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A NEW PERSPECTIVE FOR SECOND LANGUAGE ACQUISITION: PARSING

Johanne S. Bourdages

1. Introduction

One of the central issues in psycholinguistics deals with how individuals comprehend and organize incoming data. Language is seen as a multilevel structure (phonology, morphology, syntax, semantics and pragmatics), however this does not imply a stratification in real-time processing. Many experiments support the premise that a human language processor operates on many levels simultaneously and that these levels are not completely independent (Marslen-Wilson, 1975; Foss and Hakes, 1978; Winograd, 1983). But before one can explain how these levels interact with one another, one must determine how processing works within each specific level. This paper will focus on the syntactic aspect of language processing, on what is commonly known as **parsing**. However, since the syntactic processor is not completely independent from other components of grammar (e.g. lexicon, phonology, etc.), the contribution of these components will need to be mentioned in those instances where the parser must get the information provided by these levels in order to process the incoming data. The aim of this paper is to look at the relationship between the parsing mechanism and the process of language acquisition, and more specifically second language acquisition.

By definition a parsing mechanism is seen as a grammar interpreter. Berwick and Weinberg (1982) explain that parsing a language consists in finding the derivation tree by which a sentence can be generated with respect to some particular grammar. Thus, the parser uses as input sentences segmented into units (words or sequences of morphemes) and produces as output a derivational tree, a representation of the syntactic structure of the sentence being processed. Many well-known models of parsing (e.g. Frazier and Fodor, 1978; Marcus, 1980) have favored a bottom up procedure where the parser's input are surface structures. In such an information-

driven parsing model, the parser must wait to see the input strings before deciding which parsing rules to apply. However, these models allow some kind of combination of a bottom up (information-driven) and a top-down (knowledge-driven) procedure¹ to compensate the lack of predictive ability of a bottom up parser, and there is some evidence (Joshi, 1985; Pereira, 1985) that a combination of the two procedures is used by the parser.

In the field of first language acquisition some proposals concerning sentence processing have been put forward. Berwick and Weinberg (1984) and Berwick (1985) have presented a detailed model of the parser and have discussed its role and implications in language acquisition. The notion of parsing is getting increasing attention in language acquisition research, and is now considered an important component in many models of language acquisition (e.g. Roeper, 1978; Pinker, 1984). Therefore, the process of language acquisition can now be seen as an interaction between universal grammar, the language processor, previous language knowledge², knowledge of the world, and linguistic data of the target language.

This modular view of language acquisition is also accepted in second language acquisition research (e.g. White, 1989; Zobl, 1986; Gass, 1985). However, I know of very few proposals (e.g. Zobl, 1986; Goodluck and Whalley, 1980) which have attempted to clarify the relationship between parsing and the process of second language acquisition. Yet, this is an interesting research area in that it might give insights into a number of issues in second language acquisition: for example, the course of second language development, the distinction between input and intake (i.e. what allows input to become intake), the notion of transfer, etc.

2. Universal Grammar, Parsing, and Language Acquisition

Modern linguistics has tried to account for language acquisition by restricting the number of possible (learnable) grammars that can be posited by the learner on the basis of incoming data. Because of the complex nature of linguistic knowledge, the conditions in which language acquisition takes place, the nature and variety of the input data³, the rapidity of acquisition and the uniformity of the final state,

1. For a description of these procedures, see Winograd (1983).

2. In second language acquisition, the native language would be considered previous linguistic knowledge.

3. See Brown (1977); Newport, Gleitman and Gleitman (1977); Snow and Ferguson (1977).

Chomsky proposed the existence of innate linguistic knowledge, universal grammar, which enables the child to acquire language. Within the framework of generative grammar, universal grammar is responsible for restricting the possible analyses by stipulating general principles which will guide language acquisition. This approach to language acquisition, in its current form, is seen as a parameter-setting approach, where a plus or a minus value for each of a set of universal parameters must be fixed through experience. This implies that once the learner has made a decision on the value of a parameter, based on the input data available, he must obey this decision every time the parameter is to be used, i.e. the learner must be systematic in his usage of the parameter.

2.1 The Parsing Mechanism and Grammar

Anyone working on sentence processing is aware of the fact that a theory of parsing cannot be developed independently of a theory of grammar. This does not mean that there should exist a **strict transparency** or isomorphism (Berwick and Weinberg, 1984) between the two theories, but at least some sort of relationship between the grammar and the parser is necessary. Since a theory of grammar should describe the **what** (competence), and a theory of parsing the **how** (performance) of syntactic comprehension, it would seem reasonable to expect that these two theories would share many features and should, in part, be constrained by the same principles, those of universal grammar.

Berwick and Weinberg (1984), among others, believe that a theory of grammar should guide the elaboration of a theory of parsing: «Even if the grammar does not specify the exact computation or representation employed by the parser, it delimits a class of possible operations.» (p. 76). Moreover, requiring specific knowledge of grammar and a completely separate one of parsing would result in some redundancy since the elements in question are shared by both components. Therefore, it is parsimonious to assume that universal grammar will also guide the parsing mechanism in the type of decisions or analyses it will be capable of performing. The parser, then, is seen as being subject to the principles of universal grammar (Chomsky, 1981, 1982) such as the X-bar theory, Case theory, Theta criterion, Projection Principle⁴, etc.. This does not mean that the grammar and the parser

4. The X-bar theory captures general properties of syntactic categories, and it recognizes the existence of intermediate categories between a lexical category (X^0) and a phrasal category (X^n). X-phrases always

share the same type of formal operations, but whatever the operations are, they are constrained by the same general principles.

In addition to the constraints imposed by a theory of grammar, the human parser must be bound by other limitations of a more pragmatic type. First, it may not rely on an indefinitely large memory (i.e. the existing limitations on embedding) and furthermore, it must be time bound in order to reflect real time processing. Frazier (1979) points out that the parser is limited by the amount of material it may hold simultaneously because the human sensory memory decays if the material is not rapidly structured. This is particularly true when one looks at the process of language acquisition. There is more pressure on the memory load of a beginning language learner than on a more advanced one. Evidence of this can be found in second language acquisition studies using the task of elicited imitation where it is shown that the number of syllables that a language learner can repeat increases with his competence.

2.2 Parsing and Language Acquisition

The acquisition procedure within a framework of sentence processing can be defined as the acquisition of a series of parsers of increasing sophistication, going from P₀ (initial state) to P_{TL} (mature parser of the target language).

$$(1) P_0 \text{ ----> } P_1 \text{ ----> } P_2 \text{ ----> } \dots \text{ ----> } P_{TL}$$

Berwick and Weinberg (1984) assume that: «It is the parser's attempts to interpret sentences in accordance with its universal constraints that provides a specific driving mechanism for acquisition.» (p. 202). It is reasonable to presume that it is also valid in second language acquisition.

contain an X, where X represents a Noun, an Adjective, a Preposition or a Verb. (See Jackendoff, 1977; Chomsky, 1981).

Case Theory is concerned with the assignment of Case to elements that are in case-marking positions, for example, objects of transitive verbs and prepositions. (Chomsky, 1981, 1982).

A verb like *persuade* assigns certain thematic role (θ -role) to each category for which it is subcategorized, its object and complement clause and its subject. The Theta Criterion specifies that each argument is assign only one θ -role, and that each θ -role is assigned to only one argument. (See Chomsky, 1981, 1982).

The Projection Principle states that the θ -marking properties of each lexical item must be represented categorially at each syntactic level: Logical Form, S-structure and D-structure (Chomsky, 1981, 1982).

If one looks at models of parsing in conjunction with language acquisition, some studies (cf. Tavakolian, 1981; Solan and Roeper, 1978) seem to indicate that the bottom up procedure would be the first one to be used. One can suppose that, as the grammar component of the language faculty becomes more operative a combination of the two procedures becomes more attractive. Goodluck and Whalley (1980), by comparing adult second language learners to child native speakers, show that children (3-4 year old) are sufficiently advanced in their language learning not to have to rely as heavily as adult second language learners (low and intermediate levels learners) on processing strategies in interpreting input material. This implies that, at the beginning of language acquisition, be it first or second, the learner must depend on the parsing mechanism to guide the acquisition of syntax, and as acquisition proceeds, the learner comes to rely more and more on the developing grammar of the target language to interpret the incoming data. This is also compatible with findings by Solan and Roeper (1978) and Tavakolian (1981) which show that in the very first steps of the acquisition of syntactic knowledge, children tend to project a flat structure instead of the usual hierarchical structure for complex clauses. As the parser learns to recognize the features specifying the complement structure, it will become capable of building a more sophisticated structure.

From this perspective, the acquisition procedure is quite simple. If the parser, at any point during an analysis, cannot compute a sentence or part of a sentence, the acquisition procedure is activated, i.e. there is a process of readjusting the grammar. If new rules can be created (based on the data structure of the parser⁵), and if these rules are accepted, then the acquisition has succeeded. If no new rules can be created because the learner does not yet have the computational ability to build these rules, then the sentence cannot be made available for a correct analysis and successful acquisition⁶ (e.g. the interpretation of passive constructions in young children).

Berwick and Weinberg (1984) point out that, before acquisition takes place, the language acquisition mechanism already possesses a certain amount of general

5. The data structure of a parser describes the actual way a parser functions. For example, in Marcus (1980) the data structure has two main components:

- 1) the push-down stack which holds the analyzed data,
- 2) the look ahead buffer which can look for up to five new elements before continuing the analysis.

6. It may take a number of parsing failures to trigger the readjustment process.

knowledge about word segmentation and morphology, about semantic-syntactic correspondance between lexical items and syntactic categories⁷, about proper assignment of arguments to verbs (e.g. *John reads a book*; *John* and *book* being arguments of *reads*), and finally about the basic data structure of the parser and the format of its rules⁸.

According to Berwick and Weinberg (1984), the acquisition of syntactic knowledge implies learning the ordering of linguistic elements and the branching direction of the tree structure, the lexicon, and the transformational rules, represented by the general rule *Move α* ⁹. The next section will look at the acquisition of syntactic knowledge from the point of view of parsing with special emphasis on second language acquisition.

3. Parsing and Second Language Acquisition

There are very few studies which provide empirical evidence on the role of the parser in second language acquisition. Most studies in the field of second language acquisition are based on production data and not on comprehension data. There has been relatively little research in either first or second language learning from the perspective of parsing. There are, however, some relevant studies on the processing mechanism which aim at defining and describing processing strategies. These studies are not concerned with the acquisition process *per se* but can, nevertheless, provide insights and directions for second language acquisition research.

Many studies in parsing have shown the role of lexical knowledge in the processing of simple as well as filler gap sentences¹⁰, but they have never been considered from the perspective of language acquisition.

The language learner must acquire lexical knowledge: «A large part of *language learning* is a matter of determining from presented data, the elements of the

7. A person or an object corresponds to the category **NOUN** forming a Noun Phrase; an action corresponds to a **VERB** forming a Verb Phrase, etc.

8. In Berwick's model (1985), the parser functions according to three main rules: ATTACH, SWITCH, and INSERT. The acquisition procedure will try these rules in that order.

9. *Move α* represents a general transformational rule that moves any constituent in a syntactic structure.

10. Filler gap sentences are sentences in which movement has applied, where the **filler** represents that antecedent of the moved (or deleted) constituent and the **gap** represents the empty position related to the filler.

lexicon and their properties.» (Chomsky, 1982, p. 8). The learner must first learn to classify linguistic items into lexical categories which are defined by a series of features with a plus (+) or minus (-) value. For example:

(2)	N	Adj	Det	V	Prep	Comp	Infl	Particle
	+N	+N	+N	-N	-N	-N	-N	-N
	-V	-V	-V	+V	-V	-V	+V	-V
	+A	+A	-A	-A	-A	+A	+A	-A
	-P	+P	-P	+P	+P	+P	+P	-P

An argument (A) is a thematic-role bearing phrase, and a predicate (P) is a function-like phrase that assigns thematic roles. Berwick (1985, p. 65).

The learner will also need to know the specific properties of lexical items: for example, for a verb, knowledge of its complements and its θ -marking. Lexical insertion rules will also be needed: these define the proper contexts for the insertion of terminal elements into a phrase structure tree. The parser will have to compare the information carried by the incoming data with what has been stored in its data structure in order to accept or reject an entry. Because of the Projection Principle, the subcategorization information will need to be made available at all levels of representation to guide an ongoing parse. This can be achieved by percolation of the features to the maximal projection X^{\max} 11.

The acquisition of features and properties of lexical items does not seem to be a monolithic process in the sense that not all features and properties can be learned at the same time; the learner has to discover them as data are made available and as acquisition proceeds. When considering the development of syntactic knowledge, we tend to forget the implications of a developing lexical knowledge on the parsing mechanism. During the acquisition process, be it first or second language, lexical knowledge is developing alongside syntactic knowledge, implying that it is possible that, at some point, some of the lexical entries to the parser may be incomplete or even incorrect. Consequently, the parser will not be able to exploit some of the available data which will become opaque (for a time) to the acquisition procedure. For example, C. Chomsky (1969) demonstrated that children interpreted the following sentences in the same manner:

11. Bourdages et al. (1985) proposes a Syntactic Percolation Convention based on the one proposed by Lieber (1981) for morphology. This Syntactic Percolation Convention states that the head's features can percolate to its maximal phrase.

- (3) a. John promised Bill to shovel the driveway.
 b. John told Bill to shovel the driveway.

They interpreted *Bill* to be the subject of *shovel* in both sentences, probably because they did not know about the control property of the verb *promise*, thus following the Minimal Distance Principle¹².

In second language acquisition, where the learner already has an elaborated lexicon, we find, at the production level, transfer of some of the first language properties of a lexical item:

- (4) Je n'ai pas l'intention de le (ACC) répondre. (for *lui* dative)
 I don't intend to answer *him* (accusative)

(Adjemian 1983, p. 263)

From the point of view of comprehension, there exists some evidence of transfer of lexical properties in the comprehension process, and it seems to affect sentence interpretation. Bongaerts (1983) shows that second language learners seem to bring their first language learning experiences to bear on the task of interpreting certain sentences in a second language. Bongaerts used the same structures as C. Chomsky (1969) with Dutch learners of English and compared his results with studies by D'Anglejan and Tucker (1975) and Cooper et al. (1979). He found that his Dutch subjects had less difficulty than the other language groups because the studied English structures showed similarity with the equivalent Dutch structures. He concludes that the difference between his results and those obtained by the other two studies is due to the difference in the language background (the native language) of the subjects.

As mentioned previously, first language experience seems to affect the comprehension process in a second language. The question is now in trying to pinpoint what influences the interpretation of sentences in a developing second language as well as to determine which parsing strategies are employed most frequently and most successfully by second language learners.

Several studies in language processing have shown the importance of lexical information in the comprehension of sentences, particularly of filler gap sentences.

12. The Minimal Distance Principle is a general principle specifying that the implicit subject of a complement verb is the NP most closely preceding it. (C. Chomsky, 1969, p. 10).

Fodor's Lexical Expectation Hypothesis (1978) assumes that the sentence processor will first adopt the most frequent subcategorization frame for an item and that it will postulate a gap if a specified phrase does not lexically appear in that position. Clifton, Frazier and Connine (1984) demonstrate the effects of violating a lexically based syntactic expectation. Their experiments provide support to the effect that lexical information about preferred subcategorization frames is used very quickly during sentence processing. Their experiments also show that at least part of the lexical information (the rest being possibly pragmatic) used in sentence comprehension is information about the possible syntactic categories of the complement of a verb.

One possible way of checking into the question of what influences the interpretation of sentences in a developing second language, would be to verify the lexical expectancies of second language learners on verbs which have different subcategorization frames or different subcategorization preferences in the learner's native and target languages. Connine et al. (1984) present a list of lexical preferences for 127 English verbs. For example, in English the verb *sing* can be a transitive verb as in: *She sang the child to sleep*, or intransitive as in: *The babysitter sang to the sick child*, and according to Connine et al. the preferred argument frame for *sing* is intransitive. Clifton et al. (1984) show the importance of preferred argument frames in adult language processing. Their results show that a lexical decision task is faster when the phrase following the verb matched its preferred argument frame than when it mismatched the frame. With respect to second language acquisition, the most obvious hypothesis would be to assume that where there are differences between the native and target languages of a learner, difficulty in processing will appear, and where the two languages are similar, no problem will arise. The first step in checking this hypothesis would be to elaborate a list of lexical preferences such as the one by Connine et al. (1984) for verbs of the native and target languages of the learner in order to compare the possible differences between preferred lexical frames¹³. Once this tool has been developed, it will be useful in many ways to researchers interested in studying sentence comprehension in a second language.

One other possible area of investigation in second language acquisition would be to look at the processing strategies used by second language learners. Frazier (1989) mentions that with respect to adult language processing, there seems to

13. Bourdages (1990) presents a list for preferred subcategorization frames for 89 verbs in French.

exist one general preference for the parser to take the first analysis available for each word of the input string. This preference is exemplified by strategies like The Minimal Attachment (Frazier and Fodor, 1978), Late Closure (Frazier, 1979) and Recent Filler (Frazier, Clifton and Randall, 1983) which govern the parser's decisions about the attachment of incoming material.

Part of the input which the learner has to learn how to interpret consists of filler gap sentences. These sentences are the result of the application of movement rules, represented in the grammar by the general rule *Move α* . As mentioned in the preceding paragraphs, subcategorisation information guides the parsing of a sentence. This information will enable the parser to interpret a gap and insert a trace where needed. If on the basis of subcategorisation information, the parser predicts that an NP is the direct object of a verb, this NP node would be attached directly underneath the VP node and this attachment could never be incomplete (i.e. left empty). Therefore, the parser will need to learn how to recognize the fillers¹⁴ (e.g. a wh-word placed at the beginning of a clause) and it will have to find out, in conjunction with the subcategorisation information, where to insert an empty category (e.g. a trace) corresponding to the previously recognized filler¹⁵. In other words, the filler will serve as a clue to the parser, telling it to expect an empty node.

Frazier, Clifton and Randall (1983) propose a strategy called **Recent Filler Strategy** where the parser assigns the most potential filler to the first gap encountered. There is developmental evidence (cf. C.Chomsky (1969) for first language acquisition and Bongaerts (1983) for second language acquisition) that seems to support this strategy, but there is still research needed to investigate how second language learners cope with the interpretation of gaps, particularly those learners with a native language with free word order. In this case, the second language learner does not only have to learn new grammar rules but he also has to create new processing (on-line) rules to actualize or control these grammar rules.

14. Fodor (1983) defines a filler as a moved constituent or the antecedant of a deleted constituent.

15. Morphological information will help the parser in the interpretation of the gap. For example, the distinction between *que/qui* used in French to differentiate the subject from the object.

4. Implications of Parsing for Second Language Acquisition

Within a framework where the acquisition process is described as the acquisition of a series of parsers of increasing abilities (cf. Berwick, 1985), the parsing mechanism becomes partly responsible for selecting what will be acquired and at what moment it will be acquired. The acquisition of syntactic knowledge will be determined by the processing demands of the target language structures. We can assume that the more demanding a structure is from the point of view of parsing, the later it will be acquired. Zobl (1986) suggests that grammatical principles become available in lockstep with the expansion of a learner's computational abilities. With this point of view in mind, one can visualize the parsing mechanism as a filtering device between available linguistic evidence (the input) and that which will be integrated into the learner's system (the intake). The nature of the intake will therefore largely depend on the ability of the parser to process linguistic data, and on the development of the lexicon, which is closely tied to the basic operations of the parser. Thus, the parsing mechanism may for a certain time render some of the input data irrelevant to the acquisition procedure¹⁶, and, in that way, it may constrain the intake. This means that the parser will allow more complex structures to be analyzed as it is building its computational capacity. Until the parser has the computational capacity to process them, those same structures will be ignored by the acquisition procedure.

One other way in which the intake can be constrained comes about as a result of a structural difference between the learner's native language and target language. This difference may trigger a process of transfer. The notion of transfer adopted here refers to the retention of first language processing strategies or routines by second language learners in processing their target language. The native language processing strategies will influence the way a language learner perceives his second language. Moreover, the influence of first language parsing strategies may prevent the analysis of some structures in the initial steps of second language acquisition. Take, for example, the case of Francophones or Anglophones learning German as a second language. These learners are known to have difficulties in dealing with the

16. Ignoring input for acquisition purposes does not exclude comprehension which can be achieved through other means: for example, pragmatics, intonation, etc. See Roeper (1982) and Sharwood-Smith (1985).

position of the verb in German embedded sentences. In German, the verb must appear in the second position in an independent clause (see (5)) but in a dependent clause, it must appear at the end of the clause (see (6)).

- | (5) | I | II | III |
|-----|-------------------------------|----------------------|--|
| a. | Richard
Richard | kauft
buys | jetzt das Buch.
now the book. |
| b. | Richard
Richard
Richard | hat
has
bought | das Buch gekauft.
the book bought.
the book. |
-
- | | |
|--------|---|
| (6) a. | Er sagt, dass sie das Buch <i>kauft</i> .
He says that she the book buys.
He says that she is buying the book. |
| b. | Er sagt, dass sie das Buch gekauft <i>hat</i> .
He says that she the book bought has.
He says that she bought the book. |

In parsing this type of structure, one can assume that these second language learners will expect the verb to appear after its subject, as in their native language. Since this is not the case, these learners seem to keep on waiting for the verb to organize the incoming sentences, and, in doing so, may overlook the remaining elements. This implies that in formulating the rules of the target grammar, the learners must acquire new processing routines which in this case will allow them to possibly delay the organization of the embedded clause until the verb is reached. In a similar situation, Sharwood-Smith and Kellerman (1989) report that, in cases where the learners are under pressure, they are led to use an L1 verb placement routine and that under more favorable conditions the same learners are perfectly capable of producing correct embedded clauses. Sharwood-Smith and Kellerman argue that the underlying grammar of these learners is therefore poorly represented in their production. From these examples, one can hypothesize that transfer, in many cases, is more a matter of knowing about the way the language processor functions than knowing (or not knowing) about grammar.

If we accept that the parsing mechanism, a performance phenomenon, plays a major role in the acquisition of syntactic knowledge (cf. Berwick, 1985), we must accept that some of the errors produced by second language learners are due to the parsing mechanism. In other words, parsing can be considered as knowledge in the

same fashion that competence is, a somewhat different kind of knowledge, but one that still needs to be learned. The fact that syntactic learning cannot be ascertained independently of parsing implies that, if one wants to assess the linguistic knowledge of a second language learner, one will need to consider parsing as well as grammar. In addition to describing developmental grammars, researchers will also need to describe developmental parsers.

5. Conclusion

This paper has tried to show the role and possible implications of the parsing mechanism in second language acquisition. Some studies have started to show the role of the parsing mechanism in first language acquisition (e.g. Berwick and Weinberg, 1984; Berwick, 1985), but the implications of a developing parser have not yet been fully considered and applied to second language acquisition research.

There are various reasons for this, one of them being that theoretical research on parsing is still in full expansion. Researchers are still testing hypotheses about the parsing mechanism and very few have attempted to apply them to domains of applied linguistics (see, for example, Joshi, 1985). Also, it seems that research on the parsing mechanism focuses mainly on the English language. Some research has been done on languages other than English, for example, Bourdages (1990) and Frauenfelder (1981) on French, Karttunen and Kay (1985) on Finnish, but the core of the research remains on English.

From the point of view of second language acquisition, tools are missing to pursue research within this perspective. For example, descriptive norms for English verbs have been developed (cf. Connine et al., 1984), and considering their importance in the comprehension process, such an instrument should be developed for other languages as well. Moreover, experimental tasks used in adult language processing have not been tested with second language learners. Most of the studies in parsing are using a reading paradigm task which may cause some problems for second language learners who have to learn to read in the target language at the same time they are learning the language. Therefore, there is need to examine different tasks tapping the comprehension process in a second language. One must be careful in choosing the task in order to avoid results that could be artefacts of the task and not reflect the actual comprehension process.

Second language acquisition research within the perspective of parsing theory could be very useful in providing support for hypotheses on the development of parsing strategies as well as gaining a better understanding of the course of development of a second language.

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