

JAPANESE SCRAMBLING AND THE DYNAMICS OF ON-LINE PROCESSING

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This paper shows how with syntax defined as the progressive projection of semantic representations along the left-right dimension provided by the sequence of words, natural explanations can be provided for local and nonlocal scrambling of NPs in Japanese which follow from general principles of tree growth, explaining their different interaction with quantified NPs while nevertheless retaining an integrated account of scrambling itself. This formalism has many similarities with the parsing mechanism of Miyamoto 2002, but goes further in using such mechanisms as the base grammar formalism. In place of concepts of movement, concepts of structural underspecification representing partial semantic representations are invoked, with growth of such structure within a derivation following the time-linear dynamics of parsing. Two syntactic puzzles are addressed, the Proper Binding Constraint effect and multiple long-distance dependency with its attendant relative locality restriction on the constituents moved. These are both shown to follow as immediate consequences of general dynamics of the Dynamic Syntax framework in which grammar is defined as reflecting the dynamics of on-line processing (Kempson et al 2001, Cann et al 2005).

1. THE CHALLENGE OF JAPANESE SCRAMBLING

Rigidly verb-final languages such as Japanese¹, with freedom of NP ordering on the one hand yet rigidity of verb placement on the other, pose a challenge for understanding the relationship between grammars and parsing mechanisms, since they appear to require a much greater distance between grammar and parser systems than is required by other languages. The problem is that there is unambiguous evidence of the incrementality of language processing in Japanese, both from parsing and from production, just as in other languages, despite the final placement of the verb. Arguments to this effect have taken various forms (Kamide and Mitchell 1999, Ferreira and Yoshita 2003, Aoshima et al 2004, Inoue and Fodor 1995, Miyamoto 2002, Fong 2004). However, given the final positioning of the verb, this would seem to necessitate attributing greater complexity to the parse system for grammars of these languages, with parse mechanisms able to induce structure by operations over and above those provided by the grammar formalism. Amongst the most detailed recent psycholinguistic parser specification for

¹ This paper has evolved over a number of years. We thank Ronnie Cann for regular support in developing ideas, Wilfried Meyer-Viol for high standards of formal rigour, Hiroto Hoshi for sharpening the first author's understanding of current scrambling issues and the relevance of the DS analyses to these, Akiko Kurosawa and Masayuki Otsuka for early discussions, Eleni Gregoromichelaki, Justin Charity, Takashi Iida, Yo Sato and Aiko Yamanaki for comments and ongoing discussion during the preparation of the revised version of this paper. There are many more whose comments have helped to tighten the account; yet none can be blamed for the final result.

Japanese is by Miyamoto 2002, who argues for a parsing mechanism that involves a number of devices that enable incremental construction of structure: (i) construction of underspecified tree relations in building up a parse, (ii) constructive use of case to induce structural relations in a tree, and (iii) indication by case markers of higher phrasal boundaries, in particular by the subject marker *-ga*. Such devices as these enable detailed projections of structure to be made well before parsing the verb, but, given standard assumptions, it follows that, for some languages at least, there may be a very indirect correspondence between language processor and grammar formalism, with parsing mechanisms dictated solely by the form of the language, hence varying from language to language. Reflecting this increasing separation of grammar and parse mechanisms, development of grammar processors and development of the grammar formalisms themselves have not in general gone hand in hand (though see Phillips 1996, Aoshima et al 2004).

This might seem to be no more than the familiar competence/performance discrepancy, with languages varying as to the tightness of fit between grammar and parser. This would be a problematic assumption in itself, since it would suggest that some grammar-parser pairings are more efficient than others. This would be surprising, particularly since approximately half the world's known languages are verb-final. But the permutability of constituents in a sentence string displayed by scrambling raises problems for the grammar formalism itself. For minimalist assumptions in particular, scrambling constitutes a challenge, for movement processes (or their copy and delete analogue) are driven by morphological features (Chomsky 1995), but the variable ordering of NPs in verb-final languages is signally not indicated by any morphological property; and it is not obviously driven by a single interpretation-based feature either. So debates continue as to whether scrambling is a form of A' or A movement, or neither (Miyagawa 2003, 2005, 2006). To address these problems on a grammar-internal basis, syntactic characterisations of Japanese scrambling have been developing within minimalism without making reference to parsing-related research, increasing the emphasis on phase by phase bottom up projection, leaving on one side first D-structure (Saito 1992, Boškovič and Takahashi 1998), then S-structure (Miyagawa 1997, Saito 2003, Hayashishita 2004), and finally also LF (Saito 2004), with all structure and pairing of interpretation argued to be phase by phase, allowing covert and overt movement operations to interact (Saito 2004). The problematic consequence is that the intuition that interpretation from some left-placed position involves movement back into some argument position becomes simply inexpressible, because there is no longer any level of LF at which quantifier dependencies and their correspondence or not with linear order can be expressed². Faced with this accumulation of problems, there has been a

² The LF lowering of Boškovič and Takahashi is set aside, and with LF Lowering and Radical Reconstruction being argued in Miyagawa 2006 to be non-distinct, Radical Reconstruction equally becomes problematic.

move to narrow the remit of explanation for the competence grammar formalism. In consequence, such a grammar doesn't merely not correspond to properties of parsing: it doesn't reflect the full range of constituent permutability either. Hayashishita, for example, has argued that quantification construal which does not conform to order-sensitive projection of quantifier scoping is to be captured only by some as yet unspecified pragmatic theory (Hayashishita 2004), in which pragmatic processes are assigned the task of articulating constraints meeting complex structural conditions.³ Yet such a move is far from unproblematic, for no extant pragmatic theory addresses problems in terms appropriate to such an account (Sperber and Wilson 1995, Asher and Lascarides 2002, Cappelen and Lepore 2005). Such methodological decisions thus indicate the challenge which scrambling data continue to raise.

In this paper, we respond to this challenge by arguing that a grammar formalism which directly reflects the dynamics of on-line processing, namely Dynamic Syntax (DS: Kempson et al 2001, Cann et al 2005), provides a more explanatory basis for characterising the phenomenon of scrambling, in that it enables a number of syntactic puzzles associated with scrambling to be resolved while setting out a program involving a much narrower divide between competence and performance than has been hitherto envisaged. The framework proposed has many similarities to the parser system advocated by Miyamoto (2002). The central assumption is, however, that concepts of underspecification and update are taken to be part of the syntactic mechanism and not merely a property of some semantic or pragmatic sub-system, or of an attendant, independently defined parser. Syntax just is the progressive construction of tree representations of content on a left-to-right basis.

In this paper we take up three problem areas of Japanese syntax/semantics-quantifier-construal and word order variation, long-distance dislocation apparently necessitating the so-called Proper Binding Condition, and multiple long-distance scrambling. What we will show is that, by incorporating the dynamics of how interpretation is built up, all these puzzles are resolved, with quantifier construal requiring only minor lexical stipulation, specifically for indefinites, and both the Proper Binding Condition and constraints on multiple long-distance scrambling emerging as immediate consequences of the system. And, bringing these results together, we predict parallelism of construal of local scrambling and paired NP expressions in multiple long-distance dependency constructions, a novel result.⁴

1.1. Scrambling: The Point of Departure

The problem posed by Japanese scrambling is not merely the apparent free permutability of the sequences of noun phrases that occur before the rigidly ordered final verb complex (as in (1)-

³ Saito 2004 appears to concur with this methodology in so far as he sets aside non-canonical construal of existentially quantified subjects and quantified NPs that are internal to the following VP.

⁴ This paper is part of a bigger project developing an account of scrambling in both Japanese and Korean, but this paper focusses on Japanese alone.

(3)), but the fact that this extends in a more restricted way to cross-clausal dependencies as in (4)-(5):⁵

- (1) zyaanarisuto-ga supai-ni syorui-o watasita
 the journalist_{NOM} the spy_{DAT} the document_{ACC} handed.
 ‘The journalist handed the document to the spy.’
- (2) syorui-o zyaanarisuto-ga supai-ni watasita
 the document_{ACC} the journalist_{NOM} the spy_{DAT} handed.
 ‘The journalist handed the document to the spy.’
- (3) supai-ni syorui-o zyaanarisuto-ga watasita
 the spy_{DAT} the document_{ACC} the-journalist_{NOM} handed.
 ‘The journalist handed the document to the spy.’
- (4) syorui-o keisatu-ga zyaanarisuto-ga yonda to koohyoo-sita
 the document_{ACC} the police_{NOM} the journalist_{NOM} read *COMP* reported
 ‘The document, the police reported that the journalist had read.’
- (5) syorui-o supai-ni keisatu-ga zyaanarisuto-ga watasita to
 the document_{ACC} the spy_{DAT} the police_{NOM} the journalist_{NOM} handed *COMP*
 koohyoo-sita
 reported
 The police reported that the journalist had handed the document to the spy.’

(4) shows there may be at least one long-distant dependent term construed from a left-periphery position, (5) that there may be more than one such NP. Moreover whenever there is more than one such NP, these are subject to a stringent additional restriction: they have to be construed as local to each other, despite being an arbitrary distance away from any verb which can provide the head to which either of them is argument. Non-locality of the dependency would seem to impose the necessity of positing independent processes correlating each such expression with the site of its construal; but this would leave the enforced locality relative to each other which these expressions invariably display quite unexplained. None of the orthodox frameworks can provide a satisfactory explanation of this restriction. In an attempt to capture this locality, in minimalist analyses, paired expressions such as *syorui o supai ni* in (5) have been analysed by the stipulation of either vacuous verb movement to ensure the creation of a constituent

⁵ Noun phrases may follow the main verb colloquially, but there is reason to treat all such cases as ellipsis (Sells 1999), and we ignore them here. Throughout, we shall follow common convention among Japanese linguists and avoid use of *wa* unless essential. (4)-(5), in particular, are notably more acceptable if the matrix subject *keisatu-ga* is replaced by the topic-marked *keisatu-wa*, a phenomenon which we believe to be not insignificant, but in this paper, we follow common practice.

containing only the two NPs, or of analysing one expression as an adjunct to the other (Koizumi 2000, Takano 2002). Neither analysis is unproblematic, the first because vacuous verb movement is a stipulation contrary to minimalist assumptions, the latter because there is no independent reason to analyse either one of the expressions as adjunct to the other. Within LFG, the concept of inside-out functional uncertainty should provide a mechanism for describing the facts (as in the constructive use of case in Warlbiri: Nordlinger 1998), but, in order to achieve any such effect, this has to be lexically triggered. With multiple long-distance scrambling, however, there is no such lexical trigger, and hence no means of securing the relative locality of the two argument expressions. Categorical formalisms might seem the most promising formalism for addressing these data given the nonstandard assumptions made about constituency, but multiple long-distance scrambling as in (5) is problematic there too. The pair of NPs at the left periphery can certainly themselves be identified as a constituent using CCG tools (either by type-raising or multi-set typing: Baldrige 2002). However the presence of the immediately following subject prevents this created constituent from combining with some appropriately typed verb. As a result, the only way to yield a well-formed derivation for (5) is for the two verbs to combine together. But if so, the result is a multi-set composed of four arguments with only stipulation distinguishing which arguments go with which verbs (Steedman and Baldrige 2003).⁶

There is an additional unresolved puzzle within the various minimalist responses to the challenge that scrambling poses. This is the so-called “Proper Binding Condition” problem (Saito 1992). The restriction, put in movement terms, is that once an expression is moved out of a constituent, that constituent itself becomes frozen, and cannot itself be moved:

- (6) [**Hanako-ga t_i iru to*]_{*j*} Souru-nii Taroo-ga *t_j omotteiru*
 [*Hanako_{NOM} be that*]_{*j*} Seoul-in Taroo_{NOM} think
 [*That Hanako is t_i*]_{*j*} in Seouli Taroo thinks *t_j*
- (7) Hanako-ga Souru-ni iru to Taroo-ga omotteiru
 Hanako_{NOM} Seoul_{LOC} be that Taroo_{NOM} thinks
 Hanako is in Seoul, Taroo thinks.

In its original formulation (Saito 1992), this was an s-structure condition, but with the abandonment of s-structure, this constraint becomes much less natural to state, and every reformulation in the face of counterexamples is little more than a statement of the description of the problem as set out above (Müller 1996, Saito 2003, Grewendorf 2003).

⁶ The categorial account of Steedman and Baldrige faces particular semantic problems, as it is unclear what corresponding semantic lambda-term could distribute this n-tuple across appropriate argument slots in a single step of application, given that functional application is defined to apply to just one argument (see Kiaer 2007 for discussion).

Then there are semantic problems. First there are problems specific to subjects. With object-subject order there is agreement of ambiguity irrespective of choice of quantifying expression, as in (8):

- (8) hotondo-no ta-o areka-ga tatta
 most_{GEN} song_{ACC} someone_{NOM} sang
 ‘Most of the songs, someone sang’ (ambiguous: indefinite narrow/wide scope)

But with subject-object ordering however, there appears to be much less flexibility, with the additional complication that individual quantifiers impose additional restrictions. A canonical ordering of subject object verb appears to be ambiguous if the object expression is a pure indefinite (such as *dareka* (= ‘someone’)), but not if it is the subject expression that is a pure indefinite and the object expression uncontroversibly quantificational (Tada 1990, Saito 1992):

- (9) daremo-ga dareka-o aisiteiru
 everyone_{NOM} someone_{ACC} loves
 ‘Everyone loves someone.’
- (10) dareka-ga hotondo-no uta-o utatta
 someone_{NOM} most_{GEN} song_{ACC} sang
 ‘Someone sang most of the songs’ (unambiguous)

However there is sensitivity to pragmatic effects, as (11) is ambiguous, with both an interpretation reflecting linear order and one departing from it, the availability of the inverse interpretation clearly triggered by contingent information about the circumstances described precluding the interpretation matching linear order:⁷

- (11) kangohu-ga subete-no kanzya-o monsin-sita
 nurse_{NOM} every_{GEN} patient_{ACC} interview-did
 ‘A nurse interviewed every patient.’

Secondly, bringing long-distance dependency considerations into the picture, there is interaction between quantifier construal, construal of anaphoric expressions (definite NPs and pronouns) and long- vs. short-distance dependency binding. If a quantifying expression precedes an anaphoric expression in a non-canonical ordering within a simple clause, then that quantifier may be construed as binding the anaphoric expression. However, for the very same

⁷ There is the extra complication that, like other languages with widespread use of a bare noun to project quantificational construal, use of bare nouns at the left periphery is characteristically used to indicate dependence on context for interpretation, hence a definiteness effect. However, as (11) shows, this too is a pragmatic effect that can be over-ridden, and we leave it on one side here.

sequence of words, if the quantifying expression is part of a long-distance scrambling structure, a bound-variable interpretation of the subject on that preceding quantifying expression is apparently precluded (Saito 2003, 2004):⁸

- (12) dono hon-ni-mo hon-no tyosya-ga syomei-sita
 Every book_{GEN} that book's author_{NOM} autographed
 Every book_i that book's_i author autographed
 (indexical interpretation also available)

- (13) dono hon-ni-mo hon-no tyosya-ga Hiroto-ga syomei-sita to tta
 every book_{DAT} that book's author_{NOM} Hiroto_{NOM} autographed COMP said
 'That book_i's author said that Hiroto autographed every book_j.' (unambiguous)

This distribution suggests asymmetry between short and long-distance dependency scrambling forms of construal.

Finally, there is the puzzle that in multiple long-distance scrambling the paired NPs are subject to the same form of construal as in short-distance scrambling, apparently reinstating a parallelism with short-distance scrambling. The data can be displayed with pairs of direct and indirect object NPs. First, if the singular indefinite follows a quantified expression in such a pair, both narrow and wide scope construal for the indefinite relative to that other quantifier expression are freely available:

- (14) san-nin-no supai-ni syorui-o zyaanarisuto-wa watasita
 three spy_{DAT} document_{ACC} journalist_{TOP} handed
 The journalist handed the three spies a document
 The journalist handed a document to the three spies

If in such a pair the singular indefinite precedes the quantified expression, then though there is a preference for interpretations that follow linear order, this is easily set aside where contingent information dictates the plausibility of one interpretation over another. So though the preferred interpretation of (15) is that one document is handed over to a group of three spies, (16) and (17) equally allow interpretations in which the indefinite *mise-no pasupooto-o* either is or is not dependent on the numerically quantified *san-ni-no supai-ni*, in virtue of what is presumed about spies and their illegal activities:

⁸ The judgements provided by Saito 2003, 2004 for (13) are '?*' for an interpretation construing the demonstrative NP as dependent on the quantifying expression, but whether or not this is a categorical judgement, the judgement of sharp asymmetry between the availability of a quantifier-bound interpretation for (12) and for (13) is ^{robust} and widely agreed. In this connection, there are data from Ueyama 1998 largely involving *wh*-expressions, on the basis of which she argued for apparent invariant licence of quantifier binding as long as the binder precedes the dependent term, but we believe there is reason not to expect parallelism between *wh* expressions and other quantifiers, and in any case the critical examples for the Ueyama account involve D-linked *wh*-questions, which have familiar, if poorly understood, name-like properties.

(15) syorui-o san-nin-no supai-ni zyaanarisuto-wa watasita
 document_{ACC} three spy_{DAT} journalist_{TOP} handed
 The journalist handed one document to three spies

(16) nise-no pasupooto-o san-nin-no supai-ni CIA-wa watasita
 forged passport_{ACC} three spy_{DAT} CIA_{TOP} handed
 The CIA handed a forged passport to three spies

(17) san-nin-no supai-ni nise-no pasupooto-o CIA-wa watasita
 three spy_{DAT} forged passport_{ACC} CIA_{TOP} handed
 The CIA handed three spies a forged passport each.

So there are asymmetries in scope-variation potential across different arguments.

When we turn to multiple long-distance dependency structures, this relative availability of interpretations replicates itself. Whatever flexibility or not there may be with pairs of left-placed non-subject NPs in simple clauses carries over directly to multiple long-distance dependency structure. So, just as there is a preferred interpretation of just one spy in (15), so there is in (18):

(18) syorui-o san-nin-no supai-ni keisatu-wa zyaanarisuto-ga watasita-to
 document_{ACC} three-CLASS spy_{DAT} police_{TOP} journalist_{NOM} handed-COMP
koohyoo-sita
 reported

The police said that three spies had handed just one document to the journalist.

And when this preference for linear order is over-ridden, as in (16) so in (19), it is also the reverse form of interpretation which is the preferred interpretation:

(19) nise-no pasupooto-o san-nin-no supai-nikeisatu-wa CIA-ga
 forged passport_{ACC} three_{CLASS,GEN} spy_{DAT} police_{TOP} CIA_{NOM}
 watasita-to koohyoo-sita
 handed-COMP reported

The police reported that the journalist handed a forged passport to each of three spies.

This parallelism between relative scope dependencies expressible in local scrambling and multiple long-distance scrambling sequences extends across all such pairs, with both (20) and (21), and (22)-(23) having, as preferred interpretations, a wide scope construal of the indefinite relative to the accompanying quantified expression *gakusei-hitori-hitori-ni*:

(20) ronbun-o gakusei-hitori-hitori-ni sensei-wa setumei-sita
 article_{ACC} student-every_{DAT} professor_{TOP} explain-past
 ‘An article to every student the professor explained.

- (21) ronbun-o gakusei-hitori-hitori-ni sensei-wa zyosyu-ga
 article_{ACC} student-every_{DAT} professor_{TOP} assistant_{NOM}
 setumei-suru-beki-da to kangaeta
 explain-pres-modal-copula COMP think-past
 ‘An article to every student the professor thought the assistant should explain’.
- (22) dono ronbun-o gakusei-hitori-hitori-ni sensei-wa setumei-sita-ka
 which article_{ACC} student-every_{DAT} professor_{TOP} explain-past-Q
 ‘Which article to every student did the professor explain?’
- (23) dono ronbun-o gakusei-hitori-hitori-ni sensei-wa zyosyu-ga
 which article_{ACC} student-every_{DAT} professor_{TOP} assistant_{NOM}
 setumei-suru-beki-da to kangaeta-ka
 explain-pres-modal-copula COMP think-past-Q
 ‘Which article to every student did the professor think the assistant should explain?’

These facts are puzzling for minimalist accounts in particular, since long-distance and short-distance effects are handled by quite different mechanisms, providing no basis for anticipating parallelism between construal of expressions undergoing multiple long-distance dependency and local scrambling effects.

In this paper, we take up this challenge and show how these puzzles can be solved by adopting a perspective in which grammar formalisms induce structures to reflect the way in which semantic interpretation for a natural language sentence is built up in parsing.⁹

2. SYNTAX AS A PARSING MECHANISM: THE CASE OF JAPANESE

The Dynamic Syntax model (DS) which we use as the framework for this analysis is radical in being a grammar formalism that reflects the step-wise way in which interpretation is built up during a parse sequence (Kempson et al 2001). In this, it has many attributes in common with Miyamoto 2002; but these attributes, in particular constructive use of case, and structural concepts of underspecification - are not taken merely as tools that a parsing implementation of Japanese grammar might employ (unlike a corresponding parsing mechanism for non-verb-final languages), but as part of the underlying dynamics of natural-language syntax itself, universally available.

The process of both setting out and building up interpretation for a string is defined as a serial, monotonic process of tree growth following the order of words in a string, where the tree

⁹ With scrambling having received a great deal of attention over the years, the literature now includes a large amount of data, and there is an impressive number of alternative attempts to characterise scrambling relative to minimalist assumptions. See Karimi (ed.) 2003 for a representative set of views and Cann et al chapter 6 for a DS account of the interaction of quantifier binding and anaphora construal in Japanese scrambling.

under development is a structured representation of the interpretation established. To yield such structures, general tree-growth procedures interact with idiosyncratic growth procedures dictated by the words, all determining a progressive build up of structure until a fixed (in part, contextually established) interpretation is constructed. Nodes may be introduced identified only by a weak ‘dominated-by’ relation, and so not immediately assigned a fixed position in the emergent tree. Establishing where in the emergent tree such a node is to get fixed is part of the construction process, with information about such a node getting passed down the tree until the site at which its relation can be taken as definitively fixed: this constitutes a major basis for non-contiguous dependencies. As a device that reflects the dynamics of parsing, there may be several such routes, but, as a grammar formalism, no attempt is made to define a selection mechanism for determining how actual choices might get made within such a construction process.¹⁰ A sentence is defined to be well-formed just in case there is at least one possible route through that process which yields a semantic representation as output.

Interpretation in this framework is accordingly a tree structure which is semantically transparent with each node being decorated not with words but with a simple or complex concept: a propositional formula decorates the top node, and the various sub-terms of that formula decorate the nodes it dominates. Individual nodes are decorated with *Formula* (*Fo*), *Type* (*Ty*) values, and a *treenode* (*Tn*) label, reflecting semantic content in terms of expressions of the epsilon calculus, a matter we return to: for example, the *Fo* decoration in (24) includes the expression $\epsilon, x, Syorui'(x)$, which is the term-equivalent of an existentially quantified formula. As schematized in the two trees shown in (24), individual steps of the parser progressively develop a tree from one with just a single root-node decorated with $?Ty(t)$ indicating the requirement (the assigned goal) of establishing a formula of type t , to a final binary branching tree with all nodes decorated with formula values (see the two trees in (24): the trees do not reflect linear order; by convention, the functor node is always on the right).¹¹

¹⁰ Given the commitment to monotonicity of individual tree-transition sequences, a model of disambiguation would have to be one of eliminating alternative possible routes of interpretation, rather than a hypothesis-and-revise system (see Phillips 1996, Aoshima et al 2004). Psycholinguistic evidence favours the DS account (as demonstrated for Korean by Kiaer 2005, Kiaer and Kempson 2006a,b), as the DS mechanisms correspond very directly to the incremental dynamics of how online decisions are made. Contrarily, the unforced fix-and-revise account of incrementality of Phillips 1996 fails to apply to long-distance scrambling, there being no fixed structure available until the final verb is parsed.

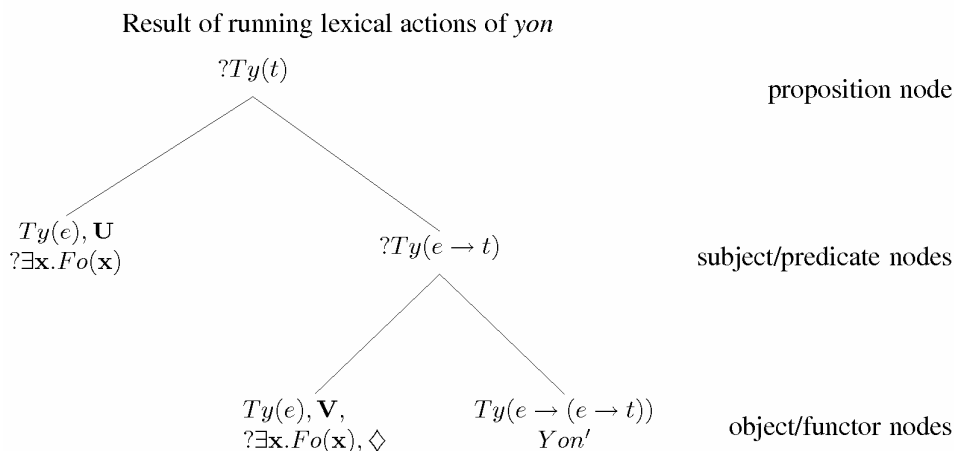
¹¹ The pointer, \diamond , indicates the node under development: $Tn(0)$ is the rootnode. Kempson et al 2001 define a predicate *Fo* for ‘Formula’ which takes expressions of the calculus as its argument. On these trees, we suppress these unless essential, for simplicity. We also largely leave tense on one side in this paper (see Shirai 2004 for a DS account of tense in Japanese).

individual steps of tree growth; and procedures are defined for step-wise building up of such structures either by computational actions or by lexical or even pragmatic actions. All are defined in the same vocabulary, a set of context-relative actions for updating representations of interpretation. Such formal tree languages by definition provide characterisations of such structural relations as dominate; and in LOFT, along with other formal tree languages (see e.g. Rogers 1994), the concept of dominate is defined in the following terms: a node can be described as dominated by a node $Tn(a)$ when $\langle \uparrow_* \rangle Tn(a)$ holds at that node, that is when the node identified as $Tn(a)$ is along some sequence of mother relations from the present node. Such structural relations will play an important part in what follows, but we start the more detailed characterisations with sample lexical specifications.

2.1. Lexical Specifications

As in other frameworks, verbs are the major projector of structure, for which actions are defined that induce some, or even all, of the propositional template they express. In Japanese, a full pro-drop language, verbs project full propositional structure, with individual argument nodes decorated with placeholders that stand for some value to be assigned either from context or from the construction process. Such place-holders are represented as metavariables of the form \mathbf{U} , \mathbf{V} , .. of type e .¹²

(25) Result of running lexical actions of *yon*



The effect is that verbs have a lexical specification inducing a sequence of actions which might equivalently be expressed by discrete words. The decoration of argument nodes with a metavariable, for example, is the intrinsic property of pronouns, underspecification with respect to content being their hallmark. Whether from a parsed pronoun, or from decorations intrinsic to

¹² Lexical tree updates are ensured by actions in an “ <IF,THEN,ELSE> ” format, in which the condition presents a specified trigger for an encapsulated macro of actions for making and decorating nodes of the subtree to be induced. We ignore all such details in this paper (see Cann et al 2005).

the verb, all such placing-holding devices must be provided with an assigned value (notice the requirement for a fixed value $\exists x.Fo(x)$); and different types of anaphoric expression can be defined according to the different constraints on that process which they impose. Reflexives have to be updated within a given locally defined propositional structure, pronouns outside such locally defined structure, and so on (see section 2.2.1, where a tree-theoretic concept of locality is adopted). Metavariables projected as part of the intrinsic specification of the verb, on the other hand, lack any such restriction, and can be defined either locally or from some more general context. The account is accordingly one of intrinsic lexical underspecification, with update to these metavariables, either from context or from the partial tree under construction, as a step of pragmatic substitution.¹³ However, though external to the grammar formalism itself, this substitution process must interact with grammar-internal processes to ensure compositionality of content as defined over the resulting tree, for successful decoration of each non-terminal node, by definition, depends on having had all requirements on its daughters satisfied.

It might seem that such a system cannot provide a representation that is transparent with respect to content because of quantification: the level from which to express syntactic generalisations across all noun phrases is very generally presumed not to coincide with that needed to express scopal dependencies for quantifying expressions.¹⁴ However, in the epsilon calculus, quantified expressions are treated as name-like, with all the force of quantification expressed as part of the evaluation of the constructed quantifying terms, a matter we return to shortly (section 2.2).¹⁵ So names and quantifying expressions are all assigned actions that introduce a term of type *e*. In a language such as Japanese, with determiners being optional, nouns are defined as projecting the necessary conceptual structure to yield a composite type *e*

¹³ Particular choice of value for such variables involves general cognitive constraints such as relevance (Sperber and Wilson 1995). The supposed evidence from sloppy and strict construals of Japanese ellipsis that NP-ellipsis in Japanese is ambiguous between an invisible pronoun and phrasal ellipsis analysis rather than underspecified (Abe 2006, Takahashi 2005) is accounted for by analysing context as n-tuples of word, structure, and actions: strict interpretations of pronouns and ellipsis pick up on context-provided content as values for the assigned meta-variable, sloppy interpretations on context-provided actions. See Purver et al 2006, Cann et al forthcoming for arguments that with this dynamic concept of context, unlike all other accounts, an integrated account of ellipsis becomes possible, in which parallelism effects are predicted rather than assumed as a primitive filter on possible interpretations (see Fox 2000, Dalrymple et al 1991, and many others).

¹⁴ This has led either to the invocation of covert movement mapping the syntactic string onto some level of LF representation (May 1985 and many others following), or to the recognition of semantic operations independent of syntax involving type-lifting and an associated quantifier storage mechanism (Cooper 1980, Partee and Rooth 1982 and many others since).

¹⁵ The epsilon calculus is the formal study of the arbitrary names used in predicate logic calculus natural-deduction proofs, in which all quantifiers are replaced by names with side-conditions controlling their use. These side conditions reflect the various scope dependencies within an individual formula, and such dependencies are reflected in the terms themselves. The epsilon calculus thus provides terms denoting witness sets which natural language expressions can then be seen to denote.

term (like verbs projecting considerably more structure than is morphologically made explicit). The internal structure of such terms involves three parts: a binder, for example the epsilon operator ϵ analogous to the existential quantifier, a variable that it binds, and a restrictor of that variable, such as *Syorui* (‘document’), which in the bare noun case is simple, but which may be arbitrarily complex:

$$\epsilon, x, \textit{Syorui}(x)$$

These lexical specifications of Japanese nouns illustrate what is a general property of lexical specifications, for a mere noun in Japanese is projecting information more commonly associated with a determiner-noun sequence: what any one word may contribute to interpretation is considerably more than just the provision of some suitable logical expression.

In general, words are taken to provide meta-linguistic instructions about the progressive setting out of structure, along with the conceptual Formula value that they provide for a node decoration, all expressed in the same tree-growth vocabulary as general structure-building operations. Indeed, some words may provide little more than such instructions; and this is a characteristic property of affixes. Final-placed affixes have a critical role to play in in verb-final languages, since they signal phrasal constituent edges in the build-up of interpretation. Japanese verbal suffix *-ta*, for example, takes as trigger a completed propositional formula of type t , with no requirements, to which a propositional operator denoting past time is added. Such a specification is no more than a transparent reflection of *-ta*’s contribution to the semantic composition of the whole. However, its effect is to signal the end of the entire sequence of steps associated with the interpretation process associated with the verb to which it is suffixed. This is because the triggering condition for the update which it provides is a completed formula of propositional type; and this can only be satisfied if all aspects of interpretation needed to provide that formula have been resolved.¹⁶ This account notably requires the tense suffix to be processed last, and we derive verb-final ordering as a consequence.

This property of signalling the completion of structure for the word to which it is suffixed isn’t just an idiosyncrasy of the suffix *-ta*. To the contrary, it is a defining property of inflectional suffixes of languages such as Japanese which are systematically head-final. Thus case particles play a similar role, over and above their basic function. This basic function is to constrain the relative hierarchical position in the tree. For example the object-marking suffix, *-o*, indicates that its mother node must be a predicate: i.e. it is defined as imposing a requirement $? \langle \uparrow_0 \rangle Ty(e \rightarrow t)$. This serves as a constraint on tree growth: the mother of such a node has to be assigned a predicate value at some point in the construction process. But in addition to this, as the last morpheme in any subtask decorating a node with a type e term, they indicate that

¹⁶ This commitment to all aspects of predicate-argument structure being identified either contextually provided or from the construction process differentiates this system from categorial grammars, where with interpretation defined over a morphological string, verbs have to be multiply defined according to the number of morphologically realised arguments, leading to multiple type homonymy (Baldrige 2002).

this task is complete. Formally, that is, by requiring some completed type e term as the triggering condition for the update that they induce, they have the effect of closing off further modification of the internal structure of that term. In this way both terms and propositions are incrementally built up as driven by the suffixing particles.

2.2. Quantifier Scope

It might seem that this project of incrementally building up structure really can't be sustained without separating syntactic and semantic vocabulary because of the problem of capturing scope dependencies between quantified expressions: this aspect of interpretation just does need globally provided information. But this turns out to be unproblematic. Because the system adopted for expressing such formulae is the epsilon calculus, scope is not represented on the tree itself but in terms of scope constraints, which are collected as they are made available and only implemented as part of a final step of evaluation of the tree once the parse process is completed. These take the form $x < y$ indicating that some introduced term binding variable x has scope over a discrete term binding y (see Kempson et al 2001 chapter 7 for formal details). This provides a basis for expressing idiosyncratic constraints on scope evaluation which words may impose: for example, indefinites, which have well-known wide-scoping specificity effects. These are taken to project a statement of scope dependency in which the first argument of their scope relation is a metavariable, $U < y$ for some scopal term binding a variable y : what this reflects is that the choice of dependency for an indefinite is pragmatically driven (analogous to the way in which interpretation of pronouns is resolved in context).¹⁷ This characterisation of the flexibility of scope dependency for indefinites correctly anticipates that indefinites can be construed as dependent on any term already constructed in the interpretation process (eg from a previously parsed quantifying expression). It also provides a natural basis for both the prevailing cross-linguistic tendency for indefinites to the left of some subsequent quantified expression to be interpreted independently (15), and for choice of scope dependency for the indefinite following another quantified expression invariably allowing but not enforcing dependency on that preceding expression, as in (8), (9) and (14). Because this choice is made on a pragmatic basis, we also expect that where such linearity considerations conflict with contingent knowledge of the situation described threatening to yield an inconsistent interpretation, they can be set aside, as in (16) and (19).¹⁸ Indeed, even in subject-object

¹⁷ Idiosyncratic scopal properties of individual determiners are inexpressible in a generalised quantifier system. In systems and frameworks advocating covert movement, idiosyncratic scopal properties of expressions can only be expressed through homonymy, with one of the expressions being a quantifier expression, the other not (see for example Szabolcsi 1997). See Kempson et al 2001, Kempson and Meyer-Viol 2004, for arguments to the contrary demonstrating close parallelism between indefinite construal and pronoun construal establishing interpretation via some other term introduced in the interpretation process.

¹⁸ This flexibility of indefinites also underpins, we suggest, the ambiguity of double-object mixed quantification sentences discussed in Sauerland and Elbourne 2002: they observe that initial indefinite accusative-marked NPs

sequences, where the subject-marking property of *-ga* forces immediate identification of a fixed subject relation, as we shall see, such inverted interpretations are possible if relevant contingent knowledge renders the canonical interpretations implausible, as already seen in (11) repeated below as (26), which, like its English congener, allows an inverted scope interpretation:

- (26) kangohu-ga subete-no kanzya-o monsin-sita
 nurse_{NOM} every_{GEN} patient_{ACC} interview-did
 ‘A nurse interviewed every patient.’

The restricted availability of this form of interpretation arises naturally in the DS account, because there are two points at which the place-holding metavariable associated with the subject expression can be identified. In (26), for example, the first point is when the expression *kangohu-ga* is parsed and an initial term with attendant scope constraint set up -i.e. at a relatively early step in the parse process, given the order of the expressions. However, there is a second point; and this is when the sister predicate value is completed and whatever aspects of underspecification had been left open in the construal of that indefinite subject have to be resolved in order for subject and predicate values to combine to yield a properly compositional interpretation of the whole. At this late stage when the interpretation of the subject expression and then the entire proposition is finally being established, there may have been additional quantified terms added to the accumulating set of scope statements during the build up of interpretation of the predicate. So, as a result, a broader range of choices will have become available on which to establish the dependency of the indefinite than was available at the earlier stage when the subject expression was first parsed.

This strategy of interpretation is analogous to the construal of (subject) expletive pronouns whose interpretation has to be established before the final propositional formula can be compiled, with development of the subject node after the construction of the attendant predicate:

- (27) It’s likely that I’m wrong.

This is argued in Cann et al 2005 to be the basis of the Right Roof Constraint (see Cann et al 2005, Kempson et al 2006); and it is notable that both expletive pronouns and inverted construal of indefinites are subject to the same tight locality constraint.¹⁹

freely license inverted construal, but initial indefinite dative-marked NPs do not, at least for some speakers. In the cited cases, there is the problem of two additional complexities. that dative expressions are systematically ambiguous between being a predicate adjunct and third argument, and that with human denoting NPs, there is a widely observed but poorly understood increased tendency to follow linear order, so that a dative-marked initial indefinite that is human-denoting is generally construed as independent of whatever term follows. Given that not all speakers agree with the reported distribution, we have not included them.

¹⁹ A similar style of explanation might apply to the pragmatic constraint observed by Hayashishita 2004. Hayashishita argues that there are freezing effects in scrambling for a sequence of three NPs in inversion cases in Japanese, with the subject having to take narrower scope dependency than any intervening VP-internal

Overall then, despite the variability of the data, general assumptions of the framework mean that such inverted interpretations are expected if the first is an indefinite, yet predicted to be dispreferred. So we have a principled basis for anticipating flexibility of interpretation for indefinites; and as we shall now see, there are independent structural reasons for anticipating that linear order considerations do not always prevail.

2.3. Structural Underspecification

So far in this exegesis of Dynamic Syntax, the primary focus has been on lexical specifications, but the system of interpretation is far from being exclusively lexicon-driven. There are general computational actions which reflect principles of semantic tree growth that the system licenses, their intrinsic incremental dynamism being the major distinguishing feature of the proposed formalism. The informal observation which the analysis seeks to reflect is that expressions parsed early on in the interpretation process may fail to fully determine the role that they are to play in the overall interpretation, this becoming available later on in the parse process (at the site familiarly known as ‘the gap’). The formal reflection of this is to have actions defined that license the construction of tree relations that are not fully determined, being an underspecified tree relation which has an associated requirement for update to be satisfied during the ensuing construction process. Unlike the parsing analysis proposed for Japanese by Miyamoto, or more generally the D-tree grammar formalisms (Marcus 1980), where the concept of an underspecified tree relation is used to define a parser that is itself defined with reference to some application-neutral grammar formalism articulating only complete trees, the partial trees constructed by the DS formalism are part of the grammar specification. For example, long-distance dependency effects are expressed by the construction of a node in some newly initiated logical structure to be developed downwards from a top type-*t*-requiring node specified only as dominated by that top node, its position within the unfolding tree being otherwise unfixed at this point in the construal process. As indicated earlier, such nodes are annotated as $\langle \downarrow^* \rangle Tn(a)$. This is formally identical to the LFG concept of functional uncertainty (see Kaplan and Zaenen 1988), but unlike that notion, in the present framework, because syntactic trees are expressed in the

quantifying expression, should the object be construed as taking widest scope:

| | | | | | | |
|-----|-----------------------|----------------------|----------------|----------------|--------------------|----------------|
| | Sanninizyoo-no | kyoozu-ga | rei-no | hutari-no | gakusei-o | hutatu-no |
| (i) | Three-more <i>GEN</i> | Professor <i>NOM</i> | the <i>GEN</i> | two <i>GEN</i> | student <i>ACC</i> | two <i>GEN</i> |
| | kaisya-ni | suisensiteita | | | | |
| | company <i>DAT</i> | recommended | | | | |

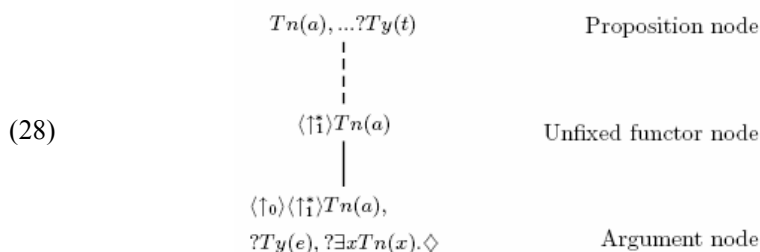
On the account of indefinite expressions in subject position suggested here, this is to be expected, demonstrating that if the scope of the subject expression is not established in a way that reflects linear order, then the only natural subsequent point for doing so is once an interpretation for the whole predicate has been established. Unfortunately, however, it is not clear that these data are robust: the intuitions of all our informants consistently failed to match those recorded by Hayashishita, most of them indeed finding the supposedly precluded interpretation the most natural.

same terms as representations of interpretation, all such underspecification can be defined to be associated with an update as part of the construction of interpretation. This analysis will provide a second basis for expecting delay in scope-dependency assignments, as we shall see.

2.3.1. Locality Variation in Structural Under-Specification

In extending concepts of underspecification to the articulation of structure, it is natural to consider stretching the analogue between the concept of semantic and structural underspecification yet further. Accordingly, we extend the articulation of different locality restrictions on the update process from anaphora resolution, where it is familiar as the Binding Principles, to structural processes of tree growth, articulating restrictions analogous to these (Cann et al 2005 where this is justified in detail). We define one type of structural underspecification which requires update within a single propositional domain (so-called Local*Adjunction); another which requires update with an individual tree (reflecting strong island constraints, so-called *Adjunction),²⁰ and a third which requires update but only relative to a sequence of trees (generalised adjunction). All such weak domination relations are associated with an attendant requirement that a fixed tree relation be provided as part of the construction process (expressed as $\exists x.Tn(x)$).

The process of Local*Adjunction applies to a type- t -requiring node. It licenses the introduction of an argument node and an underspecified functor relation, in effect a restriction on update within a given local scope domain:²¹



What the rule induces is one fixed argument daughter node immediately dominated by a node whose relation to the node of introduction is an underspecified relation across functor relations, $\langle \uparrow_* \rangle$ - in effect the functor spine along which argument nodes can be constructed. The node introduced by this macro of actions has a requirement for an argument term (of type e), a description of its tree relation to the point of departure, and a requirement for a fixed value. As

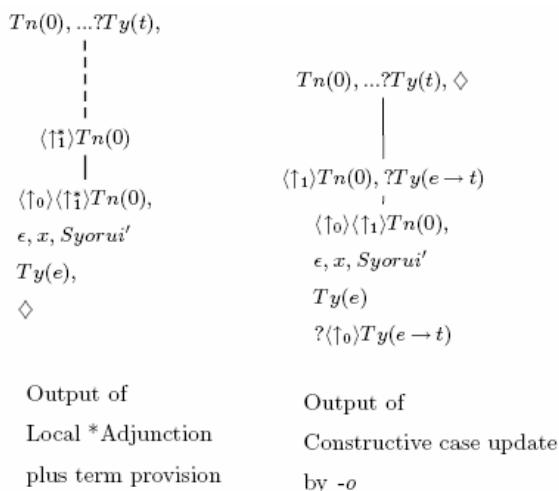
²⁰ Relative clause construal, adjunct clause construal, and coordinate structures, are all defined to involve the projection of independent “linked” structures that get compiled into the overall representation having initially been defined as separate trees.

²¹ All rules are here specified solely in terms of their tree update, for simplicity. Unfixed nodes are distinguished in the diagrams as indicated by a thickened dashed line for a locally unfixed node requiring update within an individual propositional structure, a regular dashed line for an unfixed node to be updated within a single emergent tree, and a dotted line for radically unfixed relations only requiring update within some global set of trees.

far introduced case as a filter on tree growth (e.g. accusative as requiring a predicate-node as mother). Because such specifications take the form of a requirement, they might not be satisfied until substantially later in the construction process -in effect, a filter on output.

However, case can play a constructive role, and this is very simple to implement in this system, being merely an update of the specific structural relation immediately upon decoration of the node in question in anticipation of the relative tree position dictated by the output filter, with the effect that structure may be built up progressively before the verb is processed. For example in (29), the information provided by the case marker *-o* can apply to some type-*e* node which has been introduced by Local *Adjunction to have the effect of updating the unfixed predicate relation with a fixed predicate relation, providing immediately the tree nodes with which to instantiate the relevant output filter:

- (31) *syorui o zyaanarisuto ga yonda*
 the-document_{ACC} a journalist_{NOM} read
 The journalist read the document.



Furthermore, once this tree position is identified, we expect scope constraints to be set up directly, giving rise to the familiar preference for scope dependencies to follow the order in which the NPs occur (even in cases such as indefinites where there is flexibility and potential for delay).

It is this use of case which provides the second point of comparison with Miyamoto 2002 (though Miyamoto only considers *-ga* marking in any detail). In each case, because this step is an enrichment of an underspecified 'locally-dominated' relation, the pointer returns to the locally dominating type-*t*-requiring node, allowing the process to take place all over again. This form of update means that the NPs themselves can be processed in any order, since each one will introduce the particular substructure needed for its own output, and the actions of the

verb can then serve to complete the requisite structure.²² There is no reflex of order on the resulting tree, so no matter what order the NP argument expressions occur in, the same result will obtain. With case in Japanese seen as in principle playing both a filtering and constructive role, it is straightforward to reflect the stringent idiosyncratic effect of subject marking in Japanese.²³ Seen from a parsing perspective, we can define *-ga* as having only a constructive case mechanism: the fixing of the structural relation is immediate, and the alternative of merely imposing a relatively weak output filter is not available. The effect is that *-ga* invariably identifies a boundary edge for a local propositional domain wherever it occurs in an NP sequence. Accordingly, we define it as imposing such an edge, taking as input a node introduced by either application of *Adjunction or Local*Adjunction (note that the input condition is simpler than for the construction subcase of *-o*, applying to any node which is unfixed and yielding a fixed subject relation):²⁴

(32) (31) *-ga*:

$$\begin{array}{ccc}
 Tn(a), ?Ty(t) & & Tn(a), ?Ty(t) \\
 | & & | \\
 \langle \uparrow_* \rangle Tn(a), & \rightsquigarrow & \langle \uparrow_0 \rangle Tn(a), \\
 ?\exists x Tn(x) & & ?Ty(\epsilon), \diamond \\
 ?Ty(\epsilon), \diamond & &
 \end{array}$$

Hence its boundary-marking effect in all processing sequences. This boundary-marking role will not be available to the other case-marking suffixes, since the dual function of other case specifications ensures that they will not themselves provide a deterministic parsing clue for

²² The fact that the verb's actions include explicit introduction of tree relations is harmless, as this otiose introduction of the same relations will collapse with any nodes already introduced and decorated, the argument decorations provided by the verb being invariably that of a metavariable, by definition compatible with fixed values that may have already been established through parsing of prior explicit NP expressions.

²³ In movement terms *-ga* marked NPs cannot be long-distance moved, a restriction which does not carry over to Korean. So, unlike Japanese, Korean subject marking is not exceptional.

²⁴ A putative counter-example to this account is when a left-peripheral *-ga* marked NP is interpreted as a subordinate subject immediately followed by a matrix subject marked with the topic-marker *-wa*, making it appear that the *-ga*-marked expression should be taken to modify an unfixed node that is resolved into a subordinate structure by the same mechanism as other case-marked NPs:

(i) Saito-*ga* Chomsky-*wa* totemo-*ii* riron-*o* motteiru to omotteiru
 Saito_{NOM} Chomsky_{TOP} very good theory_{ACC} has *COMP* thinks
 'Chomsky thinks that Saito has a very good theory.'

However, with an analysis of *-wa* marked expression as decorating an independent so-called 'linked' structure (see Cann et al 2005), the interrupted sequence of *Saito-ga totemo ii riron-o motteiru* can be analysed as projecting a local array of arguments plus predicate at the appropriate level of embedding, an analysis confirmed by the obligatory construal of a dative-marked NP adjacent to the topic-marked NP as within the embedded structure. If the *ga* marked expression were able to decorate an unfixed node, ambiguity of the dative construal would be expected, since, on that account, the dative-marked expression could be analysed as part of the matrix structure.

identifying a propositional constituent boundary.

This coordination of Local*Adjunction with constructive use of case reflects an intrinsic design property of the framework as imposed by the LOFT logic on which it depends. In all trees, nodes are identified by their relation to other nodes in the tree by definition, each with a unique set of such relations. This is uncontroversial for fixed tree-node relations, a node in a tree simply is uniquely defined in terms of its relation to other nodes; but it holds equally of nodes introduced by the weaker ‘dominate’ relation. There is an important consequence: there can be only one tree node relation of a type at a time in any process of tree growth (notice that this is satisfied in the sequence of partial trees constituting a derivation for any locally scrambled set of NPs). This is not a principle that has to be independently stipulated: in principle two nodes can be introduced as satisfying some tree relation, but in all such cases, the two nodes will collapse. It is therefore essential for the successful applicability of Local*Adjunction as the basis of local free constituent ordering that there be some independent process which provides the update needed to allow its subsequent re-application. Hence the essential correlation between free intra-clausal permutation of NPs and constructive use of case.

2.5. Complement clause construal and the Proper Binding Condition

As we shall now show, the constraint described as the Proper Binding Condition emerges as an automatic consequence of the role of suffixes in ensuring progressive compilation of interpretation:

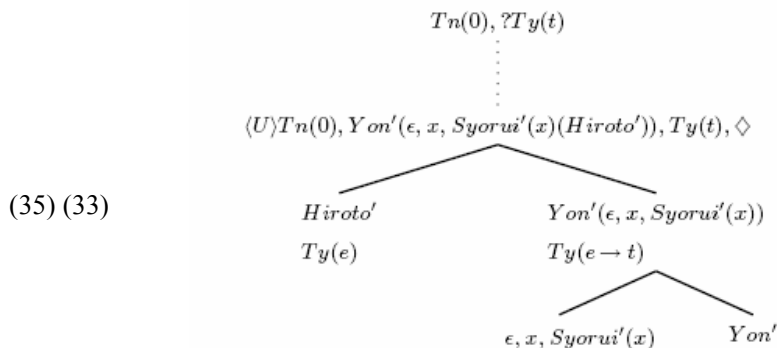
- (33) [*Hanako-ga t_i iru to] $_j$ Souru-nii Taroo-ga t_j omotteiru
 [Hanako_{NOM} be that] $_j$ Seoul-in Taroo_{NOM} think
 [That Hanako is t_i] $_j$ in Seouli Taroo thinks t_j

Following the general pattern of inflectional suffixation, the suffixed complementiser *-to* is defined as indicating the completion of the formula of propositional type, the end of whose construction it signals. This is formally reflected by imposing as condition on its update, the condition of having some completed propositional formula as input, with no subsequent revision to allow incorporation of the locative being possible. To see this effect in detail, we need to see how the construal of a simple clausal sequence is incorporated at some arbitrary level of embedding:

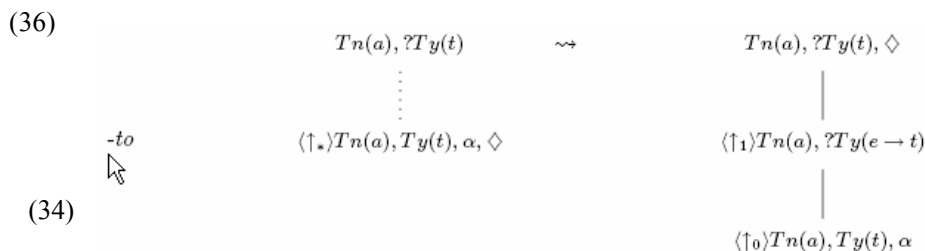
- (34) Hiroto-ga syorui-o yonda to itta
 Hiroto_{SUBJ} the document_{OBJ} read COMP said
 ‘Hiroto said he read the document’

As we saw earlier, Generalised Adjunction is a very general mechanism for initiating one structure from another of the same type requirement, with no indication of level of embedding of that introduced new node. With this now presumed as a possible first initial step from the assigned goal, the sequence of actions for projecting some simple propositional structure in

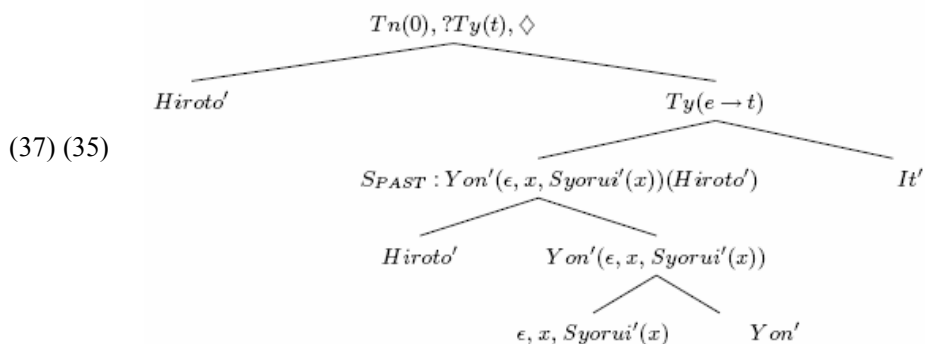
parsing a subordinate sequence can be seen as otherwise identical to that of processing an independent simple clausal sequence (suppressing the scope statement of the complement structure):



-*To* has then (in standard Japanese, where it is obligatory) to be defined to determine the nesting of the propositional structure. This can be done in one of two ways, either by making use of structure already induced and returning the pointer there, or by adding a further intermediate node locally dominating the node just completed:



For present purposes, the primary significance of these actions is that, following the regular pattern of suffixes, the condition necessary for either of the two licensed updates given by *-to* is that the node be decorated with a completed type *t*. The effect of this condition is to ensure the prior decoration of all non-terminal nodes which that node dominates (including nodes for which there are no explicit natural-language expressions). What *-to* then imposes is obligatory local subordination. The result of carrying out these actions is that some subsequent verb can project its actions, in (31) this being the verb *itta* for which the propositional template already constructed from the parsed string *Hiroto ga syorui o yonda* provides its object argument:



Finally, in the parse of (31), the subject argument can be identified anaphorically as Hiroto', to yield (as before, suppressing tense):²⁵

$$(38) \quad It'(Yon'(\epsilon, x, Syorui'(x)(Hiroto'))(Hiroto'))$$

This narrated sequence of actions may seem little more than a tutorial demonstration of a DS derivation; but there is more to it than this, for the Proper Binding Condition effect emerges as an immediate consequence. On the Dynamic Syntax account, there is simply no question of any sequence of operations licensing (6) repeated below as (39):

$$(39) \quad [*Hanako-ga \ t_i \quad iru \quad to]_j \quad Souru-nii \quad Taroo-ga \ t_j \quad omotteiru$$

$$\quad [Hanako_{NOM} \quad be \quad that]_j \quad Seoul-in \quad Taroo_{NOM} \quad think$$

$$\quad [That \ Hanako \ is \ t_i]_j \quad in \ Seoul \ Taroo \ thinks \ t_j$$

The parsing of the sequence ending with -to in (6)/(39) has to have been construed as a completed propositional formula in order to license the update provided by -to, so would have to have the argument of *iru* provided in context. Parsing *Souru-ni* following the parsing of *to* as modifying the embedded structure is precluded. There is no going back of the pointer: once that structure is completed, the only possibility would be to construe *Souru-ni* as a dative argument to *omotteiru* but this is independently excluded. In (7) repeated below as (40), by way of contrast, the full sequence of expressions needed to interpret the clausal sequence ending with -to allows a propositional structure to be routinely completed, and this then serves as the internal argument of *omotteiru* -all exactly as expected:

$$(40) \quad Hanako-ga \quad Souru-ni \quad iru \quad to \quad Taroo-ga \quad omotteiru$$

$$\quad Hanako_{NOM} \quad Seoul_{LOC} \quad be \quad that \quad Taroo_{NOM} \quad thinks$$

$$\quad Hanako \ is \ in \ Seoul, \ Taroo \ thinks.$$

For similar reasons, the occurrence of a dative-marked NP following -to, as in (41), must be interpreted relative to the matrix subject, and not within the subordinate structure:

$$(41) \quad zyaanarisuto-ga \quad syorui-o \quad yonda \ to \ keisatu-ni \quad supai-ga$$

²⁵ The anaphoric identification of the subject term as *Hiroto'* in this derivation is in virtue of the presence of the term in the partial representation already constructed and not some analogue to any c-command relation. This sequence of steps, though a natural means of interpretation since locally incremental, is by no means the only possible basis for interpreting (31). As a parsing-based formalism, the existence of such alternatives for a single output interpretation is expected: there is no commitment to uniqueness of derivational history for a given pairing of string and logical form.

the journalist_{NOM} the document_{ACC} yonda *COMP* the police_{DAT} the
 spy_{NOM}
 itta
 said

The spy said to the police that the journalist read the document.
 ≠ The spy said that the journalist read the document to the police.

As with other Proper Binding Condition examples, this result is not predicted by movement accounts. To the contrary, (41) ought on the face of it to allow an interpretation in which the dative-marked *keisatu-ni* is understood as an argument in the subordinate structure, since in movement accounts there is a possible sequence of movement steps first moving the dative NP from the complement clause to left-adjoin to the containing structure followed by a second extraction step moving the complement structure itself from its subordinate position to a left-adjoined one.

3. LONG-DISTANCE SCRAMBLING

Despite the faithful way in which the account so far reflects linear processing, the whole account might appear to be jeopardised by reconstruction effects showing that the interpretation of a left-peripheral expression may, and in some cases must, be in some sense delayed (as in (13) repeated below as (42)) :

(42) dono hon-ni-mo hon-no tyosya-ga Hiroto-ga syomei-sita to tta
 every book_{DAT} that book's author_{NOM} Hiroto_{NOM} autographed *COMP* said
 'That book_i's author said that Hiroto autographed every book_j.' (unambiguous)

Indeed, these phenomena and analogous data containing anaphoric expressions in the left periphery are taken as evidence that no linearity story of quantifier and anaphora construal is possible (see Mahajan 1997, and others). Given the perspective of tree growth, however, such a conclusion needs to be reconsidered.²⁶

Long-distance dependency phenomena constitute the canonical case for which the DS formalism defined the construction of a node with no fixed tree relation but only a relatively weak domination relation, as in (4) repeated below:

(43) syorui-o keisatu-ga zyaanarisuto-ga yonda to koohyoo-sita
 the document_{ACC} the police_{NOM} the journalist_{NOM} read *COMP* reported
 'The document, the police reported that the journalist had read.'

A left-peripheral NP is interpreted as decorating an initially introduced unfixed node, with the construction process licensed to proceed from there to continue the unfolding of emergent

²⁶ The data concerning *zibunzisin* are systematically reported to us by informants as being less clear than is indicated in the literature (Saito 2003), so we leave all consideration of anaphors on one side. See Cann et al 2005 chapter 7 for an account of *zibunzisin* that reflects data as reported in Saito 2003.

structure from the dominating node.²⁷ Such emergent structure is provided by verbs, with attendant argument nodes providing candidates for unifying with the unfixed node. Once some candidate node is identified, the two nodes can be unified. Here is where case as an output filter plays a role, as it imposes the requirement that the fixed argument node must match whatever positional requirement may be imposed by the unfixed node's case specification; and all case specifications which allow a case-marked expression at the left periphery to be associated with some subordinate structural position across a matrix-construed subject expression are defined as having such a function. Unlike the constructive role of case, whenever the case specification serves merely as a constraint on update, e.g. of the form $\langle \uparrow_0 \rangle Ty(e \rightarrow t)$ for accusative, there will have to be some other action inducing the necessary node before the update action to satisfy the case requirement can take place. Hence the implementation of case-update filters in conjunction with the processing of a verb.

3.1. Cross-clausal quantifier construal

This account of long-distance scrambling gives rise to the following expectation. Any outstanding requirements for update on that earlier unfixed node that need a fixed tree position before they can be resolved will not be able to be resolved until the requisite fixed tree-node position has been identified. Assignment of scope dependency is one of these. The assignment of relative scope dependency for a term decorating a node introduced by *Adjunction will only take place once the tree update fixing that position has taken place. In (13) repeated below the quantifying expression *dono honi-ni-mo* is first taken to decorate an unfixed node; and this node position has then to be fixed before the scopal property making it a complete quantifying term can be determined:

- (44) *dono hon-ni-mo hon-no tyosya-ga Hiroto-ga syomei-sita to tta*
 every book_{DAT} that book's author_{NOM} Hiroto_{NOM} autographed COMP said
 'That book_i's author said that Hiroto autographed every book_j.' (unambiguous)

However, the interpretation of the immediately subsequent *hon-no tyosya-ga* as matrix subject will be fixed rightaway in the processing of the suffix *-ga* because of the constructive use of case, so its containing anaphoric expression will also get fixed before the scopal property of the quantifying expression that would make it viable as an antecedent can be determined. So *sono hon-no* in (13)/(44) is interpreted indexically.²⁸ Hence the cross-clausal reconstruction effects of (13) associated with quantifier construal for some left-peripheral quantified expression.

This analysis provides a basis for explaining the asymmetries between short and long-distance scrambling environments in their licensing of scope construal for quantifying expressions. In

²⁷ Pointer movement is licensed back along any node relation which is unfixed to the dominating node.

²⁸ As noted in footnote 7, 20, there is some disagreement over data in this area, in particular in connection with *wh* expressions.

individual clausal sequences (where NPs occur in any order), such an underspecified tree-relation for each node of a type *e* requirement will be introduced as unfixed but will be updated as soon as its decoration is complete, with the result, as we've seen, that assignment of scopal dependence for a quantifying expression takes place incrementally. There is a stronger result where the subject expression is initial, as the underspecified unfixed node which it decorates will always be updated immediately (ensured by the processing of *-ga*, which encodes this action directly). In such a case, we expect that unless there is reason to over-ride the reliance on linear order in which the words are presented, a possibility in any case only available with indefinite expressions, construal of quantifying expressions will follow linear order, yielding the already noted judgement of (10) repeated below as unambiguous:

- (45) dareka-ga hotondo-no uta-o utatta
 someone_{NOM} most_{GEN} song_{ACC} sang
 'Someone sang most of the songs' (unambiguous)

However, where an expression with any case-marking other than subject-marking is initial, both Local*Adjunction and *Adjunction strategies will be available, and with the first of these operations licensing IMMEDIATE fixing of the node constructed, and the second, conversely, licensing DELAY in fixing the node constructed, both interpretations are expected to be available. And so we get the much freer availability of inverted and non-inverted interpretations with object-subject ordering in local scrambling as in (12) and (8) repeated below respectively:

- (46) dono hon-ni-mo hon-no tyosya-ga syomei-sita
 Every book_{GEN} that book's author_{NOM} autographed
 Every book_i that book's_i author autographed
 (indexical interpretation also available)

- (47) hotondo-no ta-o areka-ga tatta
 most_{GEN} song_{ACC} someone_{NOM} sang
 'Most of the songs, someone sang' (ambiguous: indefinite narrow/wide scope)

We also derive the asymmetry between long-and short-scrambling modes of construal for an identical sequence of expressions, as in (12)-(13) (the latter repeated below):

- (48) dono hon-ni-mo hon-no tyosya-ga Hiroto-ga syomei-sita to tta
 every book_{DAT} that book's author_{NOM} Hiroto_{NOM} autographed *COMP* said
 'That book_i's author said that Hiroto autographed every book_j.' (unambiguous)

Only (12)/(46) will allow the treenode position for the initial dative-marked NP to be fixed incrementally (through Local*Adjunction and constructive use of case): as a result of this tree position getting fixed, the scope of the initially projected quantifying term can be determined; and once this determined, its variable becomes available as an antecedent, to be

chosen as the value of *sono hon*. Local*Adjunction can't be used for the construal of (13), because it would lead to the precluded interpretation of *dono hon-ni-mo* ('every book_{DAT} ') as indirect object of *itta* ('said'). So the only strategy is initial use of *Adjunction, and this leads to independent construal of the following subject expression, as indicated earlier.²⁹

3.2. Implementing Long-Distance Scrambling Effects

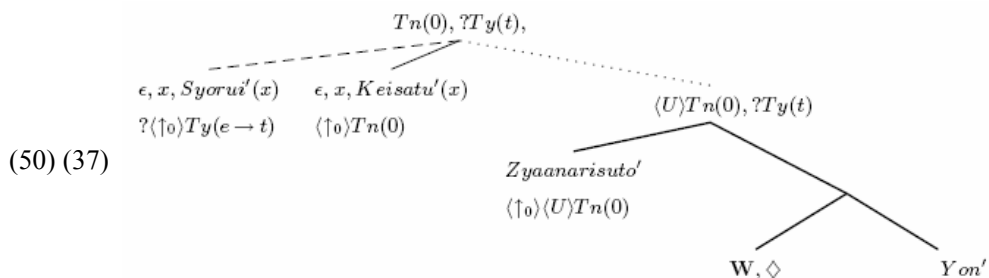
In setting out our account of long-distance scrambling phenomena, we have not yet spelled out mechanisms for constructing nested complement structure prior to the processing of the requisite verb. The problem that these structures seem to pose is that the one initially unfixed node which the left-peripheral expression decorates has apparently to be passed across what would seem to be a sequence of unfixed nodes for each of the argument expressions since the verb will not yet have been parsed ((4) repeated below):

- (49) *syorui-o* *keisatu-ga* *zyaanarisuto-ga* *yonda to* *koohyoo-sita*
 the document_{ACC} the police_{NOM} the journalist_{NOM} read COMP reported
 'The document, the police reported that the journalist had read.'

At this point, the constraint of only one unfixed node of a type at a time comes into play (see section 2.3). In this derivation, the expression *syorui o* decorates an unfixed node, but this does not preclude parsing of *emphkeisatu* as this is associated with introduction a locally unfixed node which its subject specification duly fixes as matrix subject). The immediately following *zyaanarisuto-ga* must then be taken to decorate a discrete subject node at some level of embedding: the problem is that *Adjunction has already been used in the construction of the node decorated by *syorui o*, so it cannot be used to license the introduction of a node to host the embedded structure, as this would simply collapse with that still unfixed node, with no possible way of completing a wellformed derivation. The only solution available is to use the weakest form of transition, Generalised Adjunction, to construct the embedding relation. But, this is not problem-free, since application of Generalised Adjunction, which introduces the very weakest of embedding relations, yields a structural relation which is too weak to license unification of the unfixed node originally introduced by *-Adjunction with any subsequently introduced node:³⁰

²⁹ It should be noted that on this analysis, there are no grounds for distinguishing radical reconstruction effects from other long-distance dependency effects. *Wh* expressions in Japanese are defined as projecting a requirement that they contribute a term to some Q-marked structure, the primary difference in clause typing from a language such as English being that this specification is provided by some other morphological marking, and not by the *wh* expression itself. Indeed, since early positioning of a *wh* expression will signal a question interpretation well in advance of the particle *-ka* which encodes such interpretation, (even though not encoded, as in English), we expect that *wh* expressions may freely occur at some left periphery but may nevertheless require reconstruction into a subordinate structure in order to establish the association of the *wh* term with the question particle necessary to confirm that interpretation (see Cann et al chapter 5 for discussion).

³⁰ $\langle U \rangle$ is the third Kleene operator, whose values range over mother and inverse LINK relations, the very weakest dominated relation indicating that the rootnode is above the current node, possibly across a sequence of trees.



The problem is that Generalised Adjunction is not an operation which would introduce structure that could provide an update of the tree relation introduced by application of *Adjunction as the tree relation it introduces is so weak.

This may seem to enforce a characterisation of all such strings as incapable of yielding a logical form as a result, hence ungrammatical. Yet there is a simple and monotonic repair process. The formal system is independently defined to allow interspersing of pragmatic substitution processes with building of partial structures -enrichment of formula values by substituting a metavariable with some appropriate part term is taken to feed into the general construction process. All that is needed to ensure that the partial structures constructed up to this point lead to a wellformed result is to assume that pragmatic enrichment can apply to structural underspecification. This is hardly contentious: enrichment of stimuli is a general cognitive phenomenon (see Sperber and Wilson 1995 among others), not one specific to a certain mode of representation. More specifically, what is required to yield a well-formed derivation is to introduce the requisite weak tree relation by Generalised Adjunction but, having done so, to enrich it to a fixed relation, transforming the tree into one with a relation of immediate subordination between the structure inhabited by $Fo(Zyaanarisuto)$ and the matrix structure. Formally, the node identified as $\langle U \rangle Tn(0)$ is updated to $\langle \uparrow_0 \rangle \langle \uparrow_1 \rangle Tn(0)$. The problem about this step of enrichment is that it is not morphologically triggered: it is an abduction step that is triggered solely by recognition that without it, no successful derivation will result -hence a meta-level step of reasoning. Being a pragmatic and optional process, any such choices should be expected to be associated with general cognitive constraints. And indeed, as an account invoking some intermediate step of abduction would anticipate, it is commonly reported that long-distance scrambling data are of reduced acceptability considered in isolation, and are only possible if uttered in a particular form of context (e.g. in answer to a question with fronted WH expression). Indeed, given that such front-positioning forces the evaluation of the unfixed node across a sequence of partial trees until its underspecification of tree relation can be resolved, we expect

this to be a marked option, and indeed it is invariably associated with a particular form of intonation, using an Intonational Phrase boundary, indicating a constituency break to disambiguate in favour of such a strategy.³¹

3.3. Multiple Long-Distance Scrambling

It might seem that the centrality to the DS system of the constraint of only one unfixed node of a type at a time in any case faces a serious counter-example in the multiple long-distance scrambling phenomena, since these involve long-distance dependencies, and more than one ((5) repeated below):

(51) syorui-o supai-ni keisatu-ga zyaanarisuto-ga watasita to
 the document_{ACC} the spy_{DAT} the police_{NOM} the journalist_{NOM} handed *COMP*
 koohyoo-sita
 reported

The police reported that the journalist had handed the document to the spy.'

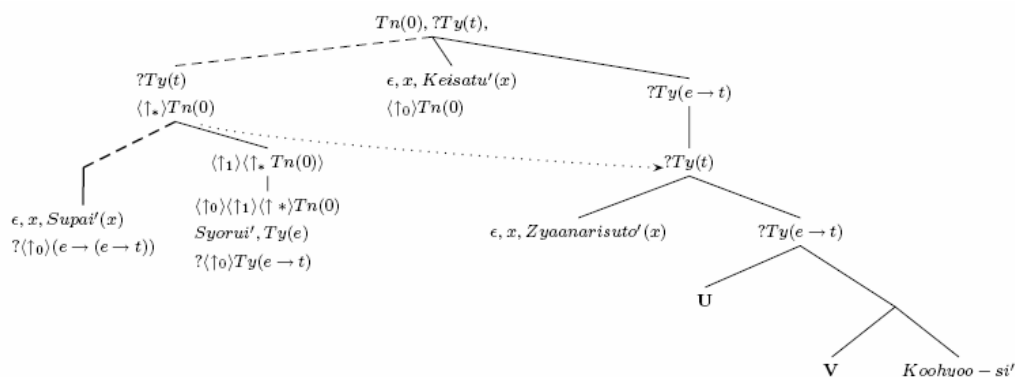
However, not only are such structures not problematic for the framework, they actually provide strong confirmation of it, for the entire set of data is directly predicted, including the expectation of a marked intonational break. Independently motivated is the assumption of three discrete processes for introducing structurally underspecified relations into the emergent tree . Local*Adjunction, *Adjunction, and Generalised Adjunction. With these as independent processes, there is nothing to prevent a feeding relation between them. In particular, nothing prevents the process of *Adjunction from feeding the process of Local *Adjunction, with the building from what is itself an unfixed node within some overall structure of a substructure of argument nodes awaiting a predicate node. Such a sequence of operations involves the construction at the left periphery of a unfixed node requiring type *t*, from which successive steps of Local*Adjunction with case-provided update can induce a partial propositional structure (containing two argument nodes but no predicate node), an incomplete structure which is then left for later resolution once some appropriate nested structure is made available (pointer movement back to the dominating node is licensed for all unfixed nodes that are type complete). This is precisely the type of unfolding derivation of structure which (5) requires, as we now see.

Such data are notably not a problem for the uniqueness constraint on unfixed nodes which the DS account imposes, despite the existence of more than one expression at an

³¹ See Kiaer 2007 for test results demonstrating the role of intonation in ensuring incrementality in processing Korean, evidence that we anticipate would in principle carry over to Japanese long-distance scrambling. Indeed a sharp intonational break is regularly reported to be necessary following the fronted expression if speakers are to judge it to be acceptable (Saito 1985, 1992, Koizumi 2000). However the phenomenon of final-syllable lengthening, characteristic of Korean and not apparently available in Japanese, means that the retrievability of this non-canonical form of interpretation is a much more marked phenomenon in Japanese than in Korean (Kiaer 2007).

apparent long-distance remove from the verb with whose argument nodes these “displaced” nodes need to unify. There is only one node introduced by *Adjunction, from which argument nodes get constructed by Local*Adjunction and enrichment. The sequence of actions is as follows. Following an initial step of *Adjunction, each NP in term in such a sequence is taken to decorate a locally unfixed node. All but the last of these is taken to be followed by a case specification construed constructively, which fixes the relation of the unfixed node to the intermediate type-*t*-requiring node. For the last term however, the case specification is construed as a filter on output, enabling the pointer to return to the top node, leaving that node as unfixed both locally to its intermediate dominating node, and to the higher dominating node. What can then follow is the regular process of introducing a matrix subject node (by application of Local*Adjunction and the fixing of the subject relation), the use of Generalised Adjunction to introduce an unfixed level of embedding, and one further process of introducing a subject relation in order to parse the second subject-marked expression: all this exactly as in the building-up of regular long-distance dependency. Once the second *ga*-marked expression is parsed, the very same problem arises as in regular long-distance dependency. Unless the very weak tree relation between the type-*t*-requiring node and the root is enriched, the unfixed node introduced initially will not be able to filter down the tree. The same solution is available as in construal of regular long-distance dependency -to assume that the very weak relation $\langle U \rangle Tn(0)$ is enriched to $\langle \uparrow_0 \rangle \langle \uparrow_1 \rangle Tn(0)$. With this, the parsing of the verb *watashi* then can take place as in a simple clausal sequence to complete the setting out of the subordinate predicate-argument frame, and a complement propositional formula can be duly derived by unifying the unfixed node with its two arguments with this complement node:

(52) (38)



From this point on, the complement structure can be compiled as in the simpler long-dependency structure, and a final derivation for the entire string completed.

An immediate consequence of this analysis is the essential locality in the construal of the dislocated constituents relative to each other: their position relative to each other results

from successive applications of Local*Adjunction to the one unfixed node initially constructed.³² Unlike accounts in other frameworks, no stipulation is required to characterise this composite left-peripheral constituent -it is simply an emergent partial propositional structure of a kind the framework's concept of tree growth naturally reflects. Moreover, given the analysis, we expect that these two or more non-subject NPs can be in any order (contra Koizumi 2000 and Takano 2002). We also expect, given the stronger case specification of *-ga* that such a sequence may not include a *-ga* marked expression. The feeding relation between *Adjunction, Local*Adjunction, and Generalised Adjunction, leads to exactly the desired result, notably without any distinction between the process of construal underpinning long-distance scrambling effects, and regular so called A' dependencies.³³

3.4. Quantifier dependencies and multiple long-distance dependency

Finally we come to the challenge of explaining how it is that multiple long-distance scrambling effects could parallel those of short-scrambling, where regular long-distance scrambling does not. Here we have a natural basis for explaining the difference, for it is only in the case of multiple long-distance scrambling that the unfixed node requires a type-t node. This introduced node then provides a platform for the construction of nodes on which to build the construal of sequences of NPs. So it will provide a basis from which scope-dependency choices can be made for the terms decorating the two introduced argument nodes, and the sequence of actions involved can be identical to that in mono-clausal sequences, even though that node itself remains as yet unfixed in the overall structure. The account therefore leads to the prediction that whatever restrictions or flexibility there might be for construing sequences of NPs in local scrambling environments should be replicated in multiple long-distance scrambling environments. This is exactly the pattern we observed in section 1.1. This parallelism is entirely unexpected if long-distance scrambling and local scrambling are unrelated processes, for such an account provides no basis for expecting multiple long-distance scrambling and local scrambling data to display any parallelism in the way they are interpreted. Indeed, given the bottom-up projection of structure/interpretation, multiple long-distance movement can't be analysed in terms of short distance movement, so to the contrary, such an account would predict that there should be no such parallelism. Furthermore, the apparent paradox that multiple long-distance dependency effects

³² As with single long-distance dependency, we would expect the use of such a strategy to be correlated with an intonational break in the form of an Intonational Phrase boundary after the pair of constituents to be so construed. Indeed misplacement of such an intonational break can lead to serious garden-pathing: see Kiaer.

³³ The primary argument that the two processes cannot be collapsed because of principle C effects associated with radical reconstruction complex NP-containing *wh* (Bošković and Takahashi 1998) expressions fails to apply in a framework in which what decorates a tree is not a natural-language name but some rigidly denoting term constructed from it. The analogue of Binding Principle C is, rather, a constraint on the construction of appropriate term from a natural-language name (that it involve a new variable, as a quantifying expression); and this constraint will apply as part of the process of building a decoration for some (unfixed) node, well before the point at which any unfixed node is unified with some fixed site.

can display parallelism with short-scrambling effects with respect to sensitivity to linearity while simple long-distance dependency effects do not is also resolved.

In sum, the system predicts a range of scope-dependency effects, but within limits. There is no overt or covert movement, no total suspension of incrementality. To the contrary, all interpretation involves building up interpretation via sequential steps of parsing; so in general interpretation is predicted to follow linear order with two systematic exceptions. First, indefinites allow a systematic local delay to their final construal in virtue of the anaphoric nature of the basis for establishing their scope dependency: it is this which provides the underpinning to wide-scope effects for some quantified expression that follows the indefinite as part of the projection of a single local propositional structure. Secondly, for any expression providing a term of type *e* to an unfixed node, there are structural reasons why interpretation may be delayed: in all such cases, interpretation will be definitively established only when their structural position in the emergent tree is established. Hence in these long-distance dependency cases, inversion of quantifier-anaphoric dependencies are expected. The mixed inversion effects of multiple long-distance dependency arise because these in part display properties of long-distance dependency, and in part properties of local scrambling.

4. CODA

Throughout this paper, we have sustained a methodology of setting up a formal mechanism which reflects the ongoing dynamics of language processing as closely as possible. Despite the coverage achieved, some might be reluctant to grant the strength of the analyses, deeming that the assumptions made violate traditional linguistic methodology, conflating competence and performance considerations illicitly. However, the arguments of this paper haven't involved any loosening of the standard methodology that grammar formalisms should be evaluated by their success in capturing structural generalisations. To the contrary, we have argued for our account of Japanese strictly on the grounds that a range of otherwise heterogeneous and puzzling data can be seen to follow from the interaction between general processes of tree-update and language-internal idiosyncrasies. A first result was an explanation of variable scope effects by analysing indefinite NPs as involving an anaphoric aspect to their construal, hence pragmatically constrained. A second result was the Scope Binding Constraint phenomena, problematic for minimalist accounts, which turn out to be ungeneratable in the present system. A further result was the multiple long distance scrambling phenomenon, an immediate consequence of the feeding relation between two construction processes inducing underspecified relations. Each of these problems constitutes a genuine puzzle for movement accounts of scrambling, with other frameworks not able to offer principled explanations of scope effects or multiple longdistance scrambling either. Finally, there was the confirmation provided by predicted parallelism between multiple long-distance and short-distance scrambling effects, a phenomenon completely unexpected from regular movement accounts. For this overall

account of Japanese scrambling, all that had to be assumed was to analyse discontinuity effects in terms of processes of structural underspecification plus update put together with an incremental perspective on scope dependencies, and then to define a family of such processes varying in terms of locality. The rest followed. So, we suggest in closing that the predictive successes which this more dynamic form of grammar enjoys is symptomatic of the need for change. In line with Hawkins 1994, 2004, Phillips 1996, we propose that an additional criterion for grammar evaluation should be the closeness of correspondence the grammar formalism can sustain between the internal constructs of the grammar and patterns directly observable in language use.

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