CHAPTER 13

SENTENCE PARSING IN L2 LEARNERS: LINGUISTIC AND EXPERIENCE-BASED FACTORS

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When we read in our second language, we face many uncertainties about how the people or objects referred to in the text are connected to one another. This is so because when our eyes move along the printed text in a left-to-right fashion, the information needed to establish correct dependencies between word strings is not yet available. So what does the second language (L2) reader do under these conditions of uncertainty? Because learners who are relatively proficient in two or more languages have access to the grammar and lexicon of each language when they comprehend written sentences, one critical question concerns whether the specific semantic and syntactic subprocesses engaged during L2 language comprehension are different when monolingual speakers and second language learners process input in the target language.

Experimental work in sentence comprehension by L2 learners has investigated this question using an array of psycholinguistic methods, ranging from behavioral tasks that measure reaction times or provide records of eye movements to electrophysiological responses recorded through the scalp while participants are exposed to stimuli (e.g., Kroll, Gerfen, & Dussias, 2008 and references therein). This rapidly growing body of work suggests that L2 learners' performance on reading tasks is sometimes strikingly close to that of native speakers, but not always. Evidence comes from studies that examine different aspects of L2 sentence processing, such as morphological processing (e.g., Hahne, Müller, & Clahsen, 2006), morphosyntactic processing (e.g., Hawkins, this volume), syntactic ambiguity resolution (e.g., Frenck-Mestre & Pynte, 1997), and the processing of syntactic dependencies (e.g., Lieberman, Aoshima, & Phillips, 2006). In this chapter, we will delimit the area of sentence comprehension to those aspects of sentence comprehension, be it sense–semantic information, syntactic-category-based

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information, or structurally driven parsing principles, that are drawn upon to derive a syntactic analysis and interpret an input word string (Pickering, 1999). We will also discuss how the learners' characteristics and specific linguistic experience may determine their performance in reading comprehension tasks. Thus, we will see how factors such as the learner's type of experience with the target language (e.g., immersion vs. non-immersion experience), competence, proficiency level, and previous linguistic knowledge all play a role in comprehension processes. Given that the learner's experience and learning style is an important variable to be considered in L2 sentence processing, we include a discussion of a particular group of L2 learners, namely deaf individuals. We will discuss whether their learning experience is qualitatively different from that of hearing learners and will examine some of the variables that affect their reading comprehension success.

As will become evident, there are currently too many gaps in the available literature for researchers to be able to construct the set of complete and detailed specifications that are used in the various stages of L2 sentence comprehension. However, existing empirical evidence from hearing and deaf L2 learners can be used to tell us something about the kinds of information that would need to be incorporated in such a set. Some of this evidence is outlined in the next paragraphs.

I. FACTORS INFLUENCING SENTENCE COMPREHENSION IN L2 LEARNERS

A number of variables have been demonstrated to influence sentence comprehension in L2 learners. For ease of exposition, we will divide them into two categories: Linguistic variables, which refer to properties that are particular to the input, and participant variables, which denote qualities of the learners themselves.

A. Linguistic Variables

"Sense–Semantic" Information

It is widely accepted that sense–semantic information (e.g., information about thematic relations, lexical semantics, and plausibility information) is useful when resolving syntactic ambiguity resolution. For example, the verb *fly* can be transitive or intransitive. In the sentence fragment *While the plane flew the man* ..., the transitive analysis (in which a plane is the agent of the act of flying) is implausible. The parser might take this plausibility information into consideration to determine that the verb *fly* is probably intransitive and might use this information to make certain decisions when parsing the input (Pickering, 1999).

Numerous experiments have investigated whether L2 speakers select among different candidate structures by relying on the same type of sense–semantic information that influences sentence processing during native language reading. Although there is some variability in the results, largely owing to effects of proficiency, the findings are generally consistent with the interpretation that proficient L2 speakers are guided by semantic information during sentence processing, and indeed parse sentences in their L2 in accordance with the semantic constraints of the L2 (for reviews, see Clahsen & Felser, 2006; Kroll & Dussias, 2004).

Lexical-Semantic Information

A number of studies have reported effects of lexical-semantic features on the assignment of thematic roles during sentence comprehension. The early work on this domain is grounded in the *Competition Model* (Bates & MacWhinney, 1982), which aims at explaining how learners determine semantic relationships (e.g., agent, patient, goal, etc) among elements in a sentence. Sentence processing is seen as the convergence or competition among various cues, each contributing to a different resolution in sentence interpretation. Cues are said to converge when they concomitantly designate the same thematic relation, and to compete when they point to different relations. For example, in the English sentence *The girl sees the plant*, three cues converge to assign *the girl* the function of agent: word order, subject–verb agreement, and animacy. However, in *The pencil kicks the donkey,* word order and agreement enter into competition with animacy.

Studies involving a variety of typologically different languages have shown the existence of crosslinguistic variation in the way forms map onto semantic functions, as well as in the weights associated with different form–function mappings. Given this, researchers have asked whether L2 learners are able to learn the mappings and weights that are specific to the L2. Gass (1987) and Harrington (1987) found evidence that learners who favored semantic-based cues (i.e., noun animacy) as the primary source of information in their L1 were dependent on these cues when assigning thematic roles in English, a language where word order provides the strongest cue. In contrast, Gass (1987) and Sasaki (1991) found that L1 English learners of Italian and Japanese were able to abandon their reliance on word order and to employ animacy as the primary cue in interpreting Japanese and Italian sentences. In addition, a recent study by Su (2001) reports that L2 learners tune into the parsing strategies that are more consonant with the structure of the L2 (i.e., rely more on either lexical-semantic or syntactic cues for the L2 rather than those for the L1) as they become more proficient.

The properties of certain words with respect to assigning a thematic role have also been shown to affect learners' choices during syntactic ambiguity resolution. For instance, the decision to interpret a temporarily ambiguous relative clause as referring to one of two noun-phrase host sites preceding it is influenced by the lexical-semantic properties of the preposition linking the two noun phrases (cf., Fernández, 2003; Papadopoulou & Clahsen, 2003). In "... the *psychiatrist with the actress who was having a glass of wine*," the preposition *with* introduces a thematic role, so the attachment domain becomes *with the actress*, and attachment of the relative clause to the noun phrase *the actress* is predicted. This outcome has been consistently observed in L1 and L2 speakers alike. Conversely, in the case of "...the *psychiatrist of the actress who was having a glass of wine*," the linking preposition does not introduce a thematic role. Hence, the relative clause is construed in relation to the whole complex noun phrase *the psychiatrist of the actress*. The decision to attach the relative clause to the first NP (NP1) or to the second NP (NP2) is a matter of debate in the literature. Some accounts explain it in terms of universal discourse-based principles that interact with language-specific rules (Frazier & Clifton, 1996), whereas other explanations are based on structurally based parsing strategies (e.g., Gibson, Pearlmutter, Canseco-Gonzalez, & Hickock, 1996). The relevant finding for our purposes is that in this linguistic context, L2 speakers have sometimes not shown any preference for NP1 or

NP2 attachment. This finding has been taken by some to indicate that L2 speakers are not influenced by structurally-based parsing strategies, but rather are mainly guided by lexical cues (e.g., Clahsen & Felser, 2006 and references therein).

Plausibility

Recently, a number of studies have also investigated how learners use plausibility information to recover from garden paths online. These studies have produced empirical evidence demonstrating the rapid influence of plausibility information during L2 sentence processing, and have shown that in this respect, nonnatives can behave in a native-like way.

Frenck-Mestre and Pynte (1997) investigated how advanced English learners of French and French native speakers resolved prepositional-phrase attachment ambiguities in sentences such as *They accused the ambassador of espionage (of Indonesia) but nothing came of it.* Eye-movement records revealed that both groups of speakers were influenced by plausibility information in that they were more likely to attach the prepositional phrase to the verb phrase if it was a plausible verbal argument, but to the noun phrase when it was a plausible NP modifier. In addition, Felser and Roberts (2004) found that Greek learners of English were strongly influenced by plausibility and had difficulty recovering from misanalysis when deciding if a postverbal NP functioned as a direct object or as an embedded subject. In particular, participants experienced processing difficulty if the initial analysis of the ambiguous NP as a direct object led to an implausible semantic interpretation.

The role of plausibility during L2 syntactic parsing has also been investigated in filler-gap structures. Williams, Möbius, and Kim (2001) explored differences between native and nonnative readers of English by asking whether the semantic plausibility of a potential filler modulated the postulation of a gap during parsing. Their study included native English speakers and advanced learners of English whose first languages had overt Wh-movement, such as German, or nonovert Wh-movement, such as Korean and Chinese. They compared the processing of sentences like (1) and (2) using a self-paced, plausibility judgment task:

(1) Which girl did the man push the bike into late last night?
(2) Which river did the man push the bike into late last night?

For the native and nonnative English groups alike, when the *wh*-filler was a plausible direct object of the verb, as in (1), it was more costly to discard it as the actual gap filler. Conversely, when it was an implausible direct object, as in (2), there was less resistance to reanalysis and, therefore, reading times were faster at the position of the actual filler (*the bike*). This indicates that adult learners of English use plausibility information in a manner that is very similar to that of native speakers, even when the parallel structures in their native languages look very different. Taken together, the findings in the studies presented above indicate that the L2 parser can behave very similarly to the L1 parser with respect to the use of sense–semantic information to resolve syntactic ambiguity.

Syntactic Category and Subcategorization Information

The category information of words (i.e., whether words are verbs, nouns, or adjectives) is part of their lexical entry. Subcategorization information, or information about whether a verb is transitive or intransitive, for example, is also assumed to be part of the lexical entry of a word. An important question in the L1 processing literature is whether the processor bases initial decisions solely on category information or whether subcategorization information is also used initially. In this respect, a number of experiments have shown that native comprehenders keep track of the relative frequencies of a verb's different subcategorization alternatives and use this information to resolve syntactic ambiguity during reading (e.g., Garnsey, Pearlmutter, Myers, & Lotocky, 1997; Wilson & Garnsey, 2009). This leads us to ask whether nonnative readers also use this same type of information in their second language.

In an early study conducted by Frenck-Mestre and Pynte (1997), French-dominant and English-dominant bilinguals read sentences in both their L1 and their L2 containing temporary subject/object ambiguities, as in *Every time the dog obeyed the pretty girl showed her approval.* In English, *obey* is optionally transitive. Therefore, it is ambiguous whether the NP *the pretty girl* is the object of *obeyed* or the subject of the ensuing clause. In French, however, this syntactic ambiguity does not exist because the French equivalent of *obey* must be interpreted as an intransitive verb. Eye-movement records from both groups failed to show any qualitative differences between the native and second language speakers at the point of disambiguation, indicating that L2 speakers were able to activate the correct lexical representation of the L2 verbs, even when these lexical representations were different in each language.

Recently, Dussias, and Cramer Scaltz (2008) examined the degree to which structural commitments made while Spanish–English L2 learners read syntactically ambiguous sentences in their L2 were constrained by the verb's preferred structural environment (i.e., subcategorization bias). The temporary ambiguity arises because an NP immediately following a verb could be parsed as either the direct object of the verb "*The CIA director confirmed the rumor when he testified before Congress,*" or as the subject of an embedded complement "*The CIA director confirmed the rumor could mean a security leak.*" In a monolingual experiment with English participants, the authors replicated the findings reported in previous monolingual literature (e.g., Wilson & Garnsey, 2001) demonstrating that native speakers are guided by subcategorization bias. In a bilingual experiment, they then showed that L2 learners also keep track of the relative frequencies of verb-subcategorization alternatives and use this information when building structure in the L2.

Structure-Driven Parsing Principles

Whether or not L2 parsing involves structure-driven parsing principles is a matter of debate. These principles have been postulated to explain the parser's preference for initially computing a certain syntactic analysis over others. A classic example of this is given in (3) below:

(3) Molly said that she will go to New Jersey yesterday.

In this case, the ambiguous constituent (yesterday) can be linked either to the higher clause or to the lower clause. If linked to the higher clause, the sentence means "it was yesterday that Molly said that she would go to New Jersey." Linking it to the lower clause results in the mistaken interpretation that "Molly will go to New Jersey yesterday." For the vast majority of readers, the tendency is to link the ambiguous constituent to the lower clause. The realization that the outcome yields an incorrect interpretation forces reanalysis of the ambiguous site.

Two of the principles that have been proposed to explain the parser's initial attachment preferences (i.e., Recency and Predicate Proximity) will be introduced later in our discussion of the role of proficiency in L2 sentence comprehension. Others include parsing heuristics such as *Minimal Attachment* and *Late Closure*, which have been proposed within the framework of the *Garden-Path Model* of Frazier (1978). *Minimal attachment* ensures that when faced with ambiguity, the parser will initially select the simplest—and therefore the quickest—structure to build. *Late closure* (which is equivalent to the notion of low attachment or NP2 attachment discussed earlier) allows incoming material to be structured more rapidly, by immediately incorporating it to already processed material.

We saw in our discussion on the role of thematic information that when L2 learners parse ambiguous relative clause constructions for which no lexical-semantic information is available to guide the parsing process, some learners do not show any preference for one attachment site over the other. Based on this and other evidence suggesting the lack of intermediate gap effects during second language reading, Clahsen and Felser (2006) have recently argued that the structure-building processes during online L2 sentence comprehension are fundamentally different from the representations built by native speakers of the target language. According to their *shallow structure hypothesis*, the syntactic representations that second language learners construct while processing input in their L2 are "shallower" and less detailed than those computed by adult L1 speakers. In their view, whereas L1 speakers prioritize on structure-driven strategies and syntactic information, second language speakers privilege lexical-semantic and pragmatic information.

As stated above, some of the data that Clahsen and Felser (2006) use in favor of shallow processing come from two studies that contrast the behavior of L1 and L2 speakers while reading syntactically ambiguous relative clauses (*The dean liked the secretary of the professor who was reading a letter*). For example, Papadopoulou and Clahsen (2003) asked native speakers of high-attaching languages to read ambiguous constructions in their L2 Greek, a language where high attachment is also the preferred strategy. They found that proficient L2 speakers showed no particular preference for high or low attachment when processing an L2 that, like their L1, also favored high attachment. This finding, coupled with evidence that clear attachment preferences were observed when lexical cues guided attachment decisions, was interpreted as evidence that L2 speakers do not use structure-based information but rather are guided by lexical-semantic cues (see Felser, Roberts, Gross, & Marinis, 2003 for similar findings; but Frenck-Mestre, 1997, 2002; Dussias, 2003; Dussias & Sagarra, 2007; Miyao & Omaki, 2006 for counterevidence).

One might speculate that the absence of an attachment preference arises not because of an inability to use structure-based parsing principles, but rather as the result of

group averaging. In other words, it may be that some learners displayed nonlocal attachment preferences while others attached locally, and averaging across the subjects produced no clear preference (cf., Frenck-Mestre, 2005). Omaki (2005), who also found no attachment preferences when Japanese learners of English read ambiguous relative clause constructions, carried out individual analyses to rule out this possibility. Germane to our discussion, when examined individually, some learners displayed target-like relative clause attachment preferences while others transferred their Japanese preferences. Because Papadopoulou and Clahsen (2003) did not carry out such analyses, it is difficult to rule out group averaging effects as a possible account of their results.

There is, in addition, some indication in the literature that the difficulties L2 speakers experience while parsing temporarily ambiguous structures could be explained by universal, structure-based principles of parsing. For example, Frenck-Mestre and Pynte (1997) showed that the L2 parser can operate on the basis of structure-based parsing principles such as Late Closure. These authors investigated the way in which advanced English-speaking learners of French and native French speakers resolved attachment ambiguities involving prepositional phrases. Records of eye movements revealed that the L2 speakers momentarily experienced greater difficulty than native speakers with verb phrase attachment (i.e., high attachment) of the prepositional phrase in sentences such as *He rejected the manuscript on purpose because he hated its author*. No such difficulty was observed when they read structures in which the correct analysis required attachment of the prepositional phrase to the noun phrase immediately preceding it (i.e., low attachment or late closure), as would be the case in *He rejected the manuscript on horses because he hated its author*. In other words, L2 speakers temporarily adopted a strategy of attaching the ambiguous prepositional phrases low, to the most recently processed constituent. This analysis resulted in an incorrect interpretation in the first example, but not in the second example. To account for this finding, Frenck-Mestre and Pynte proposed that nonnative readers may have a general preference for a low attachment strategy.

As our previous discussion indicates, it seems indisputable that the evidence discussed in earlier sections is rather tilted in support of the claim that L2 speakers are guided by sense–semantic information during L2 sentence parsing. However, the need for more research in this area is clear, given that the claim that L2 speakers never adopt structure-based parsing principles has not been convincingly challenged. As we will discuss later, the extent to which L2 learners utilize structure-based information might vary according to proficiency level.

B. Participant Variables

Proficiency

Research seems to indicate that the effect of level of proficiency on L2 sentence comprehension varies as a function of the type of information (semantic vs. syntactic) being processed. For example, results from event-related brain potential (ERP) studies on the processing of semantic violations point to similar brain response patterns between L1 speakers and high- and low-proficiency L2 learners, with differences consisting

mainly in a decrease in the efficiency of semantic processing mechanisms. Perhaps the most direct empirical evidence comes from Ojima, Nakata, and Kakigi (2005), who compared ERPs recorded from a group of adult native English speakers and two groups of adult Japanese learners who attained either high or intermediate proficiency in English. For all the groups, semantically anomalous English sentences (*This house has ten cities in total*) produced the so-called N400, which has been associated with difficulty during semantic integration (Kutas & Hilliard, 1983). Many other studies have consistently found an N400 in the ERPs of nonnative speakers when processing semantic violations (see Hahne, 2001; Hahne & Friederici, 2001 and references therein), providing strong evidence that semantic aspects of sentence processing are not severely affected by differences in language proficiency (cf., Kotz & Elston-Güttler, 2004).

In contrast to semantic processing, some data suggest that the degree to which L2 learners utilize other types of information during L2 sentence comprehension varies along the proficiency dimension, with only the proficient learners resembling native speakers. One such type of information involves the use of structure-based locality principles, which are assumed to be operative during monolingual sentence parsing. Two of these principles are what Gibson et al. (1996) have termed *Recency*—which refers to a tendency by the parser to reduce the distance between a potential host site and a modifier within the sentence—and *Predicate Proximity*—or the preference to attach a modifier as close as possible to the head of a predicate phrase. These principles have been proposed to explain crosslinguistic differences in attachment preferences. Specifically, preferences reflecting the application of recency have been found in languages such as English, Brazilian Portuguese, and Arabic, but the application of predicate proximity has been reported in other languages like Spanish, Dutch, German, or French (cf., Carreiras & Clifton, 1999 and references therein). To illustrate, consider the temporarily ambiguous sentence *The man called the daughter of the psychologist who lives in California*, in which the modifier *who lives in California* can be interpreted as referring to *the daughter* or *the psychologist* (hence the temporary ambiguity). Empirical evidence suggests that in English recency dominates over predicate proximity, so the preferred resolution of the ambiguity is to "attach" the relative clause to the noun closest to it (i.e., NP2 attachment or *low attachment*). This results in an interpretation in which *the psychologist lives in California*. Contrary to this, in Spanish, predicate proximity is strong enough to dominate over recency. In this case, the ambiguity is resolved in favor of NP1 attachment or *high attachment*, resulting in an interpretation in which *the daughter lives in California*.

Frenck-Mestre (1997) examined the processing of this construction in less proficient learners of French—a language in which NP1 is the preferred attachment site—by considering whether the general attachment preferences in the L1 and the L2 were congruent or incongruent. In the congruent case (i.e., L1 Spanish–L2 French), learners showed a preference for NP1 attachment. In the incongruent case (i.e., L1 English–L2 French), the trend was toward NP2 ambiguity resolution. That is, the L2 readers only followed the target language's general attachment preference when it was congruent with the general preference in their L1. Frenck–Mestre attributed this pattern of results to the influence of the native language on L2 processing.

A subsequent study (Frenck-Mestre, 2002), however, found that English-French learners who were more proficient in their L2 French resolved the ambiguity in favor

of NP1 attachment, the same pattern found in the French monolingual group. Frenck-Mestre suggested that the parsing preferences observed in the first group of nonnative French learners were due to their low level of proficiency in the L2. In contrast, the learners in Frenck-Mestre (2002) were more proficient. This suggests that proficiency modulates the degree to which L2 learners are guided by phrase-structure-based parsing principles of the type that are evidenced during L1 processing.

Other findings also indicate that proficiency modulates the ability to access and use syntactic information as well as plausibility information during L2 sentence comprehension. Hopp (2006), for instance, found that advanced learners of German displayed the same processing preferences as native Germans when reading subject–object ambiguities, but they did not show differences in response latencies found in native syntactic reanalysis. The near-native speakers, however, reliably used syntactic features in phrase-structure reanalysis, and also showed evidence of incremental reanalysis patterns typically found in native speakers. Finally, studies investigating theta-role assignment under the Competition Model generally find that L2 learners use parsing strategies that are more consonant with the structure of the L2 as they become more proficient (Su, 2001).

Taken together, these findings suggest that the extent to which L2 learners are able to exploit various sources of information during L2 sentence comprehension may depend on proficiency level. This may be, in part, because lower proficiency confers a processing disadvantage to second language learners, as the increased effort required to process lower-level information in the second language detracts from the cognitive resources needed to carry out higher-level comprehension processes. By contrast, higher proficiency levels free up cognitive resources needed to carry out higher-level computations involving the rapid access and integration of information, resulting in processing that is similar to that of native speakers. Some recent evidence from the L2 production literature indicates that this may, in fact, be the case. For example, Hoshino, Dussias, and Kroll (Accepted) found that only Spanish–English speakers who were highly proficient in their L2 were sensitive to conceptual number and grammatical number in the computation of subject–verb agreement, replicating in behavior the performance of native English speakers with high memory span. However, low-proficiency L2 learners showed sensitivity to only the grammatical number, much like the native speakers with low-span scores. This result, together with the findings discussed above, suggests that only at near-native levels of proficiency do nonnatives converge on native-like processes.

Immersion Experience

Previous literature on adult native speakers has raised the possibility that the sentence parser is experience based, and that initial parsing choices are made on the basis of the experience that the individual readers or listeners have with the language spoken in their environment (e.g., Cuetos, Mitchell, & Corley, 1996). Although this claim has been subjected to much empirical testing in the monolingual literature, few studies have examined whether immersion experience impacts L2 sentence comprehension, and whether, in fact, learners immersed in their L2 tune in to linguistic variations of the environment and use this information to resolve syntactic ambiguity.

One such experiment is reported in Fernández (2003). A pencil-and-paper questionnaire was employed to investigate relative clause attachment preferences in Spanish learners of English living in an English-speaking environment and Spanish monolingual controls. Participants read stimulus materials in Spanish and English, in which the important linguistic variable was the manipulation of the length of the relative clause—a factor known to influence relative clause ambiguity resolution in monolingual sentence parsing (Fodor, 1998). Accordingly, sentences either had short relative clauses (e.g., *The nephew of the teacher that was divorced*) or long relative clauses (e.g., *The nephew of the teacher that was in the communist party*). Consistent with the proposal advanced in Fodor that the parser has a tendency to equalize the prosodic weight size of constituents (so, long RCs should "attract" NP1 attachment and short relative clauses should attract NP2 attachment), Fernández found overall higher rates of NP1 attachment with long versus short relative clauses for monolingual Spanish controls. However, the Spanish learners of English were sensitive to the length of the relative clause when reading in English, but failed to exhibit length effects with Spanish materials, despite the fact that Spanish was their dominant language. To explain the findings, Fernández hypothesized that sensitivity to length emerges more clearly in the language that the participants read more frequently. In the case of the Spanish–English speakers, the fact that they were immersed in an English environment and were, therefore, more frequent readers of English, may have contributed to the lack of a length effect in Spanish, their own native language.

Similar findings were reported in Dussias (2003) who also tested Spanish–English speakers in their two languages. As in previous studies, the construction examined contained a complex noun phrase followed by a relative clause. Findings for the control groups (i.e., Spanish and English monolinguals) showed the conventional bias for NP1 and NP2, respectively, reported in the literature. However, for the Spanish-dominant bilinguals, the prevailing strategy was NP2 attachment regardless of whether they were reading Spanish or English materials. To account for the findings, Dussias suggested that the amount of exposure to the second language by these learners could have played a role. The Spanish–English participants had lived in the second language environment for approximately 8 years and had been under intense contact with English. It could have been that exposure to a large number of English ambiguous constructions resolved in favor of NP2 may have rendered this interpretation more available, ultimately resulting in the preference for NP2 attachment observed in the results.

More recently, Dussias and Sagarra (2007) compared the performance of monolingual Spanish speakers with that of Spanish–English bilinguals who had limited or extensive immersion experiences in the L2 environment. Participants read temporarily ambiguous constructions in Spanish, their dominant language, again consisting of a complex NP followed by a relative clause. The findings showed that the Spanish–English speakers with limited immersion experience in the L2 environment resolved the ambiguity using the same strategies employed by monolingual Spanish readers. Conversely, the Spanish–English speakers with extensive exposure to English parsed the ambiguous construction using strategies associated with English, their second language. Importantly, the results were apparent after proficiency between the

two groups of bilinguals was matched, showing that the difference was not due to proficiency in the L2, but rather to immersion experience.

These results taken together suggest that amount of immersion in the L2 language can alter the processing strategies of the L2 learners and counteract the influence of L1 processing patterns when processing the L2. Moreover, the above studies also suggest that L2 immersion can have the effect of altering processing patterns in the bilingual's L1.

Working Memory

In the L1 sentence processing literature, working memory has been hypothesized to play a central role in language comprehension. During reading, comprehenders must recognize words, compute syntactic structure, and assign thematic roles to phrases. They must also quickly retrieve the representations of previously processed words and phrases to integrate them with newly processed phrases in the text. In addition, they need to store other information, such as explicit text propositions and inferences based upon those propositions, which are implicated in the construction of a functional, coherent representation of the text in memory (Kintsch & Van Dijk, 1978). During the execution of these processes, working memory is important in storing the intermediate and final products of a reader's successive computations. This allows for the construction and integration of different types of information from the text (cf., Just & Carpenter, 1992).

A number of studies in the monolingual literature support the view that individual differences affect parsing behavior. For example, high-span individuals have shown a speed advantage for integrating pragmatic information, but a speed disadvantage when resolving certain types of syntactic ambiguity (MacDonald, Just, & Carpenter, 1992). Other studies examining the influence of working memory resources in the resolution of relative clause ambiguities of the type discussed above, suggest that high-span speakers have sufficient cognitive resources to keep both the nonlocal NP1 and the local NP2 active in working memory when resolving the ambiguity, but low-span individuals can only encode the nonlocal NP in working memory (Mendelsohn & Pearlmutter, 1999). These findings raise the question of whether the observed differences in sentence processing between L2 speakers and monolingual speakers could be explained under a cognitive load account. This question is even more relevant when considering that studies in the L2 domain indicate that even for relatively proficient bilinguals, processing the L2 requires additional cognitive resources compared to L1 processing (e.g., Michael & Gollan, 2005).

The available findings generally show no relationship between availability of cognitive resources, as measured by reading span tests, and L2 sentence comprehension. For example, Juffs (2004, 2005) failed to find a correlation between reading times and span scores when high- and low-span L2 learners read sentences that are known to cause a garden-path effect in monolingual speakers. Although these results suggest a dissociation between working memory capacity and L2 sentence processing behavior, one major challenge to the findings involves the type of working memory measure employed. Studies that have used Daneman and Carpenter's (1980) reading span test, or a variant of the test (as is the case in Juffs, 2004, 2005), may have found no

correlations because the test is potentially invalid as a measure of working memory capacity (see Omaki, 2005 for a similar argument). In the Daneman and Carpenter span test, participants are asked to read sentences aloud while remembering the last word of each sentence for a subsequent recall task. Because reading aloud does not guarantee that participants process sentences for meaning, it has been argued that the processing component of working memory is not taxed in the manner that it normally is during language comprehension (Waters & Caplan, 1996).

To address this limitation, Omaki (2005) used a modified version of the Waters and Caplan (1996) reading span test to examine whether ambiguity resolution was associated with working memory capacity when Japanese learners of English read ambiguous relative clauses in English (e.g., *The doctor said that the sister of the bishop who injured himself (herself) last summer was concerned about the infection*). Once again, no relation was found between reading span and attachment preferences. However, as Omaki suggests, the lack of a relationship is expected if the Japanese-English learners had failed to learn that English is a subset of Japanese with respect to the scope of the interpretation that a modifier phrase (e.g., a relative clause) has over the two nouns in the genitive phrase. In other words, English is like Japanese in that its genitive construction contains two noun phrases separated by a genitive marker. The two languages differ, however, in that Japanese genitive constructions allow a relative clause to modify either one of the two nouns in the genitive phrase, but the English genitive only permits attachment of the relative clause to the local noun. This means that Japanese L2 learners of English must know, minimally, that a relative clause following a genitive construction in English can only be construed as referring to the syntactically closer (i.e., local) noun phrase before this knowledge can interact with availability of cognitive resources. Because Omaki did not explicitly test whether the learners favored only the local, more restricted interpretation of the modifier, it is difficult to interpret the lack of an effect between cognitive resources and L2 sentence comprehension reported in his study.

Contrary to the empirical evidence reviewed above, some other studies suggest that L2 speakers employ processing resources to the degree that is necessary to perform the task at hand. In Williams (2006), participants were required to perform one of two tasks: (1) To press a button as soon as they thought that a sentence displayed on a computer screen had stopped making sense, (2) to perform a memory task that required the completion of a sentence using a word that had appeared in a previously displayed sentence. The results showed that L2 speakers processed the input incrementally, just as native speakers did, when the task encouraged such type of processing (i.e., in the stop-making-sense task). However, when the task imposed memory demands, the nonnative readers did not process the input incrementally, most likely because they were not able to allocate sufficient resources to perform such processing. This suggests that availability of processing resources plays a role during L2 sentence comprehension; it also indicates that L2 readers may be able to overcome processing limitations under the appropriate task conditions. In a similar vein, Dussias & Piñar (in press) found that although higher working memory resources did not prevent an initial misparse for Chinese-English speakers reading *wh*-subject and *wh*-object extraction structures in English, only the participants with higher working memory scores, like the native English speakers, were able to

use semantic plausibility cues to recover from misanalysis, with implausible analyses facilitating recovery.

The Nature of the Language Input: The Case of Deaf Learners

As we discussed above, the learner's individual linguistic experience can interact with both semantic and structural factors and determine the outcome of the parsing process. Given that the experience of deaf learners is different from that of hearing learners, a review of some of the issues that affect reading processing among deaf individuals can inform our understanding of second language processing in general. The following discussion can apply to deaf readers in any language, but for the purpose of this chapter we will focus on deaf Americans reading English. (See also Berent, this volume.)

For most deaf Americans, English is considered to be a second language. Although only 10% of deaf people are born to deaf parents and are thus exposed to a sign language from birth (American Sign Language in this case), most deaf children learn ASL (or some form of sign language) at school, and most deaf adults use ASL as their primary form of communication (Musselman [Reich] & Reich, 1976). With few exceptions, profoundly deaf children, including those from hearing families, have a very limited knowledge of English by the time they start going to school and learning how to read. In contrast to hearing children, who typically learn how to read after they have acquired the spoken language, deaf children learning how to read in English have to learn the skill of reading at the same time as they learn English (cf., Berent, this volume). Additionally, deaf children who have not been exposed to sign language at home (about 90%) most typically have to learn how to read in an L2 before they have even fully developed an L1. To the above circumstances, one must add the fact that written language is a representation of the spoken language, to which deaf individuals do not have direct access. For all these reasons, deaf people's experiences with print pose interesting questions for the study of written language parsing. One question that arises is whether reading is qualitatively different for hearing and for deaf individuals. Research addressing this issue will be reviewed and discussed within the wider context of second language processing in general. We will focus on three selected variables, competence in the L2, cognitive resources, and knowledge in an L1.

The Role of Competence in the Target Language

Some studies have found a relation between deficiencies in knowledge of English grammar and vocabulary and low reading comprehension among some deaf readers (e.g., LaSasso & Davey, 1987; Quigley, Wilbur, Power, Montanelli, & Steinkamp, 1979). However, in spite of the identified gaps in grammatical knowledge that some deaf individuals may have, other studies reveal that grammatical competence in English cannot completely explain reading comprehension differences between skilled and not skilled deaf readers, or even between deaf and hearing readers.[1] For example,

[1]Competence is understood here as the internalized knowledge of a language (Chomsky, 1965). In this sense, competence must be understood as different from actual performance in the language. It is, therefore, different from level of proficiency, which incorporates the notion of performance.

Lillo-Martin, Hanson, and Smith (1992) conducted a study on deaf reader's competence in relative clause structures. They compared two groups of college deaf students with different levels of independently measured reading comprehension skills. A difference between the two groups in the syntactic processing of complex structures, such as relative clauses, would have indicated that specific syntactic deficits might underlie the difference in reading comprehension skills between the higher and the lower-skilled readers. Their subjects completed a battery of tests to determine their knowledge of relative clause structures in written English, ASL, and Signed English. No significant group effect was found in any of the three language conditions. Interestingly, for the English sentences, both high- and low-skilled readers displayed the same pattern of errors depending on the pragmatic felicity conditions of the relative clause type, thus showing similar competence and similar processing patterns for both groups across different types of relative clauses. This suggests that the independently measured differences in the reading skill levels of the two groups were not due to differences in knowledge of complex structures.

In a more recent study, Kelly (2003) also found that deaf readers with very different levels of reading comprehension skills did not differ qualitatively in how they processed relative clause structures. Although only the less skilled group showed a significant decline in relative clause comprehension in contrast to the control sentences, the reading pattern was similar for both groups of subjects. For example, both groups showed markedly slower reading times for the main verb in relative clause structures as compared to the same verbs in the control sentences. This is the expected reading pattern for relative clause sentences, since the main verb is the point at which the reader first identifies a syntactic gap, as in "She is the woman who__kissed the man." The same processing pattern has been consistently found among L1 readers in the sentence processing literature. The reading patterns obtained in this study suggest strongly that, in spite of the comprehension differences between the high- and low-skilled groups in the relative clause structure condition, both groups displayed a clear command of relative clauses and processing patterns that were consistent with that of L1 readers.

On the basis of these findings, both Lillo-Martin et al. (1992) and Kelly (2003) conclude that differences in reading comprehension skills between skilled and nonskilled readers cannot be accounted for simply on the basis of differences in syntactic competence of complex structures. More generally, we might add that, given that the deaf readers in the above-mentioned studies showed processing patterns that were equal to those found among L1 hearing readers, differences in reading comprehension among hearing and deaf subjects do not seem to be solely attributable to differences in syntactic knowledge. Interestingly, the literature on L2 sentence processing has come to the same conclusion regarding the comprehension performance of hearing L2 learners. A case in point, for example, is Juffs & Harrington's (1995) discussion of the processing of English long-distance *wh*-questions. In their study, L2 learners displayed evidence of knowing the *wh*-structure, yet differed significantly in their comprehension performance when compared to L1 subjects. A wider range of syntactic structures needs to be methodically tested in order to clearly determine the role of grammatical competence in sentence comprehension. But if, as the cited research suggests, grammatical competence alone cannot account for

differences in comprehension skills among the different groups of readers, what else might be driving the subjects' performance? Below we discuss how the nature of the L2 input (namely, written only) and the deaf reader's general linguistic experience may influence the amount of cognitive resources he or she brings into the task of performing higher-level reading operations.

Cognitive Resources

Readers use different decoding mechanisms to perform basic reading operations, such as identifying words and other basic text units and relating them to one another. For example, it is widely assumed that phonological coding (or the mapping from print to sound) is one strategy used by hearing readers to identify basic text units and keep them in short-term memory. Since deaf readers do not have access to the phonological aspects of English, are their lexical retrieval and storage strategies different from those utilized by hearing readers? And how might different strategies affect cognitive resources while reading?

There is no consensus on which decoding or short-term memory strategies deaf readers are more likely to use. Some studies have found that they use a variety of strategies available to them: visual strategies (such as grapheme or whole word recognition, as well as cheremic associations with signs) and also speech-based strategies (developed through articulation, visual cues, and finger spelling, e.g., Hanson & Fowler, 1987; Padden & Hanson, 2000). Lichtenstein (1998), for example, observed that the subjects in his study could not be classified into groups that used one strategy versus another. He concluded, however, that speech-based recoding was the most effective system for temporarily storing information—given its higher correlation with scores in the sequential recall of word lists—but that it was not likely to be the strategy used to help with lexical retrieval. Similar conclusions were drawn in an earlier study by Hanson (1982). From the results of these studies, it might seem that effective deaf readers use a more visual strategy for basic reading operations such as word identification, and a more sequentially based strategy for storing information in short-term memory. The role of phonological awareness, or speech-based recoding, in reading among deaf individuals, however, is rather controversial. First, evidence establishing a relationship between reading skill level and the use of phonological coding in word recognition and recall tasks is mixed and unclear (cf., Musselman, 2000 for a review). Second, even those studies claiming that there is a relation have not been able to establish a causal direction.

Investigating decoding and short-term memory strategies is, nevertheless, important because shortcomings in either one would take up cognitive resources while reading and overburden working memory. One of the goals of the above-mentioned experimental design by Kelly (2003) was precisely to tease out whether reading processing differences among higher and lower-skilled deaf readers could be attributable either to differences in processing automaticity for basic reading tasks, such as word identification, or to short-term storage capacity. In order to isolate automaticity as the variable that might distinguish between high- and low-skilled readers, Kelly administered the working memory test designed by Daneman and Carpenter (1980) twice in a row to two groups of college-age deaf students with different levels of reading comprehension skills. The logic was that the readers' familiarity with the

vocabulary and the sentences would make the basic reading tasks more automatic the second time around and, thus, reduce any possible initial reading automaticity differences between the two groups. Administering the test a second time, however, would not affect the storage capacity demands of the task. As expected, the less skilled readers performed lower than the more skilled readers in the first test administration. However, both groups performed more similarly on the second test administration, after any possible initial automaticity differences between the two groups were reduced by enhancing familiarity. Kelly concluded that this result points to automaticity and not to storage capacity as the factor that differentiates reading performance between the two groups.

To isolate the short-term storage capacity variable, Kelly administered sentence reading tasks in which the demands on processing and storage were experimentally manipulated. Specifically, the subjects had to read relative clause structures and their simpler controls in a whole sentence condition and in a word-by-word presentation condition in which subjects only saw one word of the sentence at a time. Arguably, the word-by-word presentation condition imposed a heavier burden on storage capacity. Interestingly, Kelly found that neither group showed any significant comprehension differences in the whole sentence versus the word-by-word presentation condition, which suggests that a difference in storage capacity did not make a difference in comprehension for either group. Since short-term storage is the variable that has been linked to type of decoding strategy in the literature, it would seem that the comprehension differences in this study did not stem from whether the subjects made use of phonological decoding or not.

The less skilled readers in Kelly's study, however, were overall much slower than the skilled readers, even in the simple sentence condition—with speed being a sign of processing automaticity. Additionally, in contrast to the higher-skilled group, the lower-skilled group was not only slower, but also showed significantly lower comprehension in complex structures. This suggests that automaticity had a significant effect on the lower-skilled group's comprehension performance. That is, as automaticity decreased due to structure complexity, comprehension also decreased for the lower-skilled group. Interestingly, in spite of these differences, recall that both groups showed the expected processing pattern for relative clause structures (i.e., both groups' reading times were significantly higher at the site of the main clause verb). On the basis of these results, Kelly concluded that sentence comprehension differences between the two groups was not due to deficient knowledge of the relative clause structure on the part of the lower-skilled group or to storage capacity differences, but rather to a difference in processing automaticity. Arguably, low automaticity taxed cognitive resources and derailed sentence comprehension for the slower readers.

In sum, just as has been found in the L1 and L2 processing literature, differences in cognitive resources among deaf subjects may affect their comprehension performance. More specifically, the previous discussion suggests that automaticity in decoding and recognizing the basic units of printed texts may be an important factor in accounting for differences in comprehension performance between different groups of readers. The question is what produces low automaticity and how do skilled readers acquire the necessary automaticity to efficiently comprehend written text? As Kelly (2003) points out, the causal relation between automaticity and reading experience might, in fact, be

reciprocal. Thus, while automaticity seems to influence the quality of the reading experience, successful experiences with reading might also enhance automaticity in recognizing and establishing relations among basic text units.

Bottom-up reading components, such as automaticity in recognizing basic text units and their syntactic relationship to each other normally interact with the so-called top-down aspects of the reading process, such as application of context and topic knowledge and stored linguistic knowledge. One factor, not yet discussed, that seems to be key in enabling the mapping between print and meaning for deaf learners, is the quality of stored linguistic knowledge. Below, we discuss the relationship between sign language skills and reading skills and the role that the development of a first language might play in the development of literacy skills in a written language.

Stored Linguistic Knowledge and Deaf Literacy

The role of the L1 in the acquisition of an L2 has been a topic of hot debate in the second language learning literature (cf., see Gass, 1996 for a review). Interestingly while knowledge of an L1 is assumed for hearing L2 learners, deaf learners present a wide range of variation regarding their previous linguistic knowledge in an L1 by the time they start learning written English. Since not all deaf learners come to the task of learning English with a fully formed L1, deaf people's experiences in acquiring English literacy can inform the debate on language transfer in interesting ways. For example, research in deaf literacy can provide insight into the question of how Universal Grammar and the L1 interact in the development of an L2. Specifically, how much previous knowledge is enough, and to what extent can Universal Grammar principles compensate for gaps in L1 experience?

The relationship between signing skills and the acquisition of English literacy has also been a source of controversy in the history of deaf education. The proliferation of oral programs before the 1970s was based on the assumption that ASL would interfere with the acquisition of English. More current approaches adopt Cummins' (1981, 1989) model of linguistic interdependence as a model for bilingual education for deaf students. Based on Cummins' tenet that there is a common proficiency underlying the two languages of a bilingual person, it is argued that development of cognitive and academic skills in ASL will translate into the development of similar skills in English.

It has been shown that deaf children of deaf parents attain higher reading achievements, on average, than deaf children of hearing parents—who are less likely to experience early exposure to sign (cf., Kampfe & Turecheck, 1987 for a review). Signing skills, however, are only one variable in the dynamics of hearing versus deaf families. In order to isolate the role of ASL in the academic achievement of deaf children, Strong and Prinz (2000) investigated whether the deaf versus hearing family effect would persist if the ASL skills of the children were held constant. They studied a group of children, ages 8–15, from the same deaf residential school and found an overall statistically significant relation between ASL skill level and English literacy skills. Moreover, they found that the students within the highest ASL skill-level groups performed equally well on English literacy tasks regardless of family hearing versus deaf status. They conclude that this result confirms the hypothesis that the reported academic performance difference between deaf children of hearing versus deaf families is due to linguistic knowledge of ASL. The same kind of relation between ASL and

English literacy has been found in other studies, such as those of Hoffmeister (2000) and Padden and Ramsey (2000).

The evidence from the studies above indicates that knowledge of ASL facilitates English literacy. At the same time, it is important to understand that ASL is a *bona fide* language with grammar and vocabulary that are completely different from English (Klima & Bellugi, 1979; Stokoe, 1960). Given the lack of a one-to-one correspondence between printed English and ASL, much remains unknown about how exactly sign language might be used to bridge the gap between print and meaning (Chamberlain & Mayberry, 2000; Hirsh-Pasek & Treiman, 1982; Padden & Hanson, 2000). The reported facilitatory effect of ASL, however, may well be an important factor for the establishment of the reciprocal relationship between automaticity and reading experience.

II. CONCLUDING REMARKS

The field of L2 sentence comprehension has reached an exciting point. The number of findings involving different types of syntactic structures is rapidly growing, and explanations are beginning to emerge that attempt to characterize the type of processing in which L2 learners engage while constructing a syntactic parse. The framing question underlying the studies discussed in this chapter is to what extent L2 processing is qualitatively similar or different from L1 processing. In addressing this question, we have discussed a number of variables that appear to affect reading processing among L2 learners. Some of these variables are linguistic in nature in that they are concerned with the specific sources of linguistic information that L2 learners access and use during L2 sentence comprehension. We have seen that, just as in L1 processing, "sense–semantic" information appears to have very rapid effects on L2 comprehension and, under some circumstances, influences incremental sentence processing. However, it is much less clear whether the L2 processor takes into account structure-driven parsing principles of the type proposed in the L1 sentence processing literature. We have also discussed other variables that are related to the characteristics of learners or to their linguistic experience. We saw, for example, how learners' characteristics, such as proficiency and type of linguistic experience, often interact with linguistic aspects of the input in producing a parsing outcome.

In order to arrive at an accurate representation of L2 language processing, more interdisciplinary collaboration is needed that examines a wider variety of L2 learners and use a range of methodological tools. A case in point, which was highlighted in this chapter, is deaf learners. The case of deaf L2 learners is particularly interesting because the written language constitutes their primary access to the L2. As we saw, this raises important questions about the nature of the decoding mechanisms they use and about whether those mechanisms ultimately affect their syntactic processing and render their reading experience qualitatively different from that of hearing L2 readers. Their unique language and learning experience can inform the field of second language processing in insightful ways. At the same time, the study of deaf written literacy can be enriched when looked at in the context of the experiences of other second language learners.

Recent research efforts are also trying to incorporate other learner groups that have heretofore been excluded from the literature on L2 processing. One example of this is Juffs (2007) study on what he terms "low-educated learners." As we examine a wider range of learners, we will have a more complete picture of the factors that are implicated in second language processing and will find ourselves in a better position to identify the crucial variables that lead to successful second language comprehension.

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