The role of experience in syntactic processing: a critical view from the linguistics building[1]

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ABSTRACT
Linguists with an interest in psycholinguistic research on the processing of language often feel concerned that psycholinguistic experiments truly reflect important aspects of the nature of language and not artefactual dimensions of the methodologies used in them. In this paper I intend to argue that one of the main theories of language comprehension, Tuning, is flawed precisely because the theory has virtually no connection with the world of linguistics. If my view is correct, information about language obtained within the Tuning paradigm is therefore unlikely to reflect truly significant aspects of the nature of language. Tuning is premised on the role played by frequency in many cognitive domains, including the processing of language. It claims that ambiguous sentences are processed initially by preferring more frequent syntactic trees over less frequent ones. A prerequisite to the verificability of the theory is that its corpus analyses be well-founded. Another is that the theory spell out precisely what counts as a segment subject to frequency effects. I intend to argue that these two prerequisites are not adequately controlled by the proponents of the model.

Key words: syntactic processing, Tuning, parsing, frequency, corpus.

El papel de la experiencia en el procesamiento sintáctico: una visión crítica desde la lingüística

RESUMEN
Algunos lingüistas interesados en la investigación realizada sobre el procesamiento lingüístico suelen expresar su preocupación de que los experimentos psicolingüísticos reflejen verdaderamente aspectos importantes de la naturaleza de la facultad lingüística humana, y no sesgos incontrolados de las metodologías con las que se realizan. En este artículo pretendo defender la tesis de que una de las principales teorías de procesamiento lingüístico, Tuning, está fundada sobre bases teóricas endebles, precisamente porque apenas goza de conexión alguna con el mundo de la lingüística. De ser esto cierto, es poco probable que la información sobre la facultad del lenguaje que proceda de dicho paradigma investigador arroje un conocimiento de aspectos verdaderamente significativos sobre la naturaleza del lenguaje humano. Tuning enfatiza el papel de hecho desempeñado por la frecuencia en la formación de hábitos pertenecientes a diversos dominios cognitivos, entre los que figura el procesamiento lingüístico. Mantiene que las oraciones ambiguas se procesan en un primer barrido a través de un sesgo

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o predilección por los árboles sintácticos más frecuentes. Un primer prerrequisito para la verificabilidad de la teoría es que sus análisis de corpus sean fiables. Otro segundo prerrequisito es que la teoría explicite de modo preciso qué segmentos sintácticos concretos están sujetos a recuentos de frecuencia. Es mi intención demostrar que estos dos prerrequisitos no están suficientemente controlados por los defensores del modelo.

Palabras clave: Procesamiento sintáctico, *Tuning, parsing,* frecuencia, corpus.

1. INTRODUCTION

Linguists interested in the results of psycholinguistic experiments view the psycholinguistic agenda as an appealing way of attempting to break what for many is a distressing circularity in the world of linguistics. On the basis of linguistic evidence, one may debate endlessly whether *ten dollars* in *that shirt cost me ten dollars* is a complement or a modifier, so it would be reassuring to find out whether reaction time experiments (like self-paced reading or eye-tracking), or electrophysiological experiments (like evoked-response potentials (ERP) or functional magnetic resonance imaging (fMRI)), can cast some light on that (see Kennison, 2002, on differential processing of complements and modifiers). It would likewise be interesting to know whether the mind treats *wh*-trace and NP-trace (to use habitual Chomskyan terminology) in the same way, as formal theories of grammar disagree on their status. Thus, for instance, GB/MP claims that the two empty categories are syntactically-governed, but GPSG insists that only the former is. Experimental research by Osterhout and Swinney (1993), for instance, shows NP-trace to be a semantic phenomenon, a result that is consistent with GPSG. Keeping so-called empty categories in mind, it would also be interesting to know something about their representational reality in the mind (McElree and Bever, 1989; Nicol and Swinney, 1989; Featherston, Gross, Munte, and Clahsen, 2000; Fiebach, Schlesewsky and Friederici, 2001).

As a linguist with an interest in psycholinguistic research on the processing of language, I feel concerned that psycholinguistic experiments truly reflect important aspects of the nature of language and not artefactual dimensions of the methodologies used in them. In this paper I intend to argue that one of the main theories of language comprehension, Tuning (Mitchell, Cuetos, Corley, and Brysbaert 1995; Brysbaert and Mitchell, 1996), is flawed precisely because it is the only theory which has virtually no connection with the world of linguistics. If my view is correct, information about language obtained within the Tuning paradigm is therefore unlikely to reflect truly significant aspects of the nature of language. Tuning is premised on the role played by frequency in many cognitive domains, including the processing of language. It claims that sentence structure is processed initially by preferring more frequent syntactic trees over less frequent ones. In theory, predictions by Tuning are easy to falsify: one only needs to prove that results from on-line psycholinguistic experiments do not match

the statistical tendencies cast out by corpora. Thus, for instance, if in an ambiguous segment like *the teacher told the boy that* ..., a complement *that*-clause occurs more often than a relative *that*-clause, Tuning would predict facilitation (faster latencies) for continuations as complements (... *that he had to work harder*) and re-processing (lower latencies) for continuations as relatives (... *that had asked the question to stand up*; see Brown, van Berkum, and Hagoort, 2000). A prerequisite to the verifiability of the theory is that its corpus analyses be well-founded. Another is that the theory spell out precisely what counts as a segment subject to frequency effects. I intend to argue that these two prerequisites are not adequately controlled by Tuning, in large part as a consequence of the theory's lack of touch with the world of linguistics. First, in section 2, I show how other theories of language comprehension have benefitted from knowledge of language and contact with linguistic theories. In section 3 Tuning and Tuning's way of invoking frequency as a determinant of language processing is explained. In section 4 I suggest that Tuning is flawed because of its preference for so-called 'coarse grain' analyses. Section 5 offers a second critique of Tuning based on its narrow use of corpus analyses. Finally, section 6 suggests some implications of the modifications suggested both for Tuning in particular and, more generally, for our knowledge of the nature of language.

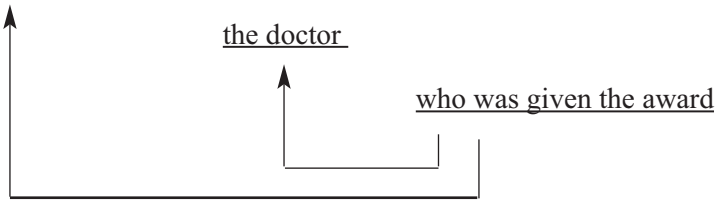
2. LINGUISTICS IN PSYCHOLINGUISTICS

Consider the psycholinguistic theory known as Garden Path (Frazier and Rayner, 1982; Frazier, 1987). Garden Path is a universal formal account of parsing based on informational encapsulation (Fodor, 1983). It claims that the mind has a modular parser that is initially geared towards syntactic trees only, which means that the first processing done on any linguistic input is a syntactic analysis in terms of vacuous category labels –like NP, VP and so on. At this early stage of processing the parser has no access to any layer of meaning (lexical, semantic, pragmatic), even if this is immediately available. Only after mandatory syntactic parsing is complete will other processing ranks (modules) enter the processing scene in a markedly serial chain. Garden Path is premised on the presumed need for the parser to seek, and be molded by, computational economy, and especially the need to reduce the strain imposed on working memory. This, in its turn, manifests itself in the parser's predisposition to opt for the simplest possible analysis when the ongoing linguistic input is grammatically compatible with more than one (as is the case of the complement/relative clause temporary ambiguity involving *that*-clauses referred to above). Simplicity is defined by direct reference to the geometry of the tree. The highest-order instruction is a 'Minimal Attachment' (MA) principle to the effect that trees should be preferred which contain the fewest possible nodes.[2] When

[2] For instance, in the momentarily ambiguous *Amanda believed the senator* ..., 'the senator' may be analysed as a DO of 'believe' (*Amanda believed the senator during the speech*) or the subject of the complement clause of 'believe' (*Amanda believed the senator was lying*). Since this latter analysis involves one extra node, the MA interpretation is the DO reading.

MA does not adjudicate between competing analyses, another principle, called 'Late Closure' (LC), operates to select recent adjunctions over distant ones. For instance, in the ambiguous construction in (1)

(1) I once met the daughter of



the parser should obey LC by preferring an adjunction of the RC to the second, nearer, noun (*doctor*) in the complex NP (CNP), rather than to the first one (*daughter*), as this latter is higher up the tree and therefore more distant. Attachment to *daughter* should thus be dispreferred on economy grounds. However, despite its sound logic, the model was proved to be wrong when Cuetos and Mitchell (1988) published evidence, in the form of a questionnaire study, of Spanish readers' preference for the NP1 –ie the more distant, higher site– as a host for the RC. When on–line experiments both in Spanish and in other languages confirmed the first off-line results, it was evident that Garden Path–and its pretensions of universality– could not be maintained without serious modification[3].

The problem with Garden Path was that its syntactocentrism was far too narrow and crude to account for something as notoriously complex as language. Thus, Garden Path evolved into *Construal* (Frazier and Clifton, 1996, 1997; Gilboy, Sopena, Clifton, and Frazier, 1995). *Construal* advocates still believe that LC and MA are mandatory universal parsing strategies, but they have narrowed down the scope of their operation to primary syntactic relations. For non-primary relations they have put forward a new principle that gives the model its name: *construal*. 'Construed' relations are not discrete, automatic phrase-structure adjunction ties, but merely 'associations' between portions of sentences. Such 'associations' are allowed to be processed "using both structural *and* nonstructural information" (Gilboy et al. 1995: 133; emphasis added). Primary phrases include: a. the subject and the main predicate of the sentence; b. their obligatory constituents (complements); and c. the complements and obligatory constituents of primary phrases. Non-primary relations include, among others, phrases related via conjunction, adjunct predicates and, keeping in mind the construction in (1) above, relative clauses. When a non-primary has been recognised, the Construal principle conducts its operations in a very specific way:

[3] To the sentences in the previous questionnaire study Cuetos and Mitchell added continuations which forced disambiguation in either one of the two possible directions (for instance, 'in her bikini' forces disambiguation towards N2 in (1)). Mitchell and Cuetos found out that every time disambiguation was forced towards N2, the disambiguating region took longer to read than when it was forced towards N1. This was taken as evidence that readers must have initially favoured the N1 site and were later obliged to undertake time-consuming reanalysis.

> *Construal principle*: associate a phrase XP (which cannot be analysed as instantiating a primary relation) into the current thematic processing domain; interpret XP within the domain using structural (grammatical) and nonstructural (extragrammatical) interpretive principles.
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> *Current thematic processing domain*: the extended maximal projection of the last theta-assigner. (Gilboy et al. 1995: 134)

Construal is immensely superior to Garden Path. In the first place, its philosophy of making a firm divide between primaries and non-primaries is in line with classic tenets of linguistic theory, as indeed virtually all known theories of grammar distinguish between arguments and non-arguments, and their syntactic projections. In the second place, and of more practical importance for psycholinguists, the theory's linguistic sophistication, with its specification of a current thematic processing domain expressed in GB terms, crucially affects the way we analyse the construction in (1), as we now need to look into the internal structure of the CNP for predictions regarding the 'association' of the RC. Thus, when the CNP contains a preposition which is capable of assigning a theta-role (basically a preposition with semantic content), the current processing domain excludes the first noun, which means that the association of the RC with that noun becomes a costly choice. This is the case of strings like 'the house of the painter that' or 'the house with the roof that', which contain prepositions that assign 'possessor' and 'accompaniment' theta-roles respectively, and where the RC is predicted to prefer low attachment. Conversely, in 'the author of the book that', the preposition *of* is not a theta-assigner but merely a case assigner, which means that the whole CNP constitutes the entire theta-domain now. Whenever that is the case, the final interpretation is determined by all kinds of late-acting sources of information, such as lexical and pragmatic knowledge, communicative clarity, and context fit.

Since RCs are non-primaries, even presumably very late-acting Gricean principles are allowed to affect 'associations'. Thus, for instance, since in English, but not in Spanish, the CNP structure (*the house of the painter that*) co-exists with the Saxon Genitive (*the painter's house that*) and in this latter the RC cannot refer to the possessor, the choice of the prepositional structure makes sense when the RC refers to that noun. In this way, the slight N2 preference found in (British) English may be accounted for. As a matter of fact, Gilboy et al. (1995) found out in their questionnaires that most of the difference between the English and the Spanish results affects only two types of CNP: the 'alienable possesive' type (*the house of the painter that*) and the 'kinship relationship' type (*the relative of the painter that*), that is, precisely the types where the Saxon Genitive is more common in English (see Brysbaert and Mitchell, 1996, for partial evidence from Dutch). Frencke-Mestre and Pynte (2000a, 2000b), among others, offer clear confirmation of the role played by the preposition in molding the CNP and therefore affecting 'association' preferences in both Italian and French.

This is not the place to further evaluate the merits of Construal relative to competing models of language processing[4]. The point is simply that the model's linguistic

[4] See Brysbaert and Mitchell (1996) for critiques. In fact, how precisely adjunction remains in suspension (Deevy, 2000) to be later determined by a host of late-acting processes, and how these are to be

foundations give it a considerably enhanced predictive power, as well as a much greater degree of testability. Nor is this the only case where close contact between linguistics and psycholinguistics has produced fruitful and very specific lines of research. Without leaving the Garden Path model,[5] de Vincenci (1998: 338) has proposed that cross-linguistic investigation into the application of a particular processing strategy can be successfully accomplished if the processing strategy in question can be "reconducted to a more abstract level of generalization, so that the principle applies to different structures, regardless of the form of the superficial string, but according, say, to the underlying level of syntactic representation". With that Chomskyan level of syntactic representation in mind, de Vincenci (1998) postulates a Minimal Chain Principle (MCP) along the following lines:

> Minimal Chain Principle: To postulate required chain members at the earliest point grammatically possible but to postulate no potentially unnecessary chain members. (De Vincenci 1998: 339).

According to de Vincenci, the MCP predicts that in the ambiguous Italian construction with a *pro* subject in (1):

(1) Ha chiamato Gianni
  a *pro* has called Gianni
  b Gianni has called

the parser will show a bias to opt for interpretation (a) because in (b), assuming that Italian is an SVO language, the movement of Gianni from the canonical preverbal subject position to the displaced position after the verb must be undone. The MCP actually "amounts to saying that the parser prefers to analyse an element as being in its deep structure position" (p. 339), as Gianni is in (1a) above. Put differently, the parser prefers a non-movement alternative to one involving movement (see also Featherston, Gross, Munte, and Clahsen, 2000, for evidence of harder processing of raising structures –presumably involving movement– relative to presumably base-generated control structures in German). De Vincenci backs up her universalist theory citing instances from Italian, Russian, and German, where disambiguations forced towards the likes of (1b) are consistently harder to process. Her comments on the difficulty of processing 'complex derivations' elicit a context where others like Hemforth (1993) have referred to the cognitive cost of derivations, and to current linguistic theorising by Chomsky (1995) that sees movement as an extremely costly grammatical operation. MCP is directly reminiscent of Rosenbaum (1967)'s Minimal Distance Principle, and especially of Chomsky´s (1995) Minimal Link Condition. In its formal explicitness, sophistication, and degree of testability, it is also a far cry from

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ranked, has never been clear (Traxler, Pickering and Clifton, 1998; Mitchell, Brysbaert, Grondelaers, and Swanepoel, 2000).

[5] Despite its reformulation and refinement, the model known as Garden Path is still generally used to date for any approach to parsing that relies on two-step, universal, syntactic determinism.

the equally-formalist psycholinguistic theorising of the early 70s which merely viewed presumed preference for SVO structures as reflecting a preferred 'sentoid'-like strategy (Kimball, 1973). In sum, when psycholinguistic research is based on the formal apparatus of linguistics, psycholinguistic experiments are more likely to help us face the challenge of psychological adequacy (Dik, 1991; Kaplan and Bresnan, 1982).

3. TUNING: THE ROLE OF EXPERIENCE IN LANGUAGE COMPREHENSION

As pointed out in the introduction, Tuning bases its appeal as a theory of syntactic processing on the role played by frequency in many cognitive domains. The entrenching of cognitive schemata (frames, scripts, scenarios) in the mind, for instance, is directly based on actual accumulated experience. More to the point, it is well known that frequency also regulates specific and important aspects of the cognitive domain of language. In word retrieval, for instance, on average, more common words are accessed 80 milliseconds faster than less common ones (Balota, 1994). Syllabic frequency has also been shown to be a powerful determinant of word access in the sense that lexical items which contain very common syllables (syllabic neighbours) slow down the retrieving process as word selection depends on the precise discrimination among competing candidates (Perea and Carreiras, 1998). Likewise, we know that the more common meanings of ambiguous words are more active than the less common ones, so that contexts need to be very strong indeed to cause activation of the subordinate meaning to reach the same activation threshold as the more common one (Duffy, Morris, and Rayner 1988). In fact, the clearest evidence for the role of frequency in language processing comes from a set of lexicalist models sharing the assumption that syntactic ambiguity resolution is derivative of frequency-based lexical biases. For instance, for strings like *the witness examined ...* there is a temporary syntactic ambiguity between a main verb/active and a reduced relative/passive reading of the VP. Continuations like *the documents* or *by the lawyer* disambiguate the sequence towards either one of those two syntactic choices respectively. However, MacDonald et al. (1994) have insisted that the parser deals with such cases of syntactic ambiguity by consulting its lexical database and checking, *inter alia*, whether the *–ed* word that figures in each particular example is more often used (in the Francis and Kucera (1982) corpus) as a past participle or a simple past. After reviewing a series of experiments which had produced mixed results, they managed to show that in those experiments where preference for a main verb interpretation had been found verbs predominated that occur more often as main verbs in the corpus; conversely, in those experiments where facilitation for the reduced relative structure had been detected they recognised more verbs which occur more often as participles in the Brown and Kucera corpus. The conclusion was reached that :

> This result clearly shows the interaction between lexical and contextual information: Given a verb with frequency biases that make the reduced relative interpretation a viable option, contextual information can guide the comprehender to one or the other inter-

> pretation. The context will have little effect, however, if the lexical biases of the ambiguous verb overwhelmingly favor the main verb interpretation. This pattern is the analog in syntactic ambiguity resolution of the Duffy et al. (1988) results for meaning ambiguity: Lexical frequency information has a substantial effect on interpretation of the ambiguity, and contextual information can have the effect of promoting one interpretation of an equibiased item but cannot overcome strong frequency biases to promote a subordinate interpretation over the (frequency) dominant alternative. These results strongly indicate the lexical basis of syntactic ambiguity resolution. (MacDonald et al 1994: 692-3).

Given these premises, it made sense to expect a theory of language processing that claimed that frequency also plays a role in registering syntactic structures as wholes. That happened when, after proving Garden Path wrong, Mitchell, Cuetos, Corley and Brysbaert (1995) proposed that syntactic ambiguities are resolved by the parser by consulting stored tallies of the frequencies of the competing structures in the language at large and blindly opting for the more frequent one. When they went on to show that the N1 attachment preference found in on-line experiments for Spanish [CNP + RC]s like (1) above corresponded with a 60% preference in a Spanish corpus, and that, conversely, a corpus of N2-biased British English cast only a 38% preference for the NP1 site, it seemed that cross-linguistic variation in parsing –Garden Path's Achilles heel- could be accounted for. As a theory, Tuning arose out of a simple prediction of a match between on-line measures and corpus counts: if high adjunction occurs more often in corpora, then disambiguation towards high hosts should be faster in experiments. If that is not the case, the theory is wrong.[6]

Tuning is a hybrid between syntax-based, principle-grounded models (like Garden Path or Construal) and lexically-based, constraint satisfaction approaches to parsing (Bates and MacWhinney, 1989; Taraban and McCleland, 1988; Macdonald et al., 1994; Tannenhaus, Spivey-Knowlton and Hanna, 2000). Like principle-grounded models, it posits a parser that is initially sensitive to abstract syntactic trees only. Like constraint-based approaches, however, it maintains that preference for any of those abstract representations is directly dependent upon frequency of use. Tuning advocates insist that the parser does not choose specific trees based on properties intrinsic to them (like cognitively simpler geometries), but solely as a result of comprehenders' direct experience with language: when dealing with a particular ambiguity, the syntactic *form* that has proved most successful in the past will simply be chosen preferentially as a heuristic (Cuetos and Mitchell, 1988; Brysbaert and Mitchell, 1996). A crucial difference between Tuning and constraint-based approaches is that the former is a two-stage model molded by frequency alone, whereas the latter make heavy use of frequency but admit of other processing forces competing to determine the first processing path. Notable among these are: argument structure, context fit, and recency. Constraint-based theoreticians envision processing of language as the satisfaction of multiple simultaneous competing constraints which are deemed more likely to be implemented by a parallel (as opposed to a serial) architecture of the mind (Lewis, 2000).

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[6] The name 'Tuning' suggests that the parser is shaped, or 'tuned', by the neverending flow of experience and that it keeps registering frequencies of syntactic alternatives through life.

4. WHAT IS WRONG WITH TUNING? THE COARSE GRAIN

Tuning initially received substantial empirical confirmation from languages such as English, Spanish, French, and Dutch. However, recently corpora studies and on-line measures have been shown not to coincide in Ducth, where an N1 preference has been found in on-line experiments (Brysbaert and Mitchell, 1996) and an N2 preference in a corpus study (Mitchell and Brysbaert, 1998; De Baecke, Brysbaert, and Desmet, 2000). In English, Gibson, Schutze and Salomon (1996) have also detected the same discrepancy for CNPs containing three sites (like *the lamp near the entrance to the house that ...*).

However, no language processing model is free from some embarrasing counter evidence, and this is not the place to consider how Tuning fares against its rivals. When it first arose as a theory of language processing, critics were quick to point out that the model had an in-built escape door that made it hard to falsify. Thus, when results came out that contradicted its predictions, such predictions could always be altered by invoking a different 'grain size', that is, the delimitation of precisely how big a portion of language should count as a segment subject to frequency effects (Mitchell et al. 1995). In the case of (1), for instance, it was not clear whether one should consider the frequency of the overall [CNP + RC] as a syntactic template, that of particular prepositions inside the CNP, that of the relative clause with particular nouns, etc. Given such lack of specification in the delimitation of the grain of analysis, proponents of the model were frequently accused of being able to accommodate *any* finding. Forced to tackle the 'grain size' problem, Mitchell et al. (1995) settled for syntax: the frequency tallies that the parser makes use of are of a 'coarse grain', by which is meant that syntactic structures are subject to frequency effects independently of the words that make them up. It is this aspect of the theory –so central to it- that I would like to discuss critically. There are three main objections to a 'coarse grain', and the three compose a theoretical approach to the comprehension of language that is essentially out of touch with the complexities of actual linguistic structure, and with the nature of language.

In the first place, even though circumscribing Tuning to the structural level of language may leave out of consideration by a syntactic parser a myriad of possible lexically-related counts (for instance, whether the Ns denote abstract, or animate, or collective, or plural entities), that move still fails to specify precisely over which strecthes of syntax frequency is supposed to act. In the case of a [CNP + RC] like (3):

(3) The amazingly spectacular daughter of the old rusty and decrepit colonel who...,

the nested, recursive nature of syntactic structure allows for several exclusively syntactic counts. Of no less importance is the fact that, since Tuning advocates a two-stage parser, the syntactic processor is supposed to act prior to any other submodule, including lexical meaning. Yet, it is hard to believe that all along the processing of that long NP meaning is restrained from acting till the parser recognises the right abstract syntactic template. In (3) there are eleven words (seven of which with lexical meaning) before the RC makes its appearance on the scene. It is profoundly counterintuitive to imagine all linguistic monitoring systems on hold while syntax is divining the tree. And (3) is

not a twisted example: it has just one determiner per noun (arguably the most basic), no downtoners or intensifiers, no parentheticals or appositions, and hardly any coordination. The first contradiction one notices about Tuning is that, being an exposure-based system, it has however very little consideration for the nature of what the parser is actually exposed to: complex language.

In the second place, Tuning's use of the notion of 'syntactic structure' is problematic too. Consider the facts of control (Chomsky, 1981) exemplified in (4)-(5):

(4) I^i begged Sue^j to PRO^j come soon
(5) I^i promised Sue^j to PRO^i come soon

For these structures, Tuning's open view of syntax would lead it to predict that recovery of PRO subjects should be facilitated when PRO is object-controlled, as object-control verbs are much more numerous than subject-control ones, in English at least (Rosenbaum, 1967). However, that prediction simply flies in the face of available experimental evidence (Betancort, Carreiras, and Acuña, submitted) and it probably does so because, on more theoretical grounds, it fails to make opportunistic use of the important fact that control is largely a lexically-driven grammatical phenomenon (Chomsky, 1981; Jackendoff, 1972, 1974; Bresnan, 1982; Chierchia, 1988; Sag and Pollard, 1991). In fact, the model's invocation of syntactic structure is extremely reductionistic, given the extraordinarily complex nature of what is processed. If, as Culicover and Jackendoff (2001) have recently pointed out, one expands the subject-control *promise* class of predicates to nominals, the exceptionality of the class vanishes, as (6) demonstrates:

(6) John's promise/vow/offer/obligation/pledge/oath/commitment to Susan to PRO take care of himself/*herself. [Compare:
(7) John's order/instruction/encouragement/reminder/invitation to Susan to PRO take care of herself/*himself]

Since, being tree-dependent, Tuning is supposed to allow the parser to recognise syntactic categories at least, we may expect it to circumvent such a problem by being able to make differential predictions about control depending on whether the parser recognises it in either verbal or nominal constructions. But being able to choose which count is the right one (control at large as a separate syntactic phenomenon, or control with verbs, with nouns, etc., separately) seems reminiscent of the old escape door and *ad hoc*. Furthermore, since, as Culicover and Jackendoff insist, "the most plausible

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[7] This is evident from the fact that all the nominals in (10) receive control, not from a subject position, but from the thematic role of Source (the giver of the promise) wherever that may be located syntactically:
(i) The promise to Susan from John to take care of himself/*herself
(ii) John gave Susan some sort of promise to take care of himself/*herself
(iii) Susan got from John some sort of promise to take care of himself/*herself.
If the controller is the lexically-entrenched semantic role of Source, and not the configurationally-defined function of subject, "the facts emerge elegantly. However, the price is that the controller cannot be identified in terms of syntactic position" (Culicover and Jackendoff 2001: 506).

basis for the difference in controller between [6] and [7] is thematic structure" (p. 505)[7], Tuning's syntactic rigidity would appear to be ill-suited to cope with such structures, as thematic information would only be allowed to influence an already made syntactic first pass which, in this case, would have no basis for initially adjudicating between competing processing options. A parser that faces the processing of thematically-driven syntactic structure by putting aside its store of thematic information just because it must first obey syntax at all costs is not the most competent parser one can imagine. As a theory of processing based more on psychological findings (the role of frequency in cognition at large) than on knowledge of language, its proponents seem to confuse linearisation with formal structure. The grammar of control is a reminder that at least some aspects of inevitably linearised language cannot be properly understood unless one recognises the intricately multistratal nature of language.

In the third place, it is odd that frequency should be restrained from unleashing all of its great power. In other words, it is not immediately clear why, if frequency is such a powerful determinant of at least lexical processing, the processor should not be able to make use of frequency-based lexical tallies in the process of lexical items combining to form syntactic structures. For instance, Pynte and Colonna (2000) have recently shown that, for structures like (1) above, when N1 is of lower frequency than N2, French readers are more inclined to attach the RC high. By contrast, when N2 is less frequent than N1, then it is N2 that is most likely to attract the modifying clause. This makes sense if one considers the functional role that relative clauses usually perform in language: they delimit the potentially infinite reference of a previous noun which is not presented as being sufficiently specified. Lexical frequency is different from the lexically-specified tendency that some nouns may have to take modifiers (MacDonald et al., 1994). As Corley (1996) has pointed out, in the case of [CNP + RC]s in particular, such lexical forces are not likely to have a major role in shaping adjunction ties. Yet, it is easy to conceive of *some* circumstances in which *some* nouns do show a strong propensity to 'invoke' a relative clause. For instance, in *well, you know, my boss is the kind of old-fashioned guy ...* we surely expect an RC (like *who prefers to pay cash)* more than in (1) above, or more than in *this is the end of the story*. Notice that *guy* is not even a referential NP while *kind* is;[8] however, the RC points to *guy* because *kind* is only 'formally referential' and *guy* actually inherits its referentiality (just as in *an apple core* the formally indefinite *core* is actually definite, paraphrasable by *the core of an apple*; cf. Burton-Roberts, 1975). By contrast, in *this is the end of the story*, *this*, *end* and (definite) *the story* indicate that the latter noun is anaphorically-specified and therefore unlikely to need any 'major' restrictive specification. The bare syntactic template (*the end of the story* and *the kind of guy* are both formally CNPs, so exactly the same object for Tuning) does not reflect either all of what may be subject to important frequency effects or, more importantly, all that is central to the nature of such pieces of language. Similar comments may be made about the *the witness examined* type of structure mentioned above. It has been shown that a passive interpretation is much more likely after *the evidence examined ...* (as in *the evidence examined by the*

[8] It is relatively uncontroversial that non-referential nouns do not attract RCs (Gilboy et al. 1995).

jury was incomplete) than after *the witness examined ...*, for obviously witnesses (but not evidence) can examine something (MacDonald et al., 1994; Trueswell, Tannenhaus and Garnsey, 1994; MacDonald 1994, Trueswell, 1996). In sum, it would appear that Tuning's syntactocentrism is strangely at odds with what is most definitorial about the theory: namely, the recognition of the role played by frequency in simultaneously shaping several aspects of the processing of language.

5. TUNING'S USE OF CORPORA

The previous contradictions reveal an impoverished view of language, a view that comes about probably as a result of approaching it only as a psychological process (which it obviously is), and not as a complex, self-regulated, systemic, Saussurean network of relations defined both syntagmatically and paradigmatically. Essentially, Tuning conceives of a parser that must deal with language but refuses to know anything about it. Such a neglect of language is evident in its handling of corpora. For predictions concerning a structure like (1), the coarse grain means that all that the parser needs to tabulate and find in corpora is a syntactic template of the form [CNP + RC]. Now, apart from the lexical contingencies of the nouns that make up the CNP, and the counterintuitive idea that the RC is adjoined to it irrespective of the time it took for the parser to recognise the CNP as such (see above), consider, very briefly, how much of language complexity a mere [CNP+RC] template can accommodate:

1. Prosody-segmentation. Gilboy and Sopena (1996) claim that the differences found between Spanish and English are caused by the different segmentation techniques used in experiments. These often include large segmentation (the whole CNP) and small segmentation (each NP is given a separate display). Segmentation-related effects have been found for a variety of structures (Kjelgaard and Speer, 1999; Carlson, Clifton, and Frazier, 2001).
2. The size of the RC. According to Fodor (1998), the syntax-prosody interface is ruled by a peculiar antigravity law according to which light constituents prefer to attach low whereas heavy ones opt for high heads. Assuming that a constituent "likes to have a sister of its own size" (p. 285), adjunction preferences should vary depending on whether the RC is short or long. Such 'balance effects' can be traced in studies by Lovric, Bradley, and Fodor (2000) (on 'prosodic visibility' in general, see Schafer, 1997; Carlson et al., 2001).
3. The nature of the preposition. As has already been noted, the fact that the preposition inside the CNP is either predicative or not affects processing (Gilboy et. al., 1995). Predicative prepositions like *with* or genitive *of* circumscribe adjunction to the NP2 domain, whereas non-predicative ones, like case assigner *of*, leave the options open.
4. The mixing of prepositions affects processing. In particular, Frenck-Mestre and Pynte (2000a) have shown that having French readers initially read a series of CNPs containing the theta-marking preposition *with* affects their subsequent processing of another series of CNPs containing the preposition *of* (but not viceversa).

5. The restrictive/non-restrictive nature of the RC. According to Baccino et al (2000), the N1 bias found in Frenck-Mestre and Pynte (2000a, 2000b)'s French and Italian sentences is the result of the restrictive/non-restrictive dimension of the RCs used in them, as the French researchers often used proper nouns in the N2 position, thus promoting an N1 choice.

6. Modifiability. Thornton et al. (1999) claim that nouns which have already had some previous modification are less likely to attract an RC (but see both de Baecke et al. (2000) and García-Orza, Fraga, Teijido, and Acuña et al. (2000) for the opposite suggestion).

7. Number. The Mismatch Asymmetry Effect first observed in production studies (Bock and Ebenhard 1993) refers to the fact that a plural NP in a CNP domain increases processing of a singular verb. Deevy (2000) has shown the effect is replicated in comprehension. This is an important finding, as plurality itself does not affect the geometry of a tree.

8. Animacy. Using other structures, Barker, Nicol, and Garrett (2001) have discovered, in production, that animacy interferes with agreement, "indicating that the mechanism involved in implementing agreement ["an ostensibly grammatical process] cannot be blind to semantic information". Prat-Sala and Branigan (2000) have reported that animacy plays a significant role in choosing among competing syntactic alternatives in Spanish and English, also in production. It is worth remembering that the N2-biassed 'alienable possessive' type referred to above (Gilboy et al. 1995), as in *the house of the painter that ...,* has an animate second noun. More to the point, Mak, Vonk, and Schriefers (2002) have shown that in Dutch the well-attested advantage of subject-relatives over object-relatives in processing (King and Kutas, 1995) can be eliminated if the RC contains an inanimate object (thus, instead of, for instance, *this is the professor that the student ...*, *this is the professor that the book ...*). Finally, Desmet, Brysbaert, and De Baecke (2002) have uncovered signs of a clear animacy effect in the NP1s of Dutch [CNP + RC]s.

If Tuning's predictions about the processing of structures like (1) are to be tested by examining in corpora only whether in [CNP + RC]s the RCs are adjoined more often to NP1 or NP2, all the previous facets of that structure must simply be initially ignored. That is surely a strange form of apriorism. Animacy, plurality, language-specific prosodic chunking (through subvocalization), lexical frequency, prosodic balance, size, or modifiability do not affect the geometry of a tree. But since, out of all that constitutes the form of grammar, Tuning has chosen to rely only on geometrical determinism, it is impossible for it to claim the role of frequency in connection with all the aforementioned parameters when it comes to determining the adjunction ambiguity in (1). This is unfortunate, not just because, as we have just seen, recent psycholinguistic research is proving that such parameters may be strong, but also because, if used with no restraints, corpora can cast out a wealth of important data that may actually reveal that they are very significant in corpora themselves. In a corpus of Galician that we have recently analysed,[9] García-

[9] Galician is one of the five Iberian languages, and it is spoken in the north-west of Spain. The corpus analysis is part of an on-going research project on the processing of this language that includes both off-line

Orza et al. (2000) have uncovered a number of interesting facts and parameters that an exposure-based theory of parsing would do well in heeding. Among them:

1. The overall NP1/NP2 distribution (the only figure Tuning would claim to be necessary in order to define its 'coarse grain' approach to parsing preferences) is almost a non-significant fifty-fifty, contrary to what one should expect given the fact that Galician is a Romance language like Spanish, or French, and is therefore expected to opt for NP1.[10]
2. When only the preposition *de/of* is taken into account, the overall data do not change much. There is a 52.42% vs 47.57% non-significant preference for NP1 and NP2 respectively.
3. The little, non-significant, overall NP1 advantage is in fact even more suspect given the fact that in Galician (as well as in Spanish) noun postmodification often takes the form of a determiner-less second noun (eg, *la mesa de madera*, or 'the table of wood'), which makes non-referential NP2 a very costly choice. Our corpus shows only 41 determiner-less NP1s, but 267 determiner-less NP2s (over 25% of the total of cases).
4. Prepositions other than *de/of* show a significant NP2 bias.
5. There is a significant humanity effect in the sense that of the two types with non-equi-biassed human nouns (non-human/human and human/non-human), the human NP carries the adjunction. Interestingly, when the two NPs are human there is a strong NP2 bias.
6. There is a significant plural effect, especially when plural occurs in NP2.
7. There is also a significant presence-of-adjective effect, especially in NP2 as well.
8. The presence of an indefinite article is facilitatory only in NP1.
9. Unsurprisingly, absence of determiner (referentiality) dramatically reduces adjunction potential of NPs (Gilboy et al. 1995).
10. The vast majority of CNPs contain preposition *de/of*.
11. The non-human/non-human CNP type takes up more than twice all the other three types together.

Even assuming a blind respect for only the biggest figures of our Galician corpus (that is, a somewhat coarse grain, but in any case a grain less coarse than Tuning has generally defended), the general statistical prevalence that comes out of it is a template composed of [two non-human NPs joined by preposition *de/of* with equi bias]. Now, that is not the template upon which over ten years of psycholinguistic research on [CNP + RC]s have based the more conspicuous conclusion: namely, essentially a general NP1 or high-attachment preference in all languages examined except British

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(a questionnaire and the corpus) and on-line (self-paced reading) analyses. The corpus contains 11 issues of the daily newspaper *O Correo Galego*, covering some 400.000 words, as well as a series of short-stories taken from internet files which total some 245.000 more. For reasons of space I can only focus on the results of our corpus analysis in a very superficial way here.

[10] That is in fact the preference we obtained in a preliminary on-line reading task.

English. For instance, Cuetos and Mitchell´s (1988) questionnaire contains 11 human/human and 13 non-human/human NPs, all of them with definite determiners, all of them Direct Objects of verbs or (less often) complements of prepositional verbs, all of them with no adjective at all in any of the two NPs, and 23 out of 24 of them containing two singular NPs (in fact, all sentences are so 'core', so lacking in pragmatic colouring, that they read like a primary school grammar class; eg. *el detective fotografió la maleta del estudiante que estaba en la terraza / the detective photographed the suitcase of the student who was on the terrace*). The statistically dominant non-human/non-human class is absent from most, if not all, on-line experiments. There is obviously little point in claiming that the predictions of a model like Tuning, which are based on the role played by frequency in shaping processing propensities, are either confirmed or disconfirmed if the corpus/on-line match that the theory advocates in terms of testability is in fact distorted by the fact that the kind of structure that corpora cast as being most representative is not the same that is subsequently evaluated in psycholinguistic experiments. Initially, as already pointed out, corpora counts and on-line data failed to match in Dutch, but a mere look at more refined corpus studies recently conducted by De Baecke et al. (2000) and Desmet et al. (2002) in that language suggests that not even the disconfirmation of Tuning postulates need be taken seriously, as these new corpus studies show a strength of various potential processing parameters strikingly similar to what we have found in our Galician corpus. If frequency were allowed to show its role also in the tabulation of non-arboreal parameters like animacy or grammatical number, for instance, then the correspondence, or lack of it, found between on-line and off-line measures in Dutch might turn out to be an entirely different one (see Desmet et al. 2002 for similar considerations). Notice that if such parameters are confirmed to have a statistically-based effect on processing, Tuning could be salvaged even after the first Dutch results, but only at the expense of renouncing its syntactocentrism. It remains to be seen if, envisaged in this way, Tuning may offer anything fundamentally distinct from constraint satisfaction approaches to the processing of language.

6. EPILOGUE: LANGUAGE COMPLEXITY

In sum, if the role of recency in forging syntactic processing biases is to be effectively measured, nothing like the crude view of language that emerges out of Tuning's coarse grain approach can be invoked by way of confirmation or disconfirmation of the theory. What is needed is an evaluation of the cut-off point where fine grains start being meaningless. This entails that fine grains must be seen as a must. In view of the corpus data uncovered about Galician and Dutch, it appears that a serious, comprehensive, on-line manipulation of such non-arboreal parameters as grammatical number, animacy, modifiability, definiteness, and type of preposition is needed, in many languages. If to those parameters one adds the habitual forces recognised in the processing literature, such as recency/LC, minimal attachment, argument structure, lexical biases, and context fit, the view of language processing that emerges may shock Tuning advocates, for, in essence, the language processing challenge consists in mapping a precise time

course for the operation of all forces bearing on the determination of parsing (there is no question that *all* factors intervene sooner or later as we humans do understand each other). What is more, the increase in the number of processing forces –all subject to potential frequency effects– that is necessary for an adequate account of complex language results in an exponential growth of the number of possibilities that these forces have of interrelating with one another in what seems to be a myriad of possible time course combinations. Of course, the specification of the time course of processing is essential to the elucidation of the functional architecture of the linguistic mind (modular or interactive, serial or parallel, syntactocentric or based on a dynamically changing network of constraints). Maybe even the whole enterprise is out of reach at present. What is clear is that frequency is *de facto* a strong player, and that there is no way one can measure how strong it is if we aprioristically turn our attention away from very many areas of linguistic activity where it may be acting decisively. The very many areas do really complicate one's scientific search, but that is simply an inevitable consequence of the fact that the subject matter for the search in question is language. To reiterate a historical point, in the light of Tuning's scant regard for the wondrous complexity of language, one cannot but conclude that it makes little sense to speculate about language processing without a much better understanding of what is actually processed.

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