ATTACH AND ADJUST

The human sentence processing device sometimes makes errors, and when it does, it can sometimes correct them. This much is generally agreed, though opinions differ with respect to how and why the errors occur. In this paper we are concerned with the process of recovery from garden paths in sentence processing. A garden path occurs when the parser makes an error in assigning structure to the input word string but is nevertheless able to continue integrating some subsequent words into the structure that it has constructed for the sentence so far (the current partial phrase marker, or CPPM). Recognition that a garden path has occurred comes from the subsequent discovery that there is a word in the input string which does not fit into the CPPM. This word is the error signal, or symptom, that reveals the existence of the earlier error of analysis. The parser's task is to discover the nature of the problem and put it right if possible. The input may actually be ungrammatical, in which case nothing can be done. But the parser must also consider the possibility that it is the analysis that is at fault: that some aspect of the CPPM prior to the symptom is incorrect. Recovery from a garden path consists in finding an alternative analysis which fits the initial portion of the sentence and also accommodates the symptom and later words.
One way for the processor to find an alternative analysis would be to go back and try parsing the sentence again in a different manner. Another strategy would be to try altering the CPPM to resolve the incompatibility with the symptom word. In previous work (Fodor & Inoue, 1994, 1998) we have argued that the human parsing mechanism does the latter, and specifically that it tackles the problem by fitting the incompatible word into the CPPM as best it can, and then using the grammar to identify what aspect of the CPPM the new word conflicts with. Having discovered where the conflict lies, the parser changes the tree so as to resolve it. That may settle the matter, or it may create a new conflict elsewhere. If it does, the parser sets about eliminating that problem, and so on, until finally — if all goes well — it corrects the original error which sent the analysis astray. At that point the whole CPPM is in a stable state of well-formedness. The conflicting input item has been absorbed, and forward parsing can proceed again.

This parser is defined by three principles. First-pass parsing follows the principle Attach. Garden path reanalysis is governed by Attach Anyway (see also Lewis, 1993, Ch. 3) and Adjust.

1. **Attach**: On receiving a word of the input sentence, connect it to the current partial phrase marker (CPPM) for the sentence in such a way that the resulting CPPM is syntactically well-formed though possibly incomplete at its right edge.

2. **Attach Anyway**: Having established that there is no legitimate attachment site in the CPPM for the current input word, attach the input word into the CPPM wherever it least severely violates the grammar, and subject to the usual preference principles that govern Attach.

3. **Adjust**: When a grammatical conflict has been created between two nodes or features X and Y in the CPPM, by either Attach Anyway or Adjust, eliminate the problem by altering minimally (i.e., no more than is necessary for conflict resolution) whichever of X and Y was less recently acted on, without regard for grammatical conflicts thereby created between that node and other elements in the CPPM.

For discussion of various aspects of these principles not touched on here, see Fodor & Inoue (1998). We assume that in case of ambiguity in the first-pass parse, where more than one attachment site for an item exists, Attach chooses between them on the basis of the selection principle Minimal Everything. This subsumes more specific principles such as Minimal Attachment, Right Association (or Late Closure), and the Minimal Chain Principle, and represents a very general preference for 'least effort' options. We assume that the importance of minimizing effort is ultimately due to the First Analysis Constraint (Frazier & Rayner, 1988; see also Frazier & Fodor, 1978), under which the parser adopts whichever attachment of an item is computed most rapidly. This will be relevant to the discussion below. To free the general concept from the details of the Frazier & Rayner wording of it we could reformulate it as Attach Quickly:

4. **Attach Quickly**: On receiving a word of the input sentence, connect it to the CPPM as quickly as possible.

This simply records the fact that under normal circumstances the parser is under pressure to attach each input item as quickly as it can. It entails that the first attachment site that the parser detects is the one it must adopt. Attach Quickly overlaps with the statement of Attach in (1), and holds out the hope that they are
one and the same principle. We return to this point at the end of
the paper, after we have considered the relation between Attach
and Attach Anyway.

The importance of Attach Anyway, which forcibly integrates
the garden path symptom into the current analysis, is that the
conflict between the CPPM and the garden path symptom is
dependent moved into the CPPM, which is a linguistic
representation subject to grammatical principles. The grammar
can therefore do the diagnostic work of determining the nature
of the problem. Since the grammar must constantly be checking
well-formedness of the CPPM in the normal course of first-pass
parsing, this is not an additional burden. Forcing the
incompatible word into the tree is thus more parsimonious than a
revision system that first tries to alter the CPPM to provide a
legitimate attachment site before integrating the symptom. In the
latter case there would have to be some special-purpose device
that could reason about how a well-formed CPPM might be
altered in such a way that it could accommodate some arbitrary
word. The Attach Anyway system needs no additional
machinery, except for the operations which effect the tree
changes that eliminate grammatical violations: operations such
as expelling an item from its current location, stealing a
constituent from a nearby site, changing the values of syntactic
features. The empirical claim of the model is that these repair
operations carry no special penalty. They are no more effortful
than first-pass operations, and none of them is significantly more
difficult than any other, contrary to the claims of most other
models of re-analysis. We propose that only diagnosis carries
significant costs. What makes some garden paths harder to
recover from than others is that in the difficult ones, Adjust is
less successful at identifying which repairs to make.

The adjustment process defined by (3) is linguistically
sophisticated because it is guided by the grammar at every step,
balance against others. To summarize the argument we develop below: Revision in the diagnosis model begins with Attach Anyway, which is similar to first-pass Attach and naturally coalesces with it. Minimization of revision is then not an absolute rule entailed by a basic fact of parser design, but is just one of the preference principles that guide the operation of the attachment system. So minimization of revision may win or lose against some other preference, depending on what their relative strengths happen to be for a particular construction type. This explains how it is possible for there to be a general tendency to avoid revision and yet exceptions to it, too.

LOW ATTACHMENT VERSUS RALR

Attach and Attach Anyway are similar in both content and function. They differ primarily in the initial clause of Attach Anyway, which presupposes a failed search for legitimate attachments. If this is set aside, then Attach Anyway subsumes Attach. Attach makes only grammatically acceptable attachments, but a grammatically acceptable attachment is the limiting case of an attachment which "least severely violates the grammar". So the two principles could be folded together into a completely general attachment principle governing both first-pass parsing and garden path repair, as in (5):

5. Attach (Anyway): On receiving a word of the input sentence, connect it to the current partial phrase marker for the sentence wherever it least severely violates the grammar, subject to the preference principles.

There is theoretical elegance to be gained by this unification, but whether it is appropriate is at least in part an empirical matter. Suppose the two principles remain independent. Then it is natural to assume that Attach applies first and searches for fully grammatical attachments for the input word, and that Attach Anyway applies afterwards if none is found. There would be two distinct phases of computation, one making very strict use of the grammar, and then a later one operating with relaxed constraints. By contrast, for the combined Attach (Anyway), legitimate attachments would take priority not because of order of application, but by conformity to the "least severe violation" requirement. We will argue that there is empirical merit in this latter approach. Because of Attach Quickly, the parser's choice of an attachment site is determined by the outcome of a race. The integration of first- and second-pass attachment in (5) implies that there is just one race in which attachments involving revision and attachments without revision all participate. It is possible, in that case, that an attachment with revision might in some circumstances win the race. Thus the combined principle Attach (Anyway) offers a natural explanation for the fact that the parser does not always give priority to legitimate attachments.

Avoidance of revision was originally formulated as an absolute principle, the Revision as Last Resort (RALR) principle (Fodor & Frazier, 1980). This reflected the empirical generalization, which we believed at the time to be true, that the human parser does not alter structural decisions it has already made, except where it has some specific reason to conclude that they were wrong. The parser's actions at one point in the parse are normally predicated on the decisions it made at earlier points. For example, in They told the teacher that the children met in the schoolyard, the minimal attachment of the that-clause as a complement rather than a relative clause causes the verb met later on to be construed as intransitive (with reciprocal meaning). It is even possible in principle for the parser to end up with a more complex overall analysis, by obeying Minimal
Attachment along the way (though examples are not easy to find).

However, it now appears that this total ban on revision except where absolutely unavoidable was too strong. Some cases have been noted in which it seems that the parser does not obey RALR. In Inoue & Fodor (1995) we observed some shifts in Japanese from left-branching to right-branching structures for no obvious cause; the left-branching structure was well-formed, so this was not a last resort situation. Kamide & Mitchell (1997) have reported a similar effect for relative clause attachment in Japanese. We discuss these examples in sections 6 and 7. First we consider some striking new examples that have been noted in English. In these cases it appears that the tendency towards low attachment (= Late Closure, Right Association, or equivalently: local attachment to the nodes dominating immediately preceding input items) is so strong that the parser prefers to attach low and revise, rather than attach high without revision.

In example (6), there is a height-of-attachment ambiguity for the VP was biassed against.... Perceivers report a (mild) surprise that the sentence ends as soon as it does.

(6) The lawyer who believed the witness was biassed against repeat offenders.

This suggests that the VP was biassed against... is initially attaching low, as the predicate of a complement clause with the witness as its subject, rather than attaching high, with the lawyer who believed the witness as its subject. On the low attachment analysis the sentence is missing its obligatory matrix VP, so perceivers have the impression that it is incomplete. The preference for the complement clause analysis here is quite surprising, since it is generally regarded as derived by revision of an initial direct object attachment of the postverbal NP (in accord with Minimal Attachment). In the present case such revision is not forced on the parser; it is perfectly avoidable by attaching the VP was biassed against... as the predicate of the main clause. Note that the main clause VP is a predictable, obligatory constituent in a prominent tree position, so — even apart from a desire to avoid revision — it could be expected to be a highly favored attachment option. The fact that it is dispreferred suggests that the natural desirability of this attachment site is outweighed by a distaste for high attachment. For the HSPM, low attachment with revision outranks high attachment without revision, at least in this construction.

What we have observed is that the parser's (other) attachment preference principles can override RALR. Another instance of this is found in (7), where intuitive judgments indicate that the VP irritated the rest of us tends to attach inside the that-clause complement to fact, rather than as the VP of the matrix clause. This preference shows up as an expectation for an additional VP (e.g., spoiled the whole evening) at the end of (7).

(7) The fact that John didn't like the soprano and the baritone irritated the rest of us...

a. The fact that John didn't like [the soprano and the baritone] irritated the rest of us.

b. The fact that [John didn't like the soprano and the baritone irritated the rest of us]...

Note that the preferred low attachment of the irritated VP involves revision of a first-pass NP-coordination analysis as in (7a) into an IP-coordination analysis as in (7b). The parser could have retained the NP-coordination structure if it had attached the VP high. Also, just as in (6), high attachment of the VP would have had the advantage of filling in the obligatory matrix predicate without which the sentence could not be complete.
Again we can conclude that the preference for low attachment can outweigh other factors, including the avoidance of revision.

Phillips (1996) presents examples of other constructions which display this ability of low attachment to overpower RALR. This is the case in (8), at least if adding a relative clause into a noun phrase counts as revision.\(^5\)

(8) Because the conference organizers liked the caterers they hired them for the banquet in honor of the former president.

The clause beginning they hired... tends at first to attach as a relative clause modifying the caterers. Phillips' self-paced reading data confirm this relative clause preference. Elevated reading times for the pronoun them in (8) (relative to an unambiguous baseline sentence) indicate that it comes as a surprise, as it would if the parser were anticipating a relative clause 'gap' at that position. As in the previous examples, an apparently optimal alternative attachment is overlooked. There is an obligatory site in (8) for a finite clause at the matrix level, a site that the parser could anticipate well in advance, and that requires no revision; yet (until the disambiguation by them) the parser is oblivious to it.

To sum up: English offers a number of examples in which revision of the first-pass analysis is not treated by the parser as if it were a last resort option. It appears that what is paramount for the parser, at least in these contexts, is low attachment; to achieve it, the parser is prepared to undo its earlier work and re-attach prior material. We suppose (though the explanation is not central to our point here) that the low attachment preference is due to the way in which the parser searches for possible attachment sites (see Fodor & Inoue, 1998). We assume that appropriate nodes are projected upward over the input word (with any obligatory sister nodes represented also), and that the parser compares this stack of potential nodes with those along the right edge of the CPPM, looking for a match that will permit unification of the two partial structures. A preference for both low and minimal attachment is predicted on the assumption that this search for matching nonterminals starts at the bottom of the two structures. This would be for 'least effort' reasons, to minimize the number of nodes that need to be examined and to establish the shortest path linking the new input item with the previous one. That is, the hunt for an attachment site is governed by Attach Quickly, which favors Late Closure and Minimal Attachment.

**DOES RALR EXIST?**

We have suggested that Late Closure (low or local attachment, Right Association) is such a powerful tendency that it outweighs RALR. But this is plausible only if there is reason to believe that Late Closure is a powerful tendency. In fact there has been considerable discussion recently to the effect that LC is weak or nonexistent, or at least considerably more limited than early work on English suggested (e.g., Kimball, 1973). High attachment has been observed in Spanish, Italian, French, Dutch, German, Afrikaans, and possibly other languages (Cuetos & Mitchell, 1988; Frazier & Clifton, 1996; Mitchell & Brysbaert, 1998). This would seem to undermine our proposed explanation of RALR violations. If RALR is defeasible by a very weak Late Closure tendency, then RALR can't be very forceful either, in which case exceptions to RALR are of little interest. We will argue now that this is not the appropriate conclusion to draw from examples like (6) - (8).

Across all languages, only one case of ambiguity resolution by high attachment has been reported (for ambiguities involving two sites of the same category differing only with respect to their height in the CPPM).\(^7\), \(^8\) This involves attachment of a relative
clause to either a higher or a lower NP node, where the two sites are separated by one PP node, as in (9a). And this construction (9b) shows only a marginal LC bias for English as well.

(9a) Alguien disparó contra [NP la criada [pp de [np la actriz + REL CL (que estaba en el balcón)] Someone shot against the maid of the actress who was on the balcony

(9b) Someone shot [NP the servant [PP of [NP the actress + REL CL (who was on the balcony)

The high attachment bias seems to be weakened if the adjunct to be attached is a non-clausal constituent such as a PP, as in (10).

(10a) Alguien disparó contra [NP la criada [pp de [np la actriz + PP (con el pelo negro)] Someone shot against the maid of the actress with black hair

(10b) Someone shot [NP the servant [PP of [NP the actress + PP (with black hair)

Also, Igoa (1995) presents experimental data for examples like (11a), showing that a lower clause location is preferred for a PP argument in Spanish where the choice is between attachment as a VP argument in the matrix or in a relative clause. The same seems to be true of English, as in (11b).

(11a) Raúl vendió el libro que había robado a su amigo. Raúl sold the book which he had stolen to/from his friend.

(11b) John grabbed the book that he had borrowed from his friend.

The classic Right Association example from Kimball (1973) also works in both languages. The examples in (12) are globally ambiguous but the interpretation in which the adverb modifies the lower clause is strongly preferred.

(12a) Juan dijo que Bill se fue ayer. Juan said that Bill clitic left yesterday

(12b) John said Bill left yesterday.

These examples of low attachment could easily be multiplied. As indicated, they seem to obtain in Spanish as well as English, even though Spanish is one of the languages which favors high relative clause attachment to N1 in the $N_1 - P - N_2 - Rel$ construction in (9). If, as we claim, low attachment is the norm, some explanation is needed for the maverick construction (9), which not only differs across languages but also contrasts with other constructions in the same language; we return to this in section 7 below. Whether or not the explanation of the cross-construction difference that we give there is correct, we believe there is ample evidence that low attachment is indeed a powerful universal tendency for most constructions in natural language. From this we can conclude that its dominance over RALR in examples like (6) - (8) does not show that there is no reluctance at all to re-analyze. It indicates only that avoiding revision is not the HSPM's absolutely highest priority.

LOW ATTACHMENT WITHIN THE REVISION SYSTEM

Examples (10) - (12) show low attachment in normal first-pass parsing. Examples (6) - (8) show low attachment overriding a prior first-pass parsing preference. The preference for low
attachment is apparently even more pervasive than this. Sturt & Crocker (1996) have observed a preference for low attachment within the revision process itself. Their examples are shown in (13). There is a height-of-attachment ambiguity for the final VP.

(13) I know the man who believes the countess killed...
   a. I know the man who believes the countess killed herself.
   b. I know the man who believes the countess killed himself.

Both potential attachments involve revision of an NP from direct object of the preceding verb to subject of its clausal complement. (This does not constitute a revision in all models; see note 4. But we will not discuss this here.) The first-pass analysis of (13) makes the NP [the man who...] the direct object of know, and the NP the countess the direct object of believes. When killed is encountered, one of these assumptions must give way. In the preferred revision, the verb killed attaches as sister to the lower NP (the countess) rather than to the higher one (the man who believes the countess). This makes the feminine anaphor in the completion (13a) more natural than the masculine anaphor in (13b).

More kinds of examples are needed, of course. But if it holds up on further investigation, it is of considerable interest that the parser exhibits similar preferences in the Attach operation of first-pass parsing and the Attach Anyway operation that initiates revision, because it is compatible with the idea that there is no real dividing line between the two.

**DOES LOW ATTACHMENT ALWAYS DEFEAT RALR?**

Though low attachment sometimes defeats RALR, there are limits to its supremacy; it does not always win. In (14) there is a height-of-attachment ambiguity for the VP annoyed his wife, which is quite similar to the ambiguities in (6) - (8) above. But the preferred resolution of it is different.

(14) The fact that the old man shaved in bed annoyed his wife.

The VP annoyed his wife could in principle take as its subject the NP the old man shaved in bed with shaved in bed as a reduced relative modifying the old man. This is not the first-pass analysis of such a string, but would result from revision of shaved in bed from a main clause to a relative. In that case, another VP would be needed, such as was very obvious. In fact, perceivers do not feel the lack of another VP in this example. The VP annoyed his wife clearly prefers to attach at the matrix level, and the word string is analyzed without difficulty as a complete sentence. Thus in this case the parser chooses high attachment with no revision, rather than low attachment with revision, in contrast to examples like (6) - (8). What is the relevant difference between the two kinds of case? It seems likely that in (14) the revision needed for the low attachment is too difficult. It is well known that the conversion of a main clause into a reduced relative clause (as in The horse raced past the barn fell) tends to be overlooked by the parser, creating a severe garden path.

A less extreme example is (15).

(15) The bullies pushed the boy who put the candy in his mouth into the trashcan.

Compare this with (16) (based on examples in Gibson, 1991):

(16) The boy put the candy in his mouth into the trashcan.
It is clear from (16) that when necessary the parser can lower the PP in his mouth from first-pass VP attachment to within-NP attachment, in order to make place for the directional PP into the trashcan beneath the VP. In (15) this same re-analysis would permit the directional into the trashcan to attach in the lower clause. But at least for some perceivers the directional PP prefers to attach in the main clause, modifying pushed rather than put. This construction seems to sit approximately on the borderline, where the costs of revision and of high attachment balance out.

The contrast between (6) - (8) and (14), (15) indicates that only easy low-attachment revisions take precedence over revision avoidance. We know of no examples in which RALR is violated by a revision of a kind that is independently known to be difficult. It would be satisfactory to be able to claim, also, that there are no examples in which RALR is violated other than under pressure from an independently known preference principle. In the case of (6) - (8), the pressure is provided by Late Closure, a familiar instance of Minimal Everything. But there are other cases where the force that counters RALR is not so easy to recognize. We illustrate with adjunct attachment in Japanese, a left-branching language.

HIGH ATTACHMENT VERSUS RALR?

The Japanese examples that shift from a left-branching to a right-branching structure are particularly interesting because the revision can be seen as the RAISING of a constituent to a higher tree position, once that position becomes available. The change appears to be spontaneous, unmotivated by any other pressure from the attachment system. It seems, therefore, that a preference for the high attachment site is itself the driving force behind this violation of RALR. Given the framework we have developed so far, a revision can occur just in case it is MOTIVATED. Thus a raising revision in violation of RALR would be understandable if the tree revision is slight, and if the pressure to attach high is strong and exists independently of RALR violations. So now we must ask three questions. Does the revision in question genuinely constitute a raising revision? Is there any pressure in natural language toward high attachment? If so, does this pressure fall under Minimal Everything, ultimately due to Attach?

Quickly? We consider below some different answers to these questions. Though it is too early to be sure, we think there is reason to believe that high attachment is favored in some contexts by a preference for balanced tree structures in which sister constituents are of roughly equal 'weight', and that this taste for balanced phrases is due to the needs of prosodic phrasing rather than to any syntactic preference principle. But whether the Japanese examples actually involve a raising revision is debatable, as we show below.

The examples in question are all NPs consisting of an adjunct followed by a noun with genitive case marking (-no in Japanese, 's in the English examples below), followed by another noun. The input sequence is thus adjunct - N1+GEN - N2, which could in principle be assigned either a left-branching or right-branching structure. This is illustrated by (17), from Inoue & Fodor (1995). Intuitive judgments indicate that (17) is generally parsed as left-branching, unlike the examples we discuss below. The relationship between the adjective and the noun in (17) is NOT altered between the initial attachment, when only one noun has been encountered, and the final preferred structure once both noun sites are available.

(17) shinsetsuna gakusei-no imooto
     kind student-GEN (younger) sister

ON-LINE: [shinsetsuna gakusei] "kind student"
It should be noted that the less preferred right-branching analysis for (17) is also fully grammatical and acceptable in Japanese. The corresponding phrase in English, *kind student's sister*, has only the left-branching structure (meaning 'sister of the kind student') because on the right-branching analysis the adjective precedes a genitive that modifies the same noun, which the grammar of English does not allow. In English, unlike Japanese, when a genitive and an adjectival adjunct modify the same noun, the genitive must precede the adjective phrase (*a student's kind sister*). Apparent exceptions to this, such as *an empty dog's bowl*, can be shown to contain lexical noun-noun compounds: the adjective modifies the whole compound noun (*dog's bowl*) which contains an internal genitive. This grammatical difference between Japanese and English is of interest, but we cannot consider it further here.

Though this is easily overlooked, both ways of extending the initial tree for *shinsetsuna gakusei-no* can be regarded as involving some revision. The right-branching analysis alters the modification dependency established on-line between the adjunct and the first noun. The left-branching analysis leaves that intact but alters the external relations of the NP containing the adjective, if the parser is a full-attachment system which anticipates NP attachment into a clausal structure while the NP is being built (see Inoue & Fodor, 1995). On the left-branching analysis, the NP that contains *shinsetsuna* is demoted from presumed argument (e.g., subject, if sentence-initial), to being a lower genitive modifier within that argument, losing the relationship it had to the main predicate of the sentence. However, though it involves some revision, the left-branching structure has been argued to be the minimal way of revising the initial tree (see Frazier & Clifton, 1998). If this is correct, then the preference in (17) is as expected if RALR is generalized, as has been proposed, to a *Minimal Revision* principle (Frazier, 1990a; Inoue, 1991). In that case a shift to the right-branching structure would need to be motivated by some other influence on parsing.

One example in which such a shift occurs is (18) (from Inoue & Fodor, 1995, fn. 20), where the adjunct is phrasal, consisting of an adjective with a preceding adverbial modifying it.

(18) kyokutanni shinsetsuna gakusei-no imooto

*extremely kind student -GEN (younger) sister*

ON-LINE: [[kyokutanni shinsetsuna] gakusei]
"extremely kind student"

FINAL PREFERENCE (SOME SPEAKERS):

LEFT-BRANCHING

[[kyokutanni shinsetsuna] gakusei-no imooto]
"sister of extremely kind student"

FINAL PREFERENCE (SOME SPEAKERS):

RIGHT-BRANCHING

[[kyokutanni shinsetsuna] [gakusei-no imooto]]
"extremely kind sister of student"

We noted that some speakers, though not all, show a tendency to adopt the right-branching analysis on encountering the second noun. This right-branching tendency is of interest because it appears to be unprovoked by any grammatical problem in...
continuing the original analysis; both the left- and the right-branching structure are well-formed, just as for (17) above. The only difference between (17) and (18) is the complexity of the initial adjective phrase. In some way this facilitates recognition of the right-branching structure and encourages its adoption even at the cost of unnecessary revision.

Kamide & Mitchell (1997) have reported a similar tendency toward an eventual right-branching analysis for an adjunct preceding a $N1 + GEN - N2$ sequence, when the adjunct is a relative clause as in (19).

(19) Dareka-ga barukonii-ni iru joyuu-no mesitukai-o utta.
Someone-NOM balcony-LOC is actress-GEN servant-ACC shot
"Someone shot the servant of the actress who was on the balcony."

ON-LINE: [Rel. Cl + actress] (= the actress was on the balcony)

FINAL PREFERENCE: RIGHT-BRANCHING
[Rel. Cl. [joyuu-no mesitukai]] (= the servant was on the balcony)

FINAL NON-PREFERRED: LEFT-BRANCHING
[[Rel. Cl + joyuu]-no mesitukai] (= the actress was on the balcony)

In a questionnaire study, answers to questions (e.g., Who was on the balcony?) indicated that subjects most often preferred the right-branching structure. Branigan, Sturt & Matsumoto-Sturt (1996) have confirmed this questionnaire result (and extended the investigation to other modified noun-noun constructions in Japanese). Kamide & Mitchell also conducted an on-line reading task with similar materials (in which pragmatic plausibility of the two analyses was manipulated). The sentence version whose meaning required left-branching structure was easier to read at the first noun (with which the relative clause was compatible) and still at the second noun (with which the relative was not compatible), but by the sentence-final matrix verb the left-branching version was read more slowly than the right-branching version. Kamide & Mitchell interpret this as showing that Japanese parsing is non-deterministic, and imply that during the processing of the sentence the relative clause is detached from the lower noun and reattached as modifier of the higher second noun.

For examples with simple adjuncts like (17) and with phrasal adjuncts like (18), the contrast in final preference is supported by experimental data reported by Hirose, Inoue, Fodor & Bradley (1998). Though there are no comparable experimental data for the examples with clausal versus non-clausal adjuncts, intuitive judgments suggest that the eventual right-branching preference may be stronger in the relative clause examples than in the Adjective Phrase examples. Thus, any account of the right-branching tendency in these complex NP constructions should also explain this apparent dependence on the length of the adjunct: long (or heavy) adjuncts show the greatest tendency to rise to the higher site.

We now review, very briefly, three possible approaches to this phenomenon, highlighting just the major points for and against each one. We hope to present more extensive discussion and justification for these claims in future work. Our conclusion will be that in fact no raising is involved in these examples. We suggest that adjunct raising on the left is an illusion created by the low attachment of N2 on the right.
RIGHT ASSOCIATION IN A LEFT-BRANCHING LANGUAGE

Raising the adjunct
What is the reason for the instability of the [adjunct + N] structure? Why does the prenominal adjunct raise when N2 is encountered? Kamide & Mitchell (op. cit.), and Branigan et al. (op. cit.) suggest that the motivation for raising a prenominal adjunct in Japanese is the same as the motivation for high attachment of the postnominal relative clause in Spanish and other languages (except English) as in (9a) above. This account has the merit of reducing two puzzles to one, but there are some points that count against it.

High attachment of post-nominal relatives has been attributed to the Relativized Relevance principle of Frazier (1990b), or the Predicate Proximity principle of Gibson, Pearlmutter, Canseco-Gonzalez & Hickok (1996). These principles attribute high attachment tendencies to a general preference for nearness to a verb or to the sentence root; more precise details are not important here. As noted, English is an exception. These principles would seem to predict, incorrectly, a high attachment bias for a relative clause in a complex NP in English. For Predicate Proximity the reason given for low attachment in English is that this principle is parameterized and is weak in English, though strong in Spanish and other languages. For Relativized Relevance, it is proposed by Frazier & Clifton (1996) that there is a countervailing principle, Grice's Maxim of Clarity, which favors the use of unambiguous forms where possible. Since English has the form the actress' servant who was on the balcony, in which the relative clause unambiguously modifies servant, perceivers are entitled to assume that the use of the ambiguous form the servant of the actress who was on the balcony is reserved for cases where the relative modifies actress.

Languages which lack this alternation between the Saxon genitive (with 's) and the Norman genitive (with of) lack this reason for attaching the relative low, so Relativized Relevance applies unopposed. (But see Mitchell & Brysbaert, 1988, on Afrikaans, which is reported to have both genitive forms but to attach high.)

The Gricean argument, if correct, should apply equally to prenominal adjuncts. Let us for the moment adopt Frazier & Clifton's proposal that Relativized Relevance applies in all languages and is offset by the Maxim of Clarity in languages with alternative forms that are unambiguous. This predicts a preference for high adjunct attachment in Japanese, which lacks a Norman-type genitive, but a preference for low prenominal adjunct attachment in English. Prenominal adjuncts occur in English, though they are restricted to APs and other right-headed adjuncts such as rudely shouting or obviously unprepared; full relative clauses (which are left-headed) are not allowed before the noun. The 'adjunct raising phenomenon' observed in Japanese occurs also in English examples such as (20).

(20) the recently divorced bishop's daughter

ON-LINE: [[recently divorced] bishop]

FINAL PREFERENCE: RIGHT-BRANCHING
[[recently divorced] [bishop's daughter]]

FINAL LESS PREFERRED: LEFT-BRANCHING
[[recently divorced] bishop]'s daughter]

Perceivers' judgments indicate that at the point of processing bishop, it is understood that the bishop is recently divorced; but once daughter is encountered, there is a preference for the right-branching structure in which recently divorced modifies the
higher noun daughter.11 Now note that the alternative Norman genitive form the recently divorced daughter of a/the bishop is unambiguous; the adjunct can modify daughter only. Hence the Maxim of Clarity implies that the use of the ambiguous Saxon genitive form (20) should be reserved for cases where the intended meaning is that it is the bishop who is divorced; so perceivers should attribute that meaning to it. But this is not so.

This is a reason for doubting that the prenominal adjunct examples exhibit raising of the adjunct under the influence of Relativized Relevance: it predicts incorrectly that English should differ from Japanese by resisting the tendency to high attachment of prenominal adjuncts, just as it resists for postnominal adjuncts. Predicate Proximity faces an exactly comparable counterargument, but it is quicker to state. The Predicate Proximity parameter must be set to weak for English to account for (9b); but if it is, there is no explanation of high adjunct attachment in (20). The only way out would be to suppose that there are two unrelated parameters, one for prenominal and one for postnominal adjuncts. But then the explanatory content of the model is seriously weakened.12

We note that both Predicate Proximity, and Relativized Relevance with the Maxim of Clarity, could be said to make the correct prediction for short adjuncts in English. We observed in section 6 that a single-word prenominal adjunct in Japanese prefers to modify N1, and the same is true in English. For (21), many perceivers favor modification of bishop, or at least are neutral between the two analyses in contrast to (20).

(21) the divorced bishop's daughter

Thus both languages tend toward high multi-word adjuncts and low single-word adjuncts in prenominal position. The prediction of Relativized Relevance and Predicate Proximity that English adjuncts attach low is thus compatible with this example — the inability of these models to account for high attachment of the adjunct in (20) translates into apparent success in accounting for low attachment of the adjunct in (21). But of course, what this amounts to is a failure to address the influence of adjunct length at all. No assumptions about parameter settings or ambiguity avoidance could account for all the examples, long and short, in either English or Japanese. This is a further reason for doubting that height of adjunct attachment has to do with nearness to verbs or to the sentence root. These have no obvious connection with constituent length, and they offer no explanation for why length is a relevant factor.13

Finally, if the revision in (18), (19) and (20) is effected by raising the adjunct, as Kamide & Mitchell and Branigan et al. suggest, then it would appear that two raising operations are needed in an example like (22).

(22) this obviously incompetent plumber's assistant

FIRST PASS:
[this obviously incompetent plumber]

FINAL PREFERRED: Right-Branching
[this obviously incompetent [plumber's assistant]]

NON-PREFERRED: Left-Branching
[this obviously incompetent plumber]'s assistant]

As shown, this is ambiguous between a right-branching N1's N2 sequence in which the adjunct obviously incompetent applies to assistant, and a left-branching analysis in which this adjunct applies to plumber. In either case, the demonstrative determiner this is required by the grammar to apply to the same noun as the adjunct. (For example, in this obviously incompetent plumber's assistants, number agreement forces the determiner to apply to N1, and only the plumber can be understood as incompetent; in
these obviously worthless child's mittens, the plural determiner must apply to the plural N2, not the singular N1, and here only N2 can be understood as modified by the adjunct.) However, the determiner and the adjunct do not constitute a single phrase. Thus, to achieve the final preferred analysis by means of raising the left side of the structure would require the raising of two independent constituents. It could reasonably be expected that this would be more work than raising just one constituent, and yet the high attachment of the adjunct seems to occur just as spontaneously and naturally here as in (20). That is, the right-branching structure does not appear to be any harder to arrive at — or any easier to avoid — where two constituents raise than where only one does.

**Low attachment of N2**
A plausible explanation for the easiness of two-constituent examples is that the revision does not involve raising of the left part of the structure, but is due to low attachment of the right part of the structure: if N2 is attached at a height between the adjunct and N1, rather than above them both, the same eventual effect would be achieved, but without any operations on non-constituents. However many separate items there are to the left, one noun attaching low on the right would make them all appear to rise. This is diagrammed in (23b).

There is no evidence for (23a). For instance, as Kamide & Mitchell point out, the initial interpretation of the adjunct as modifying N1 could be due to step one, when only N1 is present, so it does not demonstrate the existence of the intermediate stage with N2 attached above the adjunct. Perhaps all that (23a) has to recommend it is an approximate analogy with post-nominal modifiers in right-branching languages. It has been claimed, for example, by Baccino, De Vincenzi & Job (this volume) that adjunct raising does occur in Italian and French. They interpret their findings as showing that a relative clause initially attaches (by Late Closure) to the second (lower) noun and then rises (for thematic reasons) to the higher N1 by the time of post-sentential semantic integration. However, the analogy is imperfect. In Japanese the relative clause doesn’t attach, in the technical
sense, to either noun; the relative is processed first, and the nouns are attached to it. From that perspective the two steps of (23a) have no obvious motivation.

In short, it seems likely that prenominal adjunct raising is the wrong picture. Though a (long) prenominal adjunct ends up attached high, associated with N2, it probably does not do so as a result of being detached from the lower site and reattached at the higher one. The fact that it starts low and ends high does NOT entail that it moved up. More plausibly, N2 subsequently attached lower than the adjunct.

Low N2 attachment is straightforward. It does not involve retroactive alteration of structure that is no longer at the active right edge of the tree. The explanation assumes only the usual incremental attachment of incoming items into the right edge. Also, low N2 attachment is in accord with Late Closure, so we need look no further for the pressure that encourages the parser to disrupt the relation between the adjunct and N1 by interjecting N2 into it. Examples (18) - (20) thus fall together with (6) - (8) in which it is the desire for low attachment on the right that outweighs RALR. It may seem surprising that Japanese, a "left-branching language", favors Right Association, i.e., low attachment on the right. But this is exactly what a universal model of the human parsing mechanism would predict: that the structural preference is universal even though the range of structures it applies to differs from one language to another. In very many constructions of Japanese, there is a rigid series of lexical heads leading up the right edge of the tree, which offers no opportunity for low right attachment. But as noted in Inoue & Fodor (1995), a right-headed language also contains right-branching structures when the head is phrasal and recursive, as when an adjunct modifies the head. In such constructions the grammar permits low right attachment, and the parser's preference for it becomes apparent, even in an otherwise left-branching language.

There are, however, a few thistles on this explanatory path also. First, the adjunct heaviness factor is not accounted for. It would have to be claimed that N2 attaches low only if the adjunct is fairly long. Furthermore, sentence completion preferences suggest that the 's in English and the -no in Japanese attach high, at the top of the whole [(D) + A + N1], prior to receipt of N2. If so, it must be assumed that when N2 attaches low, it pulls the genitive morpheme down, as shown in (24).

\[
\begin{array}{c}
A \\
\Rightarrow \\
\text{A N1} \\
\Rightarrow \\
\text{A N1's N2}
\end{array}
\]

This would constitute another violation of RALR. And though not out of the question, it seems a little odd to suppose that the genitive marker is content to attach high but the noun that follows has a strong need to attach low.

**Prosodic balance**

We turn now to a very different account of this collection of phenomena. Our suggestion is that a heavy adjunct likes to be high because that allows the complex NP construction to divide evenly into two parts of roughly equal weight, which is prosodically preferred. This was Inoue's hunch, reported in our earlier paper for example (18) above, and it appears to explain the data in both languages presented here. For instance, in (19) a prosodic balance principle would favor division into /barukonii-ni iru / and /joyuu-no mesitukai-o / rather than into the less balanced /barukonii-ni iru joyuu-no / and /mesitukai-o /. Similarly, in English the balanced division /the recently divorced bishop's daughter / would be preferred over /the recently divorced bishop's daughter /. With a short adjunct,
however, there are only three prosodic elements in the complex NP, and no strong preference about whether to divide them into two and one, or one and two; the former may prevail just because it entails the least revision, resulting in association of the adjunct with the lower noun. Thus the effect of adjunct weight is accounted for.

The fact that a three-element structure becomes prosodically unstable when a fourth item is added to it has been observed before. Kubozono (1993) discusses complex NPs (both lexical compounds and phrasal) in Japanese and reports that a sequence of three words whose meaning calls for a left-branching structure exhibits the prosody appropriate to that structure, but when a fourth word is added the prosodic pattern changes to that appropriate to a double binary structure [[- -][- -]], even though this runs counter to the meaning. For instance, he notes that the left-branching (25a) exhibits a prosodic contour virtually indistinguishable from that of (25b), which has a double binary syntactic structure; both show a "metrical boost" (a rise in F0) at the third item.


b. [[[aiko-no neesan-no] [uuru-no erimaki]] Aiko-GEN sister-GEN wool-GEN muffler "Aiko's sister's woollen muffler"

Kubozono attributes this departure from the expected syntax-conditioned contour for (25a) to the Rhythmic Structure Principle of Selkirk (1984). He emphasizes that the preference for even rhythms is a very general property of prosodic patterning in natural language. Note that (25a) contains a relative clause and has essentially the same structure as the NP in Kamide & Mitchell's (19) above, though unlike (19) it is semantically/pragmatically unambiguous. Our proposal is that the balanced prosodic contour is assigned by readers to both ambiguous and unambiguous instances, and that for the ambiguous ones it sways the structural preference of the syntactic parser.

The same prosodic considerations could account for the high attachment preference of a relative clause in construction (9a) in Spanish and other right-branching languages except English. It would also explain the low attachment preference for a shorter attachee such as a PP in (10) in all languages. Regardless of whether the adjunct precedes or follows the sequence of two nouns, a long adjunct will need to be balanced by the two nouns together, while a short adjunct can be balanced by a single noun as its sister. (The peculiarity of English with respect to (9b) needs some different explanation. Fodor, 1998, offers the suggestion that the relative pronoun is grouped with N2 in a single prosodic phrase, and that this precludes the high attachment motivated by prosodic balance.) For constructions where the host constituent is long and the attachee is short, such as (11) and (12), the balance is best achieved if the attachee takes only half of the host construction as its sister (e.g., only the lower clause of a two-clause construction).

The prosodic balance explanation accounts for the final preferred structure in examples (18) - (20) but is not committed to any particular means for arriving at it. So it is compatible in principle with either raising of a prenominal adjunct as in 7.1, or low attachment of the second noun as in 7.2. Of the two, low N2 attachment is more satisfactory. The only counts we have observed against it are now covered by the influence of prosodic phrasing. That is, the effect of adjunct weight is now explained, and so is the odd behavior of the genitive marker. The genitive morpheme forms a prosodic word with the word that precedes it.
Rather than assuming that it attaches high, as in the middle diagram of (24), we may assume that it attaches into the CPPM as part and parcel of the preceding word, though its syntactic and semantic scope may be broader (e.g., in *the man next door's dog*). In *the recently divorced bishop’s*, which is assigned left-branching structure, (and similarly for *kyokutanni shinsetsuna gakusei-no* in (18)), the genitive morpheme is part of the word *bishop’s*, but its scope encompasses the whole phrase built so far. But when the N2 *daughter* is encountered, as the fourth stressed word in the sequence, the sequence splits into *the recently divorced* and *bishop’s daughter*, and the genitive case is now associated only with *bishop*. Thus the low attachment of the second noun changes the scope of the genitive ’s without actually reattaching it in the tree.

In sum: There is a violation of RALR in (18) - (20), but the revision is slight, and the prosodic balance principle provides the motivation for it. Hence it fits our general theory of possible RALR violations.

**CONCLUSIONS**

Though the evidence is slender as yet, it begins to suggest two interesting conclusions: (i) that the same attachment preference principles (e.g., Late Closure or prosodic balance) govern both first- and second-pass parsing; and (ii) that when an attachment preference runs counter to RALR, the preference can win if it is strong enough. Obviously, we need to work harder on the question of how strong is strong enough. But already some implications emerge. Conclusion (i) is in keeping with the merger of Attach and Attach Anyway. It is at least a necessary condition on their being one and the same principle. And conclusion (ii) provides some positive (albeit indirect) support for the merger, in that it suggests that the avoidance of revision is just one preference factor among others. It appears that in all cases where revision occurs other than in a genuine last resort situation, it is because a powerful attachment tendency is pitted against an easy revision. It seems reasonable to surmise that RALR violations occur because there can be a trade-off for the parser between avoiding revision and conforming to its (other) preference principles.

This is exactly as would be expected from a parser governed by Attach Quickly. In the diagnosis model, a revision begins with the attachment of an input item in a way that is not compatible with the current analysis, which in most cases means an ungrammatical attachment (see note 4). Hence, avoiding revision would amount to avoiding illegal attachments. If so, RALR would amount to the principle that legitimate attachments should always take precedence over illegitimate ones. However, it is easy to see that this might not be the case. If a legitimate attachment exists but is very dispreferred, it will be slow to compute. Because of Attach Quickly, the parser may be tempted to adopt instead an attachment at a more preferred site because it is computed sooner — even if it is grammatically defective and will require Adjust to step in afterwards to patch up the problem. Revision represents extra work and to that extent would be undesirable; but we see that it may in some cases allow the parser to act more quickly than if it were to wait for a perfectly correct attachment site to present itself.

The fact that attachment-with-revision sometimes wins the race rules out the picture of two distinct processes - Attach operating to strict standards in the first pass, followed by Attach Anyway which imposes much looser standards on potential sites and applies only if Attach fails. If that were the case, RALR would be an absolute restriction on human parsing. The fact that RALR is not exceptionless indicates that there is in fact no hard and fast line between so-called first-pass and second-pass operations. (See also Stevenson, 1994, 1998.)
not lost altogether, since Adjust retains its own individuality; it is a follow-up process that occurs only after revision has been initiated by the choice of attachment. But the initiation of revision is continuous with normal forward parsing. In all cases, an item is attached at the first place in the CPPM that suggests itself. We conclude that there is just one attachment principle which governs all stages of parsing (including also, though we have not discussed it here, the re-attachment operation for any items expelled or ousted from their original positions by Adjust; see also Lewis, 1993.) It seems, then, that the combined Attach (Anyway) principle in (5) is indeed more appropriate than the separate principles (1) and (2). It instructs the parser to do the best it can in the circumstances. Attachment without revision is just one instance of that, sometimes achievable without sacrifice of other goals, but not set apart as a different mode of parsing.

SPECULATION

The considerations raised above suggest that Attach (Anyway), as formulated in (5), may overestimate the extent to which the parser even aims at making well-formed attachments. Quite possibly, all the facts can be accounted for on the assumption that the parser does not care whether attachments are grammatical or ungrammatical. This suggestion goes beyond the mere reduction of RALR violations to Minimal Everything and ultimately Attach Quickly. In previous work we have always assumed that the parser's primary goal is to obey the grammar. In the case of Adjust, this is apparently still a necessary assumption: why else would the parser undertake its conflict resolution work except to satisfy grammatical constraints? In the attachment system, however, we might suppose that economy of effort and speed of response to the input are the parser's ONLY priority. Whatever contributes to efficiency is favored. There is no parsing principle that defines fully grammatical attachment as a goal. Suppose ungrammatical attachments are generally a little slower to compute than grammatical ones, for whatever reason (e.g., because an imperfect match between the nodes projected over the input and the CPPM is harder to spot than an exact match, or because well-formed attachment routes are somehow facilitated by being generable by the grammar). Then all the phenomena above would still follow. On this assumption, ungrammatical attachments would usually arrive for consideration later than grammatical ones and would lose the race. But an ungrammatical attachment site could win the race if the speed differential due to the position or minimality of attachment gave it a sufficient headstart over its grammatical competitors. Then Adjust would be called in to reconcile the conflict in the CPPM created by this attachment. Such cases would look like 'RALR violations', but there would be no RALR — not even as a preference principle — and no violation.

If later work should support this conjecture, it would permit the coalescence of Attach (Anyway) and Attach Quickly. The two conditions at the end of the statement of Attach (Anyway) would fall out as consequences of Attach Quickly. That is: both the avoidance of grammatical violations, to the extent that it occurs, and the standard preferences for minimal structure and low attachment, would result from the pressure to work fast, as would the interactions between them that we have been concerned with in this paper. In that case, these conditions would be satisfied without needing to be explicitly stated. So the attachment system would be governed by the single, simple principle (4) Attach Quickly: On receiving a word of the input sentence, connect it to the CPPM as quickly as possible.

Whether this further simplification can be carried through depends on whether the relative timing advantages of all the various factors that can contribute to the attractiveness of an attachment can be worked out in detail so that they succeed in
predicting exactly the trade-offs that are observed to occur. We must leave much of this task for further work, and until then, this suggestion remains tentative. However, the more specific proposal that revision-avoidance, though indeed a desideratum for the parser, can be outweighed by its other fundamental inclinations, is an empirical hypothesis which can be tested and refined, by seeking out cases of apparently spontaneous revision and looking to see whether they contain, after all, some sufficient motivation for the parser's meddling with the existing CPPM. Our proposal here has been that prosodic phrasing may provide such motivation even when purely syntactic structural preferences do not.

NOTES

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1 In Frazier & Rayner's (1988, p.263) wording: "First Analysis Constraint: At choice points the processor adopts the first syntactic analysis available (specifically the analysis that follows from Minimal Attachment, Late Closure and the Most Recent Filler Strategy) rather than pursuing multiple syntactic analyses or delaying analysis of the input". The simpler wording in (4) separates the general principle (of taking the first analysis computed) from particular strategies (such as the Most Recent Filler Strategy).

2 A more recent extension of RALR is the Minimal Revisions Principle of Frazier (1990a); see also the Minimal Revision Principle of Inoue (1991). These become relevant in section 6 below.

3 Though we will often refer to LOW attachment in this paper, we believe the correct formulation is in terms of LOCAL attachment. There is clearly no tendency, for example, for the parser to sacrifice Minimal Attachment by attaching a word very low at the bottom of a long downward chain of left-branching nodes (e.g., to attach a sentence-initial John's very low in English, or to attach the second word of Taro-ga shinsetsuna ("Taro-NOM kind") as the beginning of an object complement clause in Japanese).

4 It should be noted that this does not constitute revision in all models, e.g., description-theoretic models (Marcus, Hindle & Fleck, 1983; Gorrell, 1995) in which domination statements can be freely added to the current description of the CPPM. Clearly, RALR differs in its scope depending on what counts as a revision. When RALR was first proposed, some subtle distinctions concerning revision processes had not yet been drawn, so its intended scope is not certain. In our current model there are two potential definitions of what constitutes revision for purposes of RALR: (a) if an item is attached into the CPPM in such a way that it alters some existing grammatical dependency, or (b) if an item is attached into the CPPM in such a way that it creates an illicit grammatical dependency which Adjust must then modify. In principle there could be an attachment that is a case of (a) but not (b). In fact we know of no really clear instances of this. (In particular, the revision in (6) from direct object NP to subject of a complement clause (a) alters the dependency between the NP and the preceding verb, and (b) also creates ungrammaticalities of argument selection and case assignment which must then be adjusted.) For present purposes it is not important which definition is assumed.

5 See Frazier & Clifton (1998) for a somewhat similar idea. They propose a trade-off between their Minimal Revisions Principle and a Visibility Principle which generally favors low attachment (replacing Late Closure in their theory).

6 Phillips does not discuss RALR in connection with examples like (8), but attributes the parser's choice to a competition between low attachment and minimal attachment. If (8) does involve revision, this would mean that low attachment is strong enough here to defeat the combined force of RALR and MA.

7 Frazier & Fodor (1978) noted that high attachment in accord with Minimal Attachment wins over low attachment in constructions like John carried the books for Susan where both are quite local. See Clifton, Speer & Abney (1991) for more recent discussion and experimental data for English, and Igoa (1995) for related data for Spanish. In this case, however, the two potential sites differ in category and other properties, not just in their height in the CPPM. We will not discuss such examples here.
According to the Construal model of Frazier & Clifton (1996), adjuncts are not attached into the tree but are associated with a thematic domain. But this distinction will not be relevant to our discussion.

Though in general, greater heaviness of the adjunct seems roughly correlated with a greater tendency for it to modify the higher noun, it may be that a relative clause shows more resistance to reinterpretation than an equally heavy AP does, because of reluctance to tamper with the binding relation between the relative clause 'gap' (empty category) and the head noun (or its associated operator). More empirical data are needed before further claims can be made concerning the relative strengths of these various factors.

We assume that heaviness, in the relevant sense, is a function of both length and grammatical category (e.g., a clause is heavier than a phrase even if they contain the same number of words). But this distinction is not central to our argument, and we will refer freely to either length or heaviness in what follows.

We emphasize that the English examples contain N's N lexical compounds. This does not greatly alter the argument we make here, however.

This argument presumes that other parsing preferences in the system favor a low prenominal adjunct, and that a high adjunct could only be due to Predicate Proximity. But we are hesitant about the premise here. The analogue to Late Closure in Gibson et al.'s model is called Recency. It is clear that for an \(N1 - N2 - \text{adjunct} \) sequence Recency favors right-branching, i.e., a low adjunct. But it is not clear what it implies for an \( \text{adjunct} - N1 - N2 \) sequence. If parsing is left-to-right, then the nouns are attached to the adjunct rather than vice versa. We discuss this way of looking at the prenominal adjunct construction below.

There is a possible grammatical explanation for the adjunct length effect in Japanese. The sequence \( \text{adjunct} + N1 [+\text{GEN}] \) modifying the same following \(N2\) is probably not base-generated but derived by transformational preposing of the adjunct. This movement (like extraposition in English) is less acceptable for a short adjunct than for a long (heavy) one. Thus for a short adjunct, attachment to \(N2\) would be less acceptable than attachment to \(N1\). This explanation of the length facts would be compatible with the Relativized Relevance and Predicate Proximity approaches (given a background preference for \(N2\) attachment). However, it does not apply to English examples like (20) and (21).

The data reported by Kamide & Mitchell (op. cit.) show the shift to high attachment occurring only two constituents later than \(N2\). However, in the data of Hirose et al. (1998), there was significant high attachment (relative to a baseline condition) at the \(N2\) position. This is consistent with direct low attachment of \(N2\) as in (23b).

REFERENCES


Frazier, L. (1990b) Parsing modifiers: Special purpose routines in the human sentence processing mechanism? In D. A. Balota, G. B. Flores d'Arcais
and K. Rayner (eds.) *Comprehension processes in reading*. Erlbaum, Hillsdale, NJ.


