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An on-line look at sentence processing in the second language

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What are the factors that affect immediate syntactic processing in the second language of bilinguals? How might processing evolve with increasing skill in the second language? Herein, we will review these questions in the light of data from several on-line investigations of syntactic processing in the native and second language of bilinguals with varying levels of second language proficiency. Performance is examined, moreover, for bilinguals of different language backgrounds. The data from these experiments highlight the role of L2 exposure, in line with models based upon linguistic experience.

The present chapter is concerned with the acquisition of syntax in the second language by adult learners, a topic that has received considerable attention and fuelled many a debate. We will review the handful of recent on-line psycholinguistic studies of second language syntactic processing in adult, late bilinguals, in order to pinpoint the factors that influence immediate syntactic analysis. None would dispute the claim that the final comprehension of a sentence is affected by a myriad of factors (at the lexical, syntactic, discourse and pragmatic levels). Our aim here, however, is to provide a clear picture of the factors that play an immediate role in second language syntactic analysis. We will examine the results obtained in studies of adult bilinguals at different levels of second-language proficiency, as well as different language pairs, to establish the role of exposure to the second language in acquiring L2 syntax and the influence of "forward transfer." As we will show, there is substantial evidence, first, that "exposure-based" models such as that proposed by Mitchell and colleagues (Cuetos, Mitchell & Corely, 1996; Mitchell, 1994) may provide a viable framework for understanding how adults acquired the syntax of a second language, and second, that many common processes underlie native and second-language syntactic processing.

Why is second-language reading slow?

Quite often, on-line measurements obtained during the reading of single sentences reveal increased processing time for non-native readers (cf. Fernandez, 2000; Frenck-Mestre, 1997; Frenck-Mestre & Pynte, 1997; Hoover & Dwivedi, 1998; Seglaowitz & Herbert, 1990). In the absence of specific lexical and/or syntactic "deficits," i.e. in the case that the second language reader has access to both the lexical and syntactic information present in the sentence, the underlying cause for this relative slowness is not immediately apparent. It has been suggested that a lesser automatization of lower-level processes may be responsible. For example, a lesser ability to encode orthographic redundancies may slow lexical access in the second language (Favreau & Segalowitz, 1983, but see Frenck-Mestre, 1993). This would not only incur a general slowing but also a more specific difficulty, related to phonological activation. That is, given what we know about the time course of orthographic and phonological activation (see, for example, Ferrand & Grainger, 1993; Frost, Katz & Bentin, 1987; Paap, McDonald, Schvaneveldt & Noel, 1987), slower orthographic processing would allow for greater phonological activation and hence possible interference when accessing homophones (such as, in

English, "fare" versus "fair" "great" versus "grate" etc.). Indeed, just such a result was reported by Segalowitz and Hébert (1990); bilinguals who read slower in their second than native language were more prone to interference from homophones when processing semantically anomalous sentences (e.g. "The weather was fare.") than were bilinguals who read equally fast in their two languages. While second language reading may indeed suffer from a lesser degree of automaticity as concerns such encoding processes, experiments performed in our laboratory provide evidence that other factors may also be at play.

If one records the eye movements of (non-native or native) readers, it is possible to distinguish the "first pass" through the sentence from eventual re-readings, whether of the entire sentence or parts thereof (see Rayner & Pollatsek, 1987; Rayner, Sereno, Morris, Schmauder & Clifton, 1989, for discussions of eye-movement recording and its use in psycholinguistic studies). This tool has enabled our research group to show that at a gross level, increased reading times for proficient non-native readers is often linked to a tendency to re-read sentences. This has been observed informally, in numerous experiments involving diverse syntactic structures, and reported in various talks and published studies (Frenck-Mestre, 1998a, 1998b; Frenck-Mestre & Pynte, 1995; 1997). It is worth restating that this general tendency to reread sentences is observed for proficient bilinguals, i.e. in spite of a high level of lexical and syntactic knowledge in the second language. A different picture arises when we consider the oculomotor behaviour of these bilinguals during the "first pass" through second language sentences (i.e. in the course of the first left-to-right pass through it). For first pass measures, advanced non-native readers and native readers do not differ notably in their performance at least insofar as we have observed (Frenck-Mestre, 1998a, 1998b; Frenck-Mestre & Pynte, 1995; 1997). That is, we have not found the second language performance of these speakers to differ notably from native performance as concerns the average length of a saccade, the mean duration of fixations, or the probability of making a regressive saccade during the first reading of the sentence. It is perhaps important to underline the differences, here, between the information provided by eye-movement recording as opposed to self-paced reading. While the latter technique allows one to track on-line processing, it does not allow one to distinguish between "first" versus "second" readings of parts of the sentence. It may be that "rereading" of the segments presented in self-paced reading studies, rather than initial processing as concerns either lexical access or syntactic analysis, are also the reason behind slower reaction times reported in these studies.

How then should one interpret "slow" non-native reading? Is it perhaps linked after all to differences and/or "deficits" in syntactic processing as compared to native readers' processing? Indeed, one could hypothesize that, despite their second language proficiency, even skilled bilinguals do not perform a full syntactic analysis during the first pass through the sentence, thus rendering necessary a second pass through it. As we report in greater detail later in this chapter, however, this hypothesis is untenable in the face of other on-line results. Indeed, proficient second-language readers demonstrate an immediate sensitivity to the same factors that influence native readers' initial progression through the sentence. Both structural ambiguity and lexical constraints influence the first pass reading times of proficient non-native readers, just as they do those of native readers (Frenck-Mestre, 1998a, 1998b; Frenck-Mestre & Pynte, 1997). It can be noted that the same immediate effect of syntactic ambiguity on second language processing has been reported using self-paced reading (Hoover & Dwivedi, 1998; Juffs & Harrington, 1996). Hence, slower second language reading times, at least in skilled bilinguals, do not appear to be linked to differences in syntactic processing as compared to native readers (see also Segalowitz, 1986; Segalowitz & Hébert, 1990), as will be discussed shortly. Our own hypothesis, indeed which remains to be tested through systematic study, is that the tendency to re-read may be a "residual" of early

difficulties experienced in second language reading. That is, at an early stage, re-reading in the second language may well be necessary due to lesser abilities (as concerns orthographic encoding, lexical access and/or syntactic analysis). Later on, the more skilled bilingual may retain this "developed habit" of re-reading, despite it no longer being necessary. Although this remains to be demonstrated, it is in line with the results reported below showing similar syntactic processing for native speakers and skilled bilinguals in their second language, despite longer overall reading times in the latter.

Slower but not necessarily different syntactic processing in the second language

Consider, first, three recent studies that examined the on-line processing of syntactically ambiguous sentences, in both native and second language readers. In two of these studies, the performance of proficient English-French bilinguals revealed immediate sensitivity to syntactic ambiguity quite independently of their overall reading speed. In the third, however, the pattern of results from Chinese ESL learners, who were both less proficient than the bilinguals who participated in the other two studies and quite slow as compared to native speakers, is more questionable as concerns their sensitivity to second language syntactic ambiguity.

Hoover and Dwivedi (1998) looked at the on-line processing of a syntactic ambiguity that is present in romance languages, in the current case French, but absent in English. The ambiguity is related to the role of the clitic pronoun (highlighted in the example) in French causative sentences, as illustrated below:

- 1a. Sarah le fera signer en présence de son avocat.
(Sara it will have signed in the presence of her lawyer)
- 1b. Sarah le fera demain en présence de son avocat.
(Sara it will do tomorrow in the presence of her lawyer).

In both 1a and 1b, a full direct object NP has been pronominalised and replaced by the clitic pronoun "le." However, in the first example, 1a, the clitic is ambiguous. This is because the verb "faire" can either be used as a thematic verb, as is the case in 1b, or in a causative construction as illustrated in 1a. Therefore, upon reading the clitic in 1a, the reader could initially treat it as an argument of the proceeding verb "faire" only to find this an erroneous assignment upon the reading of the second verb (in the example, "signer"). In 1b, no ambiguity is present, as the clitic pronoun can only be assigned as an argument of the verb "faire." This ambiguity is known to cause difficulty for native French speakers, as was demonstrated experimentally in a self-paced reading study by Dwivedi & Hoover (1996, reported in Hoover & Dwivedi, 1998). In a subsequent self-paced reading study, Hoover and Dwivedi (1998) looked at the processing of this ambiguity for two groups of highly fluent L2 French readers (L1 English). While both groups rated quite high as concerns level of proficiency in French, one group was classified as "fast" readers on a reading test and the other comparatively "slow." The main objective of the study was to determine whether sensitivity to the ambiguity present in French clitic/causative constructions would be correlated with reading speed in the second language. That is, whether "slow" L2 readers would be less sensitive to structural ambiguity than "fast" readers. Quite clearly, the answer to this question was negative. First, it can be noted that both groups of L2 readers were significantly slower than native readers. Despite this, no interactions between reading group (native, fast L2 and slow L2) and ambiguity resolution were observed at the point in the sentence where disambiguation occurred. Both slow and fast readers showed immediate sensitivity to structural ambiguity in the L2, in like fashion to native readers. That is, all groups took significantly longer to read the second verb in causative/clitic sentences such as

1a than in unambiguous constructions. Thus, in this study reading speed per se was not indicative of differences in syntactic processing, either between L2 readers themselves or as compared to native speakers.

A similar pattern of results was reported by Frenck-Mestre & Pynte (1997, experiment 2), in an eye-movement study involving proficient English-French and French-English bilinguals. These bilingual subjects displayed slower overall reading times in their second as compared to native language, and as compared to native speakers, however this factor was not correlated with differences in syntactic processing as compared to native processing. The results of this study showed that not only are L2 readers sensitive to syntactic ambiguities in their second language, but moreover they can use lexical subcategorisation information to resolve certain structural ambiguities. Consider the example provided in 2, below

- 2a. Whenever the dog obeyed the little girl she showed her approval.
- 2b. Whenever the dog obeyed the little girl showed her approval.
- 2c. Whenever the dog barked the little girl showed her approval

The first of the above examples, 2a, poses less difficulty than the second, 2b, for native speakers (Rayner, Carlson & Frazier, 1983). This is due, according to one theoretical framework, to the parser systematically adopting an initial direct object analysis of the second NP, only to find this inappropriate in the case of 2b upon the reading of the second verb (Frazier, 1987). Reanalysis is thus necessary in 2b, which is costly. In addition, in this framework 2b and 2c should both cause the parser to initially adopt a direct object NP analysis, although this error would be quickly recognized in 2c due to the lexical properties of the subordinate verb coming into play. As such, 2c is also easier to parse than 2b (Frenck-Mestre & Pynte, 1995; Mitchell, 1989; Mitchell & Holmes, 1985; Trueswell, Tanenhaus & Kello, 1993). The same result was obtained for proficient French-English and English-French bilinguals reading in their second language (Frenck-Mestre & Pynte, 1997, experiment 2). Sentences such as 2c were processed faster, causing fewer re-readings and fewer regressive saccades, than sentences such as 2b. Otherwise stated, these L2 readers were "led up the garden path" in the case of sentences like 2b just as native readers are, whereas in the case of 2c the subcategorisation information present in the subordinate verb helped these L2 readers to quickly resolve this syntactic ambiguity, just as it has been shown in native readers.

Another recent on-line study of L2 syntactic processing examined the same ambiguity as illustrated in 2b and 2c, but in less-proficient bilinguals. Juffs and Harrington (1996) looked at Chinese ESL students' processing of this structural ambiguity by means of a word-by-word self-paced reading experiment. The authors themselves concluded that their ESL readers were sensitive to the syntactic ambiguity present in these structures, and able to resolve the ambiguity faster for sentences in which the subordinate verb was intransitive (2c) than optionally transitive (2b). Indeed, these L2 readers did experience apparent difficulty with the matrix verb in sentences such as 2b as revealed by an abrupt increase in reading times at the matrix verb for these sentences. Moreover, this abrupt increase was not observed at the matrix verb in sentences such as 2c, but one constituent earlier, i.e. at the NP following the intransitive subordinate verb, thus indicating that the subcategorisation information provided by the subordinate verb was used to block/re-analyse a direct-object analysis of the NP. However, some caution may be warranted prior to concluding that these ESL readers had lesser difficulty with the structural ambiguity in the intransitive than optionally transitive cases. In fact, this direct comparison was not made in the study. The inspection of means does not lead one to believe, moreover, that at the matrix verb itself any significant interaction would obtain in the ESL group. As such, the conclusions drawn by Juffs and Harrington that ESL readers experienced the same processing difficulty as native

speakers with "garden path" sentences may need to be nuanced.

Yet another eye-movement experiment, reported in Frenck-Mestre and Pynte (1997, exp. 1) revealed quite impressive use of subcategorisation information in the resolving of structural ambiguities by second-language readers. The ambiguity studied therein involved the attachment of a prepositional phrase. Consider, first, monolingual studies of this ambiguity, illustrated in 3.

3a. The spy saw the cop with the binoculars but the cop didn't see him.

3b. The spy saw the cop with the revolver but the cop didn't see him.

In an early eye-movement study with monolinguals, Rayner, Carlson & Frazier (1983) demonstrated that readers systematically prefer 3a to 3b. That is, readers had greater difficulty (reflected by increased reading times) when the sentence biased "low" attachment of the prepositional phrase, to the preceding noun phrase ("with the revolver" is associated with "the cop"), than when it biased toward "high" attachment to the preceding verb phrase ("with the binoculars" thus modifies the verb "to see"). In one theoretical framework, this preference to attach "high" is attributed to an autonomous parser which obeys heuristic principles and prefers the least costly structure in terms of syntactic nodes (Frazier, 1987). The parser is assumed to operate independently of other levels of analysis – lexical, pragmatic, and/or referential – as attested by the fact that even when semantic/pragmatic factors favor "low" attachment for this structure, as in 3b (cops are known to carry revolvers) the initial analysis of the sentence, as revealed by first pass reading times, still reflected a "high attachment preference."

The conclusions from this seminal study were brought into question, however, by subsequent monolingual studies in which the influence of thematic constraints and referential context were clearly demonstrated (Altmann & Steedman, 1988; Taraban & McClelland, 1988). Parsing preferences were not found in these on-line (self paced reading) studies to be systematic, but to vary as a function of these "extra-syntactic" factors. Low attachment was shown to be preferred when either thematic constraints or the referential context disambiguated toward this structure. In addition, the lexical constraints of the initial VP have been shown to immediately influence the processing of this ambiguity in the native language of readers (Frenck-Mestre & Pynte, 1997; see also Boland & Boehm-Jernigan, 1998 for similar work on PP attachment, but Ferreira & Henderson, 1990, for counter-arguments). The same is true of proficient English-French bilinguals reading in their second language (Frenck-Mestre & Pynte, 1997). Consider the examples provided in 4.

4a. Il rate le train de nuit et décide alors de chercher un hôtel.

(He missed the train of night and decided to look for a hotel)

4b. Il rate le train de peu et décide alors de chercher un hôtel.

(He missed the train by little and decided to look for a hotel)

4c. Il avertit la police du quartier puis se félicite de son action.

(He warned the police of the district and congratulated himself for it.)

4d. Il avertit la police du crime puis se félicite de son action.

(He warned the police of the crime and congratulated himself for it.)

In 4, the bias towards « high » or « low » attachment of the ambiguous PP (highlighted in the examples) is provided by the lexical constraints of the verb preceding it. In 4a and 4b, the matrix verb is monotransitive, i.e. it generally selects for a single direct object complement. For this class of verb, then, the immediately following NP can satisfy the thematic grid. In contrast, the matrix verb in 4c and 4d is ditransitive, that is it generally selects for two complements, only one of which is provided by the post verbal NP. For this class of verb a second complement is

expected, which can be satisfied by the PP. This type of subcategorisation information influences the immediate decisions made by the parser (Frenck-Mestre & Pynte, 1997). For monotransitive verbs, the immediate preference of native French readers--as shown both off-line (via sentence completion data) and on-line (via the recording of eye movements during reading)--is to attach low, to the preceding NP. That is, at the disambiguating element (the noun of the PP) readers experience less difficulty with 4a than with 4b. The exact opposite is observed for sentences containing ditransitive verbs. In this instance, first pass reading times are longer at the disambiguating element for low than high attachment of the PP, i.e. for 4c than 4d.

Fluent bilingual readers show the same sensitivity to lexical constraints when resolving the syntactic ambiguity illustrated in 4. English native speakers reading in French prefer low attachment of the PP for monotransitive verbs (4a as compared to 4b), but high attachment following ditransitive verbs (4d as compared to 4c). Moreover, this effect is observed on first pass reading times, as it is in native speakers. Indeed, the pattern of processing did not differ as a function of "type of reader," i.e. whether first or second language.

What can be concluded from the above set of studies? Quite clearly, fluent bilinguals are not only sensitive to structural ambiguities when reading in their L2, but moreover are sensitive to fine levels of analysis. Although we did highlight some important differences across these three studies, it is more likely, in our opinion, that the difference in sensitivity to syntactic ambiguity in the second language across these three studies is related to L2 proficiency rather than simply reading speed. Slower second language reading is not necessarily indicative of different processing as compared to native speakers, as shown by Hoover and Dwivedi (1998) as well as by Frenck-Mestre and Pynte (1997). However, level of proficiency indeed seems to be an important factor, as can be seen in the Juffs and Harrington (1996) study. Less-proficient bilinguals may, first, be unable to immediately process syntactic ambiguity in their second language. Second, as we will outline in the next section, when a structural ambiguity can be resolved differently across languages, non-proficient bilinguals may be susceptible to effects of forward transfer. Hence, they may process the ambiguity differently from native speakers.

The role of experience (years of exposure) and effects of transfer in L2 parsing

In the previous section we reviewed three on-line studies where the native language of the bilingual readers was generally not considered to inhibit second language syntactic processing. In those studies, either the structure was absent from the native language of subjects (cf. Hoover & Dwivedi, 1998) or it was both identical across the bilinguals' two languages and resolved in similar manner in the two (Frenck-Mestre & Pynte, 1997; Juffs & Harrington, 1996). In this section, we will take a look at second language syntactic processing for ambiguous structures that are apt to be influenced by the reader's native language. This question can be addressed most easily through the study of structures which exist in both the native and second language but which are processed differently in the two. Just such a case is provided by the ambiguity illustrated in 5, below.

- 5a. Arnold watched the wife of the doctor who was leaving the medical centre.
- 5b. La police cherche le fils du médecin qui est soupçonné de trafic de drogues.
- 5c. Alguien disparó contra la criada del actor que estaba en el balcon.
- 5d. Patricia conosceva il ragazzo de direttore che era svenuto alla festa.
- 5e. De gangsters schoten op de zoon van die actrice die op het balkon zat.

The sentences presented in 5a through 5e all present the same structural ambiguity

. That is, the subject of the relative clause can be either the head of the complex noun phrase (i.e. in 5a, "the wife of the doctor") or the second noun phrase alone (i.e. in 5a, "the doctor"). To date, and despite numerous on-line studies performed in a wide range of languages, from English to Japanese (for reviews, see Cuetos, Mitchell & Corely, 1996; Fernandez, 2000; Fodor, 1998; Frazier & Clifton, 1996; Frenck-Mestre & Pynte, 2000a; 2000b; Gibson, Pearlmutter, Canseco-Gonzalez & Hicock, 1996), no single model can account for the resolution of this ambiguity. Factors known to influence the resolving of this ambiguity are, among others, the respective "weight" of the complex NP and the subsequent relative clause (Fernandez, 2000; Fodor, 1998; Pynte & Colonna, 2000), the frequency of the two noun phrases (Frenck-Mestre & Pynte, 2000a; Pynte & Colonna, 2000), the preposition in the complex NP (Cuetos et al., 1996; De Vincenzi & Job, 1993; Frenck-Mestre & Pynte, 2000b; Gilboy, Sopena, Clifton & Frazier, 1995), segmentation of the sentence (Gilboy & Sopena, 1996, but see Carreiras & Clifton, 1999), whether one considers "on-line" or "off-line" measures of noun preference (De Vincenzi & Job, 1995; Mitchell, Brysbaert & Gondelaers, 1997), and indeed the language that the ambiguity is presented in (Cuetos et al., 1996; Fernandez, 2000; Frenck-Mestre, 1997; Frenck-Mestre & Pynte, 2000b; Gibson et al., 1996). It is this latter factor that is of particular interest for the present discussion.

For purposes of the present paper, we will consider the "simplest" case, that is where the preposition in the complex NP is "of" or its equivalent in French (and Spanish, reviewed later) and the printed frequency of the two nouns is either roughly equivalent or neutralized. Consider the examples provided in 6.

6a. Charles photographie la fille de Marc qui est plus dédaigneu(se/x) que jamais.

Charles photographed the daughter of Mark who is more disdainful (fem/masc) than ever.

6b. Aline téléphone aux filles de la gardienne qui reviennent/revient de Paris.

Aline calls the daughters of the nanny who are/is returning from Paris.

6c. Aline téléphone à la gardienne des filles qui revient/reviennent de Paris.

Aline calls the nanny of the girls who is/are returning from Paris.

In 6a, the structure is disambiguated by gender agreement between one of the nouns in the complex NP and the adjective in the RC. In 6b and 6c, the same structure is disambiguated by number agreement between NP1 or NP2 and the verb of the RC. We have shown that in French, the preferred interpretation of these sentences is to attach the RC to the head of the complex NP, as revealed by the first-pass reading times of native French speakers (Frenck-Mestre, 1997; Frenck-Mestre & Pynte, 2000b, see also Zagar, Pynte & Rativeau, 1997, but also the debate between Baccino, De Vincenzi & Job, 2000 and Frenck-Mestre & Pynte, 2000b). This preference to attach "high" can be accounted for in terms of the "construal" hypothesis, forwarded by Frazier and Clifton (1996), or the "predicate proximity vs recency" model proposed by Gibson et al. (1996), or alternatively in the framework of the "linguistic tuning" hypothesis, advocated by Mitchell and colleagues (Cuetos et al., 1996; Mitchell, 1994; Mitchell, Brysbaert, Grondelaers & Swanepoel, 2000). These models also offer accounts for why the same structure, presented in English, is apparently resolved differently by native English speakers. That is, English native speakers have been shown to either prefer "low" attachment or not to display a definite preference for either host (Carreiras & Clifton, 1993; 1999; Cuetos & Mitchell, 1988; Fernandez, 2000). Of interest here, however, is which, if any of

these models can account for experienced-based differences. That is, for changes in parsing preferences in the second language of bilingual readers as these readers become more proficient in their L2.

Indeed, given the reported differences across French and English as concerns the resolution of this ambiguity, it is of interest to examine how English-French bilinguals resolve it when reading in French. Furthermore, it is important to determine whether these bilinguals' parsing preferences will be modified by their experience with their second language. Indeed, in a beginning stage, it would not be surprising to find that English-dominant bilinguals are influenced by their native language when processing L2 sentences

. What difference, however, will experience with the L2 make? The answer to this question may lie in the type of structure that is processed, as we will outline shortly. Consider first, however, the results from a series of recent studies completed in our centre, with beginning and more advanced English-French bilinguals.

In a first study (reported in Frenck-Mestre, 1997), we asked relatively non-proficient English-French "late" bilinguals (n=16) to participate in a reading experiment wherein we recorded their eye-movements during the reading of individually presented French sentences (sentences were presented on a single line). These bilinguals had a mean of three years of formal learning of French in a classroom setting outside of France, and nine months of immersion in French, in France. They rated their abilities as concerns written and oral expression and comprehension at a level of roughly 5 on a ten point scale of proficiency. The sentences of interest (n=20) were of the structure illustrated in 6b and c, where the verb of the subordinate clause agreed in number with either NP1 or NP2. These sentences were interspersed with three times as many filler sentences of varying syntactic structures (some ambiguous), such that subjects were not prone to engage in strategic processing. Subjects were not informed of the ambiguous nature of the experimental sentences. Native French speakers were included in the study as a control group. The results, are presented in Figure 1. As can be seen, the two groups showed a quite different pattern of results as concerns the immediate resolution of this ambiguity. Native French speakers showed a definite preference for "high" attachment of the RC. That is, first pass (as well as total) reading times were significantly faster at the disambiguating subordinate verb when it agreed with the head of the complex NP than when it agreed with NP2. The opposite was observed in the group of English-dominant bilinguals. These readers, who had been living in France for a mean of nine months and had a mean of three years of formal classroom learning in French, showed a trend toward N2 attachment. That is, their first pass (and total) reading times tended to be faster when the subordinate verb agreed in number with the second than with the first noun of the complex NP

. As we have argued elsewhere (cf. Frenck-Mestre, 1997), the pattern obtained in the English-dominant group is to be attributed most likely to the influence of their native language on second language processing, rather than to a general strategy of attaching new elements to the most recently processed constituent.

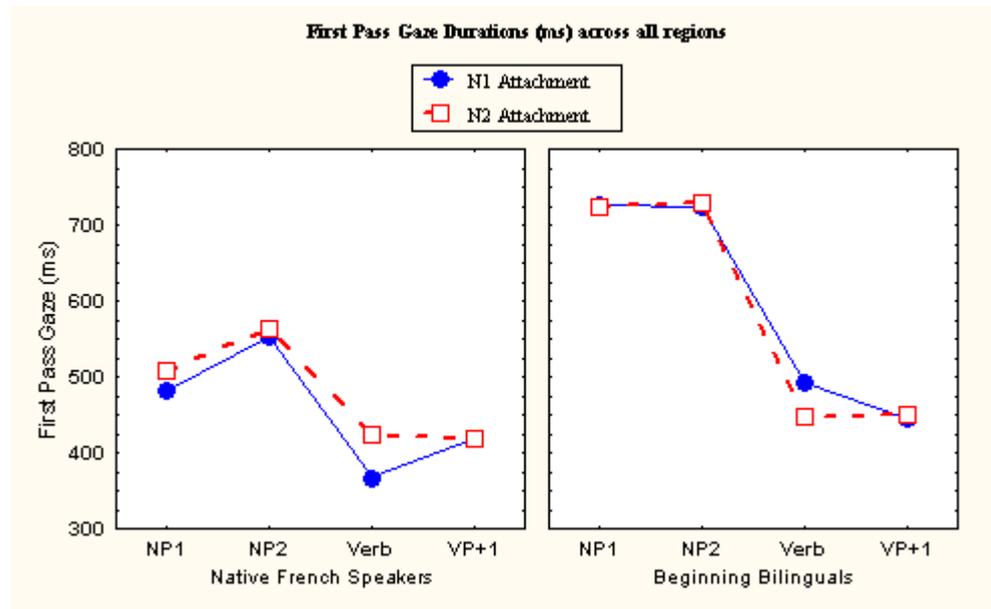


Figure 1. First pass gaze durations as a function of type of reader and sentence region for temporarily ambiguous relative clause constructions.

More recently, (French-Mestre, 1998; submitted), we examined the performance of proficient English-French "late" bilinguals for the same ambiguous structure in a new eye-movement experiment. The same set of sentences and same presentation were employed as in the previous experiment. The group had roughly three years of formal learning of French outside of the country, at least two years of study in a French university in a mainstream curriculum, and had been living in France for a mean of five years. They rated themselves at a level of 7 or better on a ten point scale of proficiency in the second language for written and oral comprehension and production skills. The results of these "proficient" bilinguals are compared to the performance of the same group of native French speakers examined in the first study, in Figure 2.

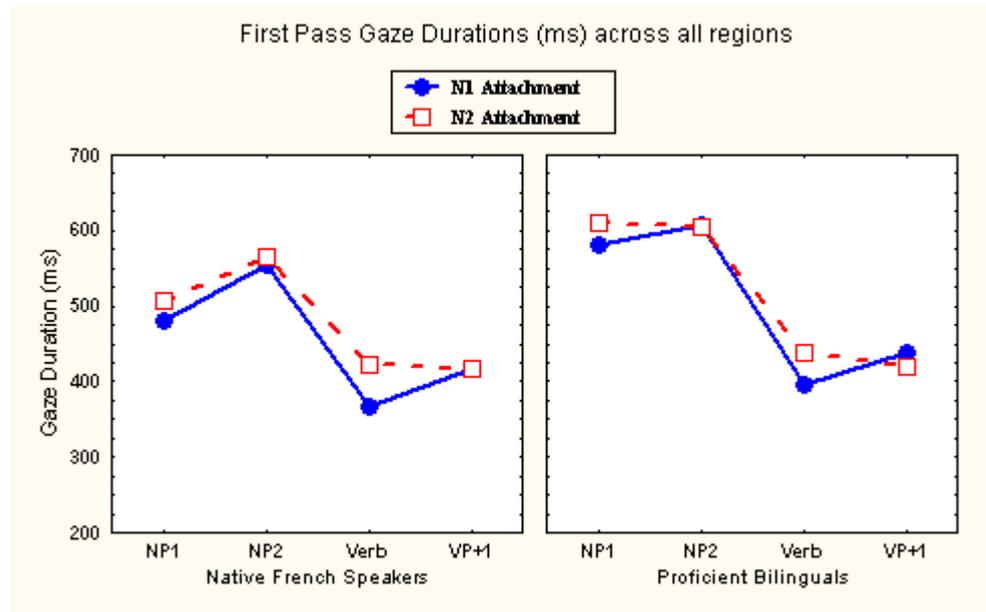


Figure 2. First pass gaze durations as a function of type of reader and sentence region for temporarily ambiguous relative clause constructions.

As is visible in the graph, the proficient bilinguals' syntactic processing of the NP1-Prep-NP2-RC ambiguity in French was highly similar to that of native French speakers. In fact, the statistical comparisons of these two groups did not reveal any significant interactions with type of reader. The proficient bilinguals were not slower in their first pass reading times than native French speakers ($p > .10$), nor did they demonstrate a different pattern of ambiguity resolution than native speakers.

A comparison was made of the three groups – native French, beginning and advanced English-French bilinguals – as concerns the first pass gaze duration at the disambiguating subordinate verb. This comparison is presented in Figure 3. As can be readily seen, the native and advanced groups showed a highly similar pattern of ambiguity resolution for the NP1-Prep-NP2-RC structure, which differed from the group of beginning (English-dominant) bilinguals. This was born out in statistical analyses, showing an interaction between type of reader and attachment preference ($F(1,36) = 4.89, p < .01$). Post-hoc comparisons revealed that the beginning bilinguals differed from the advanced and native groups as concerns the time spent reading the subordinate verb in the case of "high" i.e. N1 attachment. The beginning bilinguals were significantly slower to process the subordinate verb than advanced bilinguals and native speakers when the verb agreed in number with the first noun phrase. Otherwise stated, these English-dominant bilinguals demonstrated specific difficulty with "high" attachment.

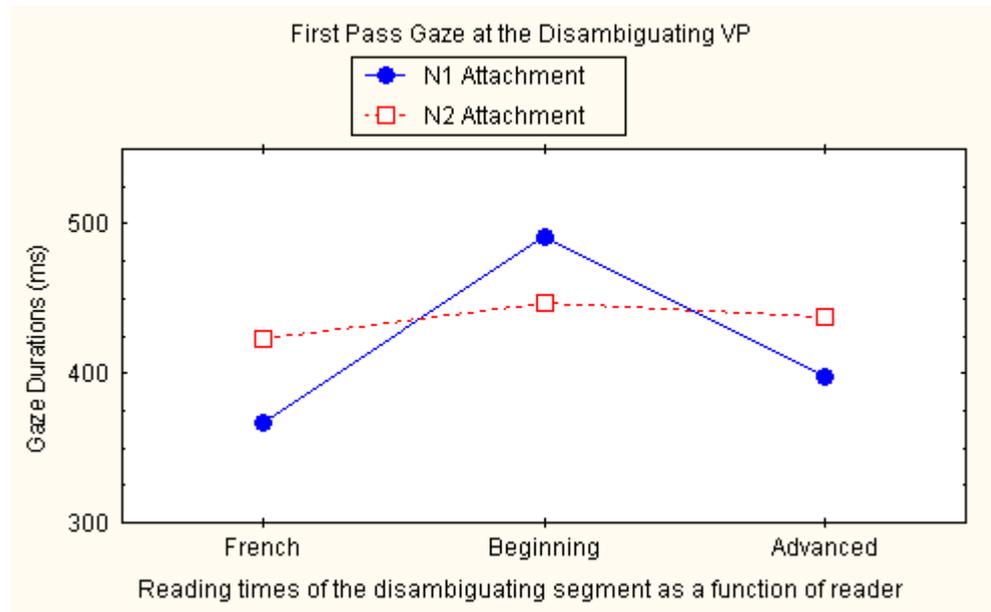


Figure 3. Initial reading times at the disambiguating verb of the relative clause as a function of type of reader.

Our data show a clear evolution of processing strategies, from performance closely tied to the native language of late bilinguals to that closely resembling the performance of native speakers of the language. It is important to underline that the difference between the two groups of bilinguals was experience with the second language. The advanced group had lived for several years in the country of their second language, in environments where they used the language as a daily means of communication. They had been "exposed" to their second language, and its patterns, for several years. Prior to examining which model of processing can best account for these data, we will consider the results of another study of the same syntactic ambiguity.

Our data can be compared to those reported recently by Fernandez (1998), for Spanish-English and Japanese-English bilinguals, in off-line studies of the same, relative clause attachment ambiguity. It is clear from the questionnaire data provided in this study that the deciding factor behind ambiguity resolution in the second language was level of expertise in this language. Whether the bilinguals learned their second language early or late was not predictive of the amount of forward transfer from the bilinguals' native language. Self-rated proficiency, however, was. Those Spanish speakers who rated themselves as more proficient in English than in Spanish processed this ambiguity akin to native English speakers, whereas those who rated themselves as more proficient in Spanish tended to process this ambiguity as would monolingual Spanish speakers. In like manner, the Japanese bilinguals, despite having learned English fairly, rated themselves in general as "Japanese dominant" and showed clear effects of transfer from their native language. In our study, the number of years of experience with and/or immersion in the second language (French) was the deciding factor : less proficient bilinguals showed clear effects of forward transfer whereas the proficient group was well on its way to processing the ambiguity in question as would a monolingual.

These data clearly show that any processing model of L2 syntactic analysis must take into account the evolution of processing with experience. The most readily adapted framework for this would seem to be the "linguistic tuning" hypothesis (Cuetos et al., 1996; Mitchell, 1994). The model incorporates both cross-linguistic differences in ambiguity resolution and changes over time in processing as a result

of exposure, due to the very nature of the model. Indeed, it is assumed that the particular analysis adopted by the adult reader will be the product of his/her exposure to a given language and its statistical properties as concerns the frequency of structures. Changes in syntactic processing are predicted as a result of exposure, as clearly stated in Cuetos et al. (1996, p. 175) "The model predicts that parsing preferences will change if, during some period prior to testing, the reader or listener has been exposed to an unusual preponderance of one ambiguity resolution rather than another." Indeed, our data (as well as Fernandez') show that English-French bilinguals will adopt a "French" strategy of "high attachment" for the RC-attachment ambiguity after having been exposed to French for numerous years

The linguistic tuning hypothesis is not alone, however, in being able to account for cross-linguistic variation as concerns the ambiguity under question, nor, as we will outline, for the evolution of processing we observed in our bilingual subjects as concerns this structure. The construal hypothesis, forwarded by Frazier and Clifton (1996) stipulates that 'non-primary' relationships such as relative clauses are 'construed' rather than being governed by strictly syntactic principles. Attachment would be the result, in this case, of "late" discourse level processes. This leaves open the possibility for cross-linguistic variation. Moreover, given the apparently strong preference for "high" attachment of the RC following a genitive relationship ("the daughters of the nanny") in French (and Spanish), it is perhaps not surprising that native English speakers would adhere to this processing strategy, all the more so as the preference in English is apparently not as clear-cut.

Conclusions

In summary, the present review of a handful of on-line studies of second language syntactic processing has shown, first, that second language syntactic analysis need not be considered as a separate case from native-language parsing. Proficient bilinguals show immediate sensitivity to structural ambiguities in like manner to native readers, quite independently of reading speed. These proficient bilinguals are also able to take advantage of fine-levels of analysis to guide (or filter) the parsing of structurally ambiguous sentences in the second language. Second, in the instance that the bilingual's two languages differ as concerns the processing of a given syntactic structure, changes in parsing strategies will occur over time as the bilingual gains experience with the second language. A decrease in forward transfer is observed for more proficient bilinguals along with increased "native-like" processing.

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Notes de bas de page

Note, there were differences between the fast and slow L2 readers at the final segment of sentences, whereby the latter group was significantly slower for structurally ambiguous sentences. Hoover and Dwivedi (1998) attributed this to the slower readers' lesser ability to process these structures.

Note, there were also effects of inappropriate forward transfer, from the native to second language as concerns lexical constraints, discussed in Frenck-Mestre & Pynte (1997).

Don Mitchell provided an impressive list of the studies run to date, across more than a dozen languages, including both major European languages, Japanese, Afrikaans and more, at a recent AMLaP meeting (1998).

Since the end of the nineteenth century, linguists have provided us with examples of "transfer" whenever two languages come into contact (Jespersen, 1912; Palmer, 1917; Sweet, 1899/1972). The sentences produced by non-native speakers often bear the mark of their first language (Durgunoglu & Hancin, 1992; Koda, 1993; Odlin, 1989; MacWhinney). For example, word order in second language sentences is frequently affected by native language constraints (Meisel, Clahsen & Pienemann, 1981). Nonetheless, the results of various studies have underlined cross-linguistic commonalities in second language acquisition as concerns syntactic development, which support the hypothesis of linguistic universals in second language development (Muysken, 1984; Zobl, 1986), rather than a "cognitive-based" approach to second language learning. At the intersection of these two theoretical viewpoints, Flynn and collaborators (Flynn, 1984; Flynn & Espinal, 1985) highlight the important role played by the native language of adult learners in the acquisition of second language syntax while underlining the universal nature of acquisition.

In both the native French and the beginning bilingual group, the effect of attachment was independent of whether the subordinate verb was singular or plural.

In a recent ERP study of early and late bilinguals (Weber-Fox & Neville, 1996), it was found that "late" bilinguals do not show the same sensitivity as early bilinguals or monolinguals to phrase structure violations. It would be of interest to see whether, eye-movement recordings would replicate these findings, or, rather, if the reported effect is linked to the inability to "repair" for this type of sentence.

It is worth noting that, though attractive, the linguistic tuning hypothesis has experienced what would appear to be a serious set-back in recent studies involving Dutch (Mitchell et al., 1997; Mitchell & Brysbaert, 1998). That is, when on-line RC attachment is examined for materials modelled closely on corpora-based sentences, the on-line preferences are quite the opposite that which would be predicted by the statistical frequency of structures in written Dutch.