approaches exploit multiple aspects of information resources; syntactical, lexical, pragmatic, contextual information required for sentence processing, or comprehension. However, Crain and Steedman (1985) distinguish two distinct aspects of 'interaction' ; *weak interaction* and *strong interaction*. In terms of weak interaction, "syntactic processing" independently "proposes" alternatives, either serially or in parallel" (Crain and Steedman, 1985, p.325) and semantic component assumes to be capable of choosing from them or go on the initial syntactic analysis. That means semantic information is not utilized by the sentence processor in the initial parsing. On the other hand, in terms of strong interaction, semantic and contextual information can be exploited in the first-pass analysis. Therefore, strong interaction can be stated as a part of constraint-based model in which each of the information is dealt with almost equally. Although referential or discourse-based approach puts more emphasis on the semantic or contextual information rather than the syntactic information regarding sentence processing or comprehension, the initial parsing decision is made principally on the foundation of syntactic information.

In addition, there has been a significant issue in controversy regarding whether discourse contexts can have crucial effects on syntactic ambiguity resolution, or not. For example, the following researchers have started to engage in controversy concerning the significant issue with one another. Murray and Liversedge (1994) strongly argues for the research results based on a series of experiments leading them to the conclusion that referential and contextual information do not have a vital effect on on-line parsing. On the other hand, Sedivy & Sevidy (1994) claim for the research findings leading them to the contrastive conclusion that contextual and referential information contribute to work on lexical information to yield syntactic ambiguity resolution.

Furthermore, here we would like to consider Ying (1996)'s research findings in order to elucidate whether discourse context can have crucial effects on ambiguity resolution in natural course of sentence processing. Ying (1996) contends the target topic on the basis of a different perspective from controversy between Muray and Murray & Liversedge (1994) and Sedivy & Spivey-Knowlton (1994). His aim is to explicate the relationship between referential models and garden path ones in the interpretations by ESL learners on PP (prepositional phrase) attachment ambiguities. He conducted the four series of experiments. The first experiment addresses the first research question; whether minimal attachment can constrain adults L2 learners' parsing preferences for ambiguous sentences. A stimulus sentence is the following one under the condition of a null context in which no prior context was provided.

The girl [VP saw [NP *the man* [PP *with a special pair of glasses*]]].

The second experiment deals with the second research question;

whether a referential context (discourse context or prosodic cues) can guide ESL learners' toward the intended interpretation of PP attachment. A stimulus sentence is pair of ones with a context-condition in which a biasing context is offered and a prosodic condition in which prosody cues are used to bias the interpretation.

(discourse context)

There were two girls. One of them had a sense of humor, and the other did not. The man [VP talked to [NP the girl [PP with a sense of humor]]].

(prosodic cues)

The man talked .. to the girl with a sense of humor. ('..' denotes prosodic break)

The third and fourth experiments treats the third research question; whether lexical information can constrain syntactic analysis for PP attachment by utilizing two different types of sentence-completion tasks on the basis of those used by Spivey-Knowlton and Sedivy (1995). A stimulus sentence is the following one regarding context condition in which a biasing context was presented.

Reasonably, in terms of Kintch's discourse model (1998), the more resources of information there are, the less ambiguity there is with a view to resolving local ambiguity of garden-path sentences. Thus, in Ying's study (1996), he attempts to elucidate what sort of syntactic processing strategy the ESL subjects adopt for the purpose of resolving the syntactic ambiguity. The research findings indicated that the syntactic processing principle of Minimal Attachment was utilized under the condition of a null

context. The condition of the prior context proved to have more significant effects than the prosodic information.

Meanwhile, in terms of the third and fourth experiments under the condition of psych and perception verbs, lexical preference; *broke* was not so influential in the syntactic analysis for PP attachment possibilities inconsistent with previous studies. This reason might derive from the transfer of L1 (Chinese) lexicons to L2 (English). Another possible reason for that might be the crucial effect of the syntactic principle of “attach anyway” advocated by Fodor and Inoue (1998).

In accord with the syntactic processing principle, it might be presumed that Chinese ESL learners carry out a syntactic analysis for and attach the newly inputted strings of word by adopting immediate processing strategy instead of delayed processing one because of their inadequate lexical access. As a result, we can conjecture that the Chinese subjects would have utilized the strategy of Minimal Attachment. Although the results of the third and fourth experiments display the significant difference between L1 and L2 in natural course of sentence processing, one of the most important parts of this argument might be that sentence interpretation is needed for more information resources.

The present research is an attempt to explicate whether subsequent, or prior discourse contexts can have significant effects on ambiguity resolution in the natural course of sentence or syntactic processing. And the present study explores which approach is the most valid for ambiguity resolution in the natural course of sentence processing.

To be continued

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