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Chapter X: Ellipsis in Dynamic Syntax*

Ruth Kempson[1], Eleni Gregoromichelaki[1,2], Arash Eshghi[3], and Julian Hough[4]

[1] King's College London

ruth.kempson@kcl.ac.uk

[2] University of Osnabrück

elenigregor@gmail.com

[3] Heriot-Watt University

a.eshghi@hw.ac.uk

[4] Bielefeld University

julian.hough@uni-bielefeld.de

Abstract In this chapter, we argue that ellipsis is a phenomenon that directly parallels anaphora, hence providing direct evidence of the concept of context on which natural-language (NL) processing depends. From this perspective, we argue first that, in failing to give due recognition to the interactive and multimodal nature of NL processing, theoretical linguistics has entered a stalemate situation in which no unitary account of ellipsis is possible. The alternative Dynamic Syntax account we provide next, to the contrary, presents ellipsis as a test case for the view that each NL constitutes a set of mechanisms for situated human interaction, with syntax, not a level of representation, but, instead, comprising a set of procedures for incrementally and predictively effecting conceptual structure - NL-strings mappings. The significance of the extended set of so-called "elliptical"

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phenomena that are examined from this perspective is that they all provide evidence for the seamless integration of NL structures and processing under domain-general action and perception processes.

Keywords: Dynamic Syntax, ellipsis, anaphora, dialogue, correction, clarifications, split utterances, incrementality.

1.1 Language as action and the phenomenon of ellipsis

From the perspective that takes language as a form of action, ellipsis is (part of) the phenomenon where use of verbal actions by an interlocutor is deemed less efficient for coordination in interaction than relying on the context, either of one's own recent verbal actions (see both utterances in (1)), somebody else's verbal actions ((1) B, (2) B and (3) B), or of the physical environment (4):

(1) A: I'm sorry I upset you. I didn't think I had.
    B: You didn't. Somebody did but I can't tell you who.

(2) A: If he needs to interrupt,. . .
    B: then I'm sure he will.

(3) A: Is he going to address. . .
    B: The European aspect of the problem?

(4) Father (said to son apparently about to dive off a cliff): I wouldn't if I were you.

This view of ellipsis, as a phenomenon seamlessly integrated in and enabling the joint action of conversational participants, has been obscured by theoretical linguistic approaches that abstract linguistic phenomena away from interaction and environmental resources and view natural language (NL) instead as a code, to be analysed in the model of formal languages with a specification of sentential syntactic organisation and parallel mapping to propositional semantics as the explanatory basis. In such an approach, linguistic strings like those in (1) are analysed as (a) containing syntactically-determined *ellipsis site*s, in the sense that the interlocutor's presumed silence is attributed some underlying structure, which (b) needs to be "licensed" by special linguistic devices so that (c) a complete proposition including the meaning of the "missing" part is recovered on the basis of identity with some other linguistically-derived structure. Assumptions (a) and (b) immediately exclude (2) and (3) because here there is no obvious ellipsis site, nor can there be predefined linguistic rules which determine the interactive meaning of these utterances as continuations, interruptions, or explicit commentary of (aspects of) another's talk. Assumption (c) immediately excludes the explanation of phenomena like the one in (4) as part of the model because here there is no linguistically-derived content to rely on in deriving interpretation. As a result, such accounts of ellipsis restrict their attention to strings like the ones in the individual utterances in (1) where, it is claimed, the specifically linguistic knowledge that people exhibit in interpreting them circumscribes them as a distinct phenomenon.

We argue here that this delimitation of the phenomenon, and its commitment only to explaining a subset of the data, shows that the standard methodology of abstract sentence-descriptive grammars impedes proper understanding of what a unified account of ellipsis really shows: namely, language users' know-how to employ and derive significance from multiple resources as they engage moment-to-moment with each other. For this reason, we argue, the standard competence-performance distinction that underlies the standard methodology has to be replaced by a different perspective in which the coordinated and context-dependent actions of conversational participants are central to the explanation.

In this chapter, we sketch an alternative view of "syntax" as an ability to act jointly, hence displaying properties in common with those that have been assumed up to now as characteristic of semantics, pragmatics and processing models. From this perspective, we will show how the presumed "syntactic" *licensing* of an "*ellipsis site*" as in (1) can be accounted for without the assumption of an autonomous level of syntactic analysis. Under the same terms, we also aim to show how *recoverability* of ellipsis interpretations, including those without linguistic antecedents such as (4), can be achieved on an incremental dynamic basis without assuming the necessity of sentence-proposition mappings. We do this through modelling the various phenomena within the architecture of Dynamic Syntax (DS, Kempson *et al.*, 2001), an inherently incremental and action-oriented formalism for modelling interaction. We introduce DS in §1.2 and then show how it captures the various interactive ellipsis phenomena in §1.3 after we discuss the challenges for other standard accounts in the next sub-sections.

1.1.1 The ellipsis stalemate in competing domains of analysis

Syntactic accounts of ellipsis rely on models of linguistic ability that postulate distinct types of declarative propositional knowledge as necessarily underpinning human linguistic performance. Having adopted this perspective, they then accordingly partition the phenomena by attributing to some instances causes distinct from those attributed to other intuitively similar cases. This is because such models, by ab initio definition of their remit, exclude in principle certain cases from consideration (see e.g. Stabler (2013)). For example, the cause of the surface appearance of the strings in (1), so-called *VP-ellipsis* and *sluicing*, is assumed to be underlying syntactic structure that has remained unpronounced: since Ross (1967) and Sag (1976), the ellipsis site is analysed as projecting complex sentential structure which is deleted at a late stage of the derivation under conditions of identity with that of an antecedent clause. However, even for this now narrowly circumscribed domain of phenomena, problems arise for such an account, which is symptomatic of the illegitimacy of this fractionating process. Firstly, the particular interpretations naturally recovered for various such ellipsis sites turn out to appear very diverse, which, due to compositionality considerations, then leads to constant differentiation of categories of ellipsis types (e.g., for VP-ellipsis: endophoric, exophoric, null-complement anaphora, tautosentential, discourse-anaphoric, etc., all terms and phenomena illustrated in Miller & Pullum (2014); for various differentiated semantic categories of sluicing, see e.g. Fernández *et al.* (2007)). Secondly, it has been shown that identity of surface structure is not required for the licensing and recoverability of meaning of ellipsis sites (see e.g. Hardt (1993)). And, lastly, meta-theoretically, the account lacks parsimony, since antecedents which present a single intuitive reading have to be assigned ambiguous underlying structures to allow for the multiple possible ellipsis types. From an empirical point of view, this makes such accounts psychologically unrealistic, since a left-to-right incremental version of them must invoke ambiguity to account for the subsequent interpretation of the ellipsis site. A particularly notorious such problem is the *strict* vs. *sloppy* ambiguity (Sag, 1976), where, for a single fixed interpretation of the antecedent clause, the ellipsis site allows for two interpretations, e.g., in (5) *his* can be taken to denote either John as 'Bill checked John's mistakes' (the *strict* interpretation), or Bill as in 'Bill checked his own mistakes' (the *sloppy* interpretation):

(5) John checked his mistakes, and so did Bill

To avoid this problem, a competing semantic account, Dalrymple *et al.* (1991) presumes that ellipsis sites are syntactically simple with no hidden structure. The burden of explanation for the strict/sloppy ambiguity is then shifted to an abstraction over semantic content of a clausal antecedent, which involves either abstracting out only the subject content (the strict interpretation), or abstracting out all occurrences of the term occupying that subject position (the sloppy interpretation).

Notwithstanding their differences, syntactic and semantic accounts share the property of being sentence-based: the elliptical string is taken to correspond to a sentence which is in some sense *incomplete*, with interpretation recovered from a clausal antecedent. Both thus confront the difficulty of characterising sub-sentential utterances which provide no evidence of having a sentential antecedent and yet are able to achieve illocutionary acts, which Stainton (2006) argues require a pragmatic inference account over and above whatever semantic or syntactic accounts of ellipsis might achieve:

(6) Chef (to assistant): Flour! [*command*]

Moreover, there are sub-sentential utterances where no identical, linguistically-provided antecedent is available on which the recoverability of some particular interpretation can be based:

(7) A: Billy left.

B: Billy? ['Who is Billy'] [*clarification*] [Ginzburg (2012)]

1.1.2 Morpho-syntactic licensing of sub-sentential talk

The difficulty confronting both semantic and pragmatic accounts of ellipsis when applied to accounts of sub-sentential utterances, is that the morpho-syntactic forms of such utterances remain the same whether they appear as sentential constituents or not (Merchant, 2004; Ginzburg, 2012; Gregoromichelaki, 2012). For example, they display specific case requirements:

(8) I Maria to egrapse to grama? Oxi, ego/*emena [Greek]

the$_{Nom}$ Maria it$_{Acc}$ write$_{Past,3sg}$ the letter No, I$_{Nom}$/*me$_{Acc}$

'Did Maria write the letter? No, I did/*Me did'

Contra Stainton (2006), in such case-rich languages, the form has to match whatever is taken as the required interpretation, even in the absence of any sententially, or even linguistically, derived antecedent (Gregoromichelaki, 2012, 2016). For example, in a context as in (9), *den Arzt* needs to be in accusative case:[1]

(9) [Context: A and B enter a room and see a woman lying on the floor]

A to B: Schnell, den Arzt /*der Arzt [German]

'Quick, the doctor$_{ACC}$ /*the doctor$_{NOM}$' [*command*]

A further problem indicating the need to integrate formal constraints with interpretational ones, is that ellipsis is argued to be subject to *island constraints* (Ross, 1967), until very recently, widely taken to be diagnostic of a syntactic phenomenon (see Merchant, this volume).For example, the so-called Complex NP Constraint is exhibited in so-called *Antecedent Contained Deletion/Antecedent Contained Ellipsis* constructions. In such cases a dependency needs to be licensed within the restrictor of a quantifying element provided by the adjunction of a relative clause. A further elaboration of the restrictor provided by a second relative clause prevents such a dependency:

(10) John had interviewed every politician [who Bill had ~~interviewed~~].

(11) *John interviewed a journalist [who Mary turned away everyone [who Bill had ~~interviewed~~]].

The challenge of defining accounts of sufficient richness to express such phenomena has been addressed in an impressively detailed manner by Ginzburg (2012) and colleagues, within a constructional version of HPSG formulated in the Type Theory with Records (TTR) representational framework (HPSG$_{TTR}$, Ginzburg (2012); Ginzburg and Miller, this volume). In this model, sub-sentential strings, as in (7), are taken to express paraphrases of what a whole sentence formulation would denote; and so the sub-sentential elements are mapped directly onto the various semantic/pragmatic functions they are taken to accomplish. However, this attempt to analyse "fragments" as commensurate to whole sentences means that the HPSG$_{TTR}$ framework retains conservative assumptions vis-à-vis syntax: fragments are modelled as "constructions" of sentential type, involving sui-generis syntactic mappings of sub-sentential constituents directly to "sentences" paired with necessarily (quasi-)propositional interpretations. For example, one of the grammatically-derived interpretations of the string in (7) will be 'A asks B who A meant by the use of "Billy"'. In consequence, each such sub-sentential string is assigned multiple such pairings and is by definition characterised to be as spuriously ambiguous as the constructions it is involved in. This means that the problematic aspects of the syntactic accounts, namely ambiguity instead of general mechanisms, is not sidestepped– on the contrary, it is wholly embraced as is natural in a constructional approach. However, as argued in Gregoromichelaki (2012), the interpretational options for such fragments are open-ended, so a constructional approach faces the problem of ignoring the radical flexibility and adaptability of linguistic resources. Additionally, there remains the empirical problem that morphological/syntactic restrictions on "fragments" pervade any occurrence of sub-sentential utterances whether these depend on linguistic or wholly non-linguistic context (see (9) and (12)):[2]

(12) [Context: A is contemplating the space under the mirror while re-arranging the furniture and B brings her a chair]

A to B: tin karekla tis mamas? / *i karekla tis mamas? [Greek]

'the$_{ACC}$ chair$_{ACC}$ of mum's? / *the$_{NOM}$ chair$_{NOM}$ of mum's?'

(Ise treli?) ('Are you crazy?') [*clarification*]

[Gregoromichelaki (2012)]

The defined HPSG$_{TTR}$-constructions apply only to linguistically-provided partial antecedents which are clarifiable, so the rules specified by the grammar will not apply to the intuitively similar clarification cases such as these.

An account that aims to capture global syntactic generalisations while, at the same time, accounting for licensing idiosyncrasies without an independent level of syntactic representation over strings is the general framework of Minimalist Grammars (MG, Stabler, 1997; Kobele, 2006). The MG formalism, applied to elliptical phenomena in Kobele (2012, 2014), requires, firstly, the relation between sentence string and semantics to be mediated by extensive transformations. This is because a copying account of ellipsis recoverability under identity is sustainable only on the basis of a decompositional mapping of surface appearance to semantic interpretation. This mapping is effected through various grammatical operations, like *merge*, *move* and, indeed, *e(llipsis)*, applying over fine-grained linguistic categories ("types") of expression, as constrained by global syntactic constraints such as the *Shortest Move Constraint* (SMC). This account presents a significant improvement on standard syntactic analyses, since an ellipsis site is considered, as in semantic accounts, syntactically atomic, i.e., no underlying syntactic structure is derived. Instead, ellipsis sites are generated due to particularised grammatical operations mapping empty or fragmentary strings to fine-grained syntactic categories. Because both syntactic categories and operations are so fine-grained, this account allows ellipsis sites to behave like pro-forms (as in Hardt (1993)) whose antecedents are syntactically restricted to be particular "derivational contexts", i.e., syntactic derivations that behave as functions on the potentially overt linguistic elements that are mismatched between the antecedent and the ellipsis site.

Given that this account incorporates global syntactic restrictions like the SMC, it can deal with formal licensing constraints like the island restrictions of (11) above. Additionally, the fact that it makes use of "derivational contexts" as antecedents, instead of syntactic structure, means that it can deal with cases of mismatched antecedents, as in (5) above, without having to postulate destructive structural operations or unnecessary ambiguity in the antecedent itself. However, this model still maintains standard assumptions regarding syntax, in that its explanations rely on assigning psychological reality to a view of syntax that is independent and distinct from other cognitive abilities. Syntactic categories, operations, and global constraints, like the SMC, are assumed to be specifically linguistic and not attributable to general cognitive constraints (see also Stabler (2013)). This has consequences: for example, in order to fully account for phenomena like (5), the grammatical characterisation provided is not adequate. Given that MG is a competence model, it has nothing to say on how antecedents are defined. In order for antecedents to be provided, MG has to be integrated in a performance model, a parser/generator (Kim *et al.*, 2011; Kobele, 2012). This is because the "derivational contexts" invoked by the assumed proforms simply represent, as far as the grammar is concerned, decontextualised descriptions of the combinatorial licensing of linguistic elements. So, from our point of view which takes the grammar-processor distinction as unsustainable and an artifact of the view of language as a code, the MG account (a) introduces theoretical redundancy because syntactic restrictions are not modeled on the basis of general cognitive processes directly, (b) in the case of ellipsis, this has the consequence that such phenomena are analysed as involving various cognitively-arbitrary category specifications or being explainable on the basis of otherwise general processing explanations, and (c) as a consequence, because the MG grammatical account is confined to linguistic structures, it is unable to account for intuitively analogous non-linguistic antecedents such as (9) and (12) above since, even embedded in a performance model, there is no linguistic derivation in the context to be invoked as the antecedent grammatical operation.

Finally, along with all the accounts already examined, given that the syntactic derivations of MGs license whole sentential strings paired with propositional interpretations, it will be unable to account for dialogue phenomena like (2) above, as we will now argue.

1.1.3 Ellipsis as completability

Accounts of ellipsis assuming a sententialist methodology confront the challenge of addressing the dynamics of conversational dialogue. The problem posed by conversational exchanges is that people commonly and purposefully do not utter full sentences. Conversations are replete with fragmentary forms which build incrementally on what has gone before, in which participants effortlessly switch between speaker and hearer roles, and commonly no-one in the conversation will have anticipated its overall content in advance:

(13) A: We're going to..

B: Burbage to see Auntie Ann

C: with the dogs?

B: if you look after them

C: in the garden

A: unless it rains.

If one attempted to preserve the assumption that all fragments are independent incomplete sentences, one might consider data like (13) as at least five elliptical sentences each to be mapped onto representations of propositional content; but it is far from obvious what source to provide to any such posited underpinning sentential structures when the overall structure cannot be anticipated. Even the illocutionary flavour of the subparts may shift as participants are more or less authoritative, or in disagreement:

(14) A: What this shows is that

B: you are completely wrong.

An account in terms of sentential ellipsis of the above misses the significance of B's action in (14) as an interruption and the ones in (13) as continuations.

In any case, such an ellipsis account cannot be sustained since this *split utterance* phenomenon can take place at any point in an emergent structure (Gregoromichelaki *et al.*, 2011; Howes *et al.*, 2011), and affects every syntactic/semantic dependency – preposition-complement, (15), reflexive-antecedent, (16), quantifier-pronoun binding, negative-polarity, quantifier-tense (17), even head-complement dependencies (18):

(15) Joe: We were having an automobile discussion ....

Henry: discussing the psychological motives for

Mel: drag racing in the streets.

[Sacks (1992)]

(16) [Context: smoke coming from kitchen, Bob emerging]

Mary: Did you burn

Bob: myself? No fortunately not.

(17) A: Has every player handed in

B: his registration form?

A: or any other documents?

(18) A: Will you . . .

B: resign? I think not unless Bill, uh,

A: forces you to?

B: Yeah.

Therefore no account that relies on specialised constructions or syntactic types, instead of general mechanisms, can provide an adequate explanation for this phenomenon. Instead, sub-sentential strings need to be licensed by the grammar incrementally and without the requirement that a whole sentence needs to be licensed eventually (as in Kobele (2012) and others). This is because such sub-sentential strings are not only interpreted incrementally but also can be used perfectly naturally to perform speech acts that rely on their very incompleteness (Gregoromichelaki *et al.*, 2013):

(19) A: And you're leaving at ...

B: 3 o'clock

But even incremental syntactic accounts (e.g. Poesio & Rieser (2010), or a conceivable extension of Kobele (2012, 2014)) cannot deal with such data if they maintain an independent level of syntactic analysis since, as (16) shows, splicing together the two strings will yield ungrammatical results.

Given the rapidly accumulating experimental evidence that parsing and production are both incremental and interdependent in achieving action and representational coordination during interaction (Pickering & Garrod, 2013), accounts of sub-sentential utterances as somehow incomplete cannot be sustained. Firstly, as we saw in (9) and (12) above for adult interaction, sub-sentential talk underpinned by the context-dependency of human interaction can achieve any function that sentential and propositional units perform. Secondly, such utterances form the basis of language acquisition. Children at the one-utterance phase can perform perfectly adequate verbal actions employing sub-sentential strings relying on the adult caregiver to provide what they lack at that stage, namely, the requisite conceptual break-down of a holistic situational representation so that new linguistically-expressible concepts can be acquired:

(20) A (pointing to an empty mooring site on the canal): Daddy

B: Yes, you were here with Daddy yesterday, clearing out the boat. That's right dear.

Moreover, the split utterance data cannot be excluded from the core remit of the grammar as performance disfluencies since they also constitute effective verbal actions for the language-acquiring child to coordinate with care-givers:

(21) Carer: Old McDonald had a farm... On that farm he had a

Child: cow.

(22) [addressing class of new nursery intake] Teacher: Your name is

Child: Mary

Teacher: And your name is

Child: Tommy.

Instead, in our view, the characterisation of sub-sentential data needs to make reference to the dynamics of real-time processing expressed in a vocabulary that allows contribution from environmental resources and non-linguistic cognitive domains at a sub-sentential level. Such a model, in our view a grammar, needs to:

- include a set of mechanisms for inducing recovery of content from both linguistic and non-linguistic sources.
- model word-by-word incremental, semantic licensing.
- model the context as an evolving record of all inputs, including words, structures and procedures that induce such incrementally developing content.
- define shared mechanisms for parsing and production.

The model we sketch below, Dynamic Syntax (DS), meets these criteria. In DS, the pervasive use of sub-sentential elements across dialogue turns and participants will not only be wholly predicted, but will be seen to serve a key purpose in communication, serving to narrow down the otherwise mushrooming alternative structural and interpretative analyses through the ongoing interactive coordination of participants (see Gargett *et al.* (2009); Eshghi *et al.* (2015)). We will argue that this perspective not only illuminates the sharing of linguistic actions in context as seen in (13)-(22), but also provides a processing approach which reveals a novel and surprising meta-theoretical generalisation: namely, the lack of need for conceptual distinction between syntactic vs. semantic vs. pragmatic procedures in the integration of verbal actions with coordinated joint action. In all three domains of traditional linguistic inquiry the mechanism of jointly developing initially underspecified information operates uniformly. In the same way that pronominal anaphora construal has been shown not to be definable as confined within sentential, speaker-turn, or linguistic boundaries, ellipsis needs to be modelled in the same way, as an anaphoric mechanism both relying on and sustaining participant coordination and context-dependent action. This is achieved in DS by modelling both pronominal anaphora and ellipsis through the initial projection of temporarily underspecified contents imposing their resolution as a goal for all conversational participants and thus subsequently resolved by exploitation of either environmental or linguistic resources. Furthermore, we argue, in contrast to any other formalism, this perspective allows us to extend the parallelism beyond ellipsis and pronominal-anaphora, to the explication of the function of syntactic mechanisms. Syntactic dependencies introduced by fragments, morpho-syntactic constraints introduced by e.g. case morphemes, but also the mechanism underpinning long-distance dependency, will be modelled as introducing initially underspecified structural projections with goals imposed on either participant in a conversation to resolve them either through context or by offering an appropriate subsequent verbal action.

1.2 Dynamic Syntax

Dynamic Syntax (DS) is a grammar formalism based on the psycholinguistically-inspired action-based modelling of NL string-interpretation mappings in context. NL syntax is reconceptualised to be no longer its own level of representation, but, instead, as a set of licensing actions for inducing or linearising semantic content, incrementally, predictively, and on a word-by-word basis. Parsing and production are interdefined as coordinated activities operating in tandem, each having access to the same set of construction steps. Context in DS is modelled as including an incrementally evolving record of all the actions employed and their outcomes, enabling recoverability of any of these for re-use. The interaction achieved in split utterances emerges as an immediate consequence, since both parsing and production employ predictive actions which make available to each interlocutor, at each sub-sentential step, the role of parser or generator.

1.2.1 String-content mappings

To model this action-directed perspective, DS is founded on a dynamic modal logic that defines the transitions among states taken to constitute the current context of processing at each point in a parse/generation task (see Kempson *et al.* (2001) for formal details). The accessibility relations among these states are defined through *actions* which license goal-driven, time-linear transitions from state to state. Such states can be taken to model the total context of each processing step, linguistic and non-linguistic, so that the whole system licenses mappings from context to context.

In DS, particular conceptualisations of eventualities are taken to involve actions of building (*parsing*) or linearising (*production*) a semantic tree whose nodes incrementally come to reflect the content of some utterance. Keeping in mind that processing can start at any point, if we take the case of aiming to achieve a propositional structure, the first step is a one-node tree that merely states the goal to be achieved, namely, to derive a formula of propositional type (Fig. 1.1, above $\Downarrow$), indicated by the *requirement* $?Ty(t)$, the query symbol ? indicating this is a goal as yet unrealised. This single node tree is then incrementally enriched as word-by-word processing proceeds, eventually leading to a complete tree of propositional type with no goals left outstanding (Fig. 1.1, below $\Downarrow$), a result achieved through combining grammatical actions with content derived from context.

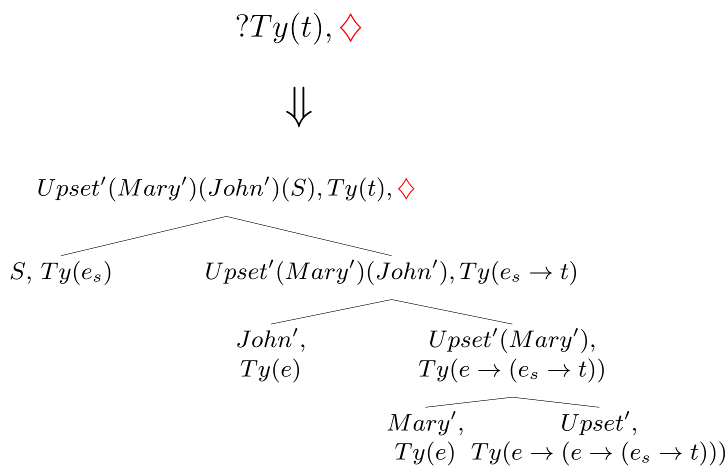

Figure 1.1. Processing *John upset Mary* in DS

DS trees are invariably binary, reflecting functor-argument structure (argument node on the left branch, functor node on the right), with a *pointer* $\diamondsuit$ identifying the node under development). Each node is annotated, not with words, but with terms of a logical language (e.g. $Mary'$), and their type (e.g. $Ty(e)$), these terms here being sub-terms of the resulting propositional representation at the root node. The representation includes an event/situation argument S of type e_s, enabling tense/aspect construal (we suppress details here, see Gregoromichelaki (2006); Cann (2011)).[3] Since event/situation arguments are first-class citizens of the combinatorial structure, predicate assignments reflect this: $Ty(e \rightarrow (e_s \rightarrow t))$ the intransitive-verb type for combining with a subject first and then the situation argument; and $Ty(e \rightarrow (e \rightarrow (e_s \rightarrow t))$, the transitive type.

1.2.2 Formalisation of tree structure and incremental tree development

In order to talk explicitly about how such structures are constructed incrementally, *trees* are formally defined, so that their incremental construction can be achieved through *actions* that induce the requisite tree development. DS adopts a logic with modalities indicating not only what is currently true about the tree but also what is to be true at future developments of the tree (Blackburn & Meyer-Viol, 1994). For example, the daughter relation is defined as $\langle\downarrow\rangle$: $\langle\downarrow\rangle\alpha$ holds at a node if α holds at its daughter (with variants $\langle\downarrow_0\rangle$ and $\langle\downarrow_1\rangle$ for argument and functor daughters respectively). There is also the inverse mother relation $\langle\uparrow\rangle\alpha$ with argument/functor variants, $\langle\uparrow_0\rangle$, $\langle\uparrow_1\rangle$.

Thus a DS grammar includes a set of *actions* which are procedures for building/linearising trees: "syntax" is just the subset of actions which unfold tree structure under the guidance of linguistic elements. *Syntax* is formulated as the employment of packages (macros) comprising simple atomic actions – `make`(X) for creating new nodes, `go`(X) for moving the pointer, `put`(Y) for annotating nodes, where X and Y are tree relations and node-annotations (labels) respectively.

Computational actions are language-general macros not needing a lexical trigger: these introduce tree relations, move the pointer $\diamondsuit$ around some partial tree under construction (e.g. COMPLETION, which moves the pointer out of a node once its type requirement is satisfied), remove satisfied requirements (THINNING), perform function-application (BETA-REDUCTION) operations compiling information up a tree on a bottom-up basis once all daughter decorations are suitably provided. Primary amongst these is the construction of "unfixed nodes" (*-ADJUNCTION): such actions are defined using the Kleene star operator $*$ annotating a so-called "unfixed" node with the specification $\langle\uparrow_*\rangle Tn(a)$, which indicates that this node is related to some node a along a sequence of zero or more mother relations to it. *Lexical actions* are macros triggered by individual words of the particular NL whose actions also perform the same tree or string development along with introducing semantic content on the nodes of the tree.

1.2.2.1 Partial trees: imposing constraints on update

The underpinning dynamic which drives NL processing is the gradual resolution of initial underspecifications. There are three basic types each with an attendant requirement for update:

(1) *content underspecification* expressed with insertion of a typed place-holding *metavariable* as the content that is contributed by anaphoric elements: $\mathbf{U} : e$, $\mathbf{U} : e \rightarrow (e_s \rightarrow t)$; such content is accompanied with the requirement $?\exists x Fo(x)$ indicating the constraint that the metavariable needs to be replaced by a proper value;

(2) *type underspecification*, either expressed through requirements $?Ty(e)$, $?Ty(e \rightarrow (e_s \rightarrow t)$ etc., or by assigning an underspecified type $Ty(\mathbf{U})$ which will then also be accompanied by the requirement $?\exists x Ty(x)$;

(3) *tree-relation underspecification* ("unfixed nodes") expressed as $\langle\uparrow_*\rangle Tn(a)$ with requirement $?\exists x Tn(x)$.

Such underspecifications all allow modal constraints on their resolution, giving rise to a variety of locality restrictions. For example, anaphoric expressions can impose locality constraints associated with limits on recoverability of their antecedent. *Locality* within a given predicate domain is definable as the tree traversal of an unbroken functor path: arguments local to a given predicate meet the characterisation $\langle\uparrow_0\rangle\langle\uparrow_*^1\rangle Tn(a)$ (i.e. there is a path up one argument-relation plus a possibly empty sequence of function-path relations from the current node to the dominating $Tn(a)$ node). *Reflexive anaphors* are characterised as projecting a restriction on putative antecedents that they be "co-argument" terms, i.e. holding along the relation $\langle\uparrow_0\rangle\langle\uparrow_*^1\rangle\langle\downarrow_0\rangle Tn(a)$. Conversely, *pronominals* exclude as antecedent any formula at a node standing in such a local relation; and *wh-pronouns* contribute a metavariable (**WH**), defined as awaiting substitution by a term, the answer, in some future utterance, a yet further long-distance dependency effect (see Gregoromichelaki (2006, 2013) for a reformulation of Binding Theory in DS terms).

Unfixed tree-relations vary as to whether or not their resolution is subject to such tight locality restrictions. An *unfixed node* within some tree is identified by the annotation $\langle\uparrow_*\rangle Tn(a), ?\exists x Tn(x)$ which defines it as unfixed but within a tree whose tree-root is $Tn(a)$. There is also a more specific localised variant defined as $\langle\uparrow_0\rangle\langle\uparrow_1^*\rangle Tn(a)$ i.e. the tree-root now encompasses a local predicate-argument sub-tree.

Morpho-syntactic specifications also involve locally stateable constraints. *Accusative* case marking, for example, is definable as imposing a requirement on a node of the form $?\langle\uparrow_0\rangle Ty(e \rightarrow (e_s \rightarrow t))$, dictating that in the outcome, it must be immediately dominated by a predicate node.

In every case, what drives processing is the set of requirements lexically or computationally imposed: such requirements operate as predicted goals for either participant in the joint task to accomplish that constraining of future developments. Of these, it is underspecification of hierarchical position within a tree that lies at the core of the account, underpinning many discontinuities, and expressible through the construction of unfixed nodes. Fig. 1.2 shows how the building of a locally-unfixed node (LOCAL-*-ADJUNCTION) can feed lexical actions, so that in combination, the word order properties of each particular NL are derived. In some languages this underpins *scrambling*. In English, this mechanism, in combination with the lexical action of the verb induces the imposed SVO (subject-verb-object) ordering: the DP before the verb is taken to annotate a locally-unfixed node; its position as logical subject (or not) is determined by the action sequence projected by the following verb, which among other actions includes such specification. The left-peripheral nature of long-distance dependency is expressed through the building of an unfixed tree relation without such a single-clause locality restriction, which involves a computational action defined in the presence of a node requiring completion to a propositional type

$Tn(a), ?Ty(t)$ with a precondition that the node is not already developed in any other way, relative to which the action defined licenses the construction of an unfixed node annotated as $\langle\uparrow_*\rangle Tn(a)$,Ty($\mathbf{X}$), $?\exists x Tn(x)$, i.e., with a resolution of this underspecified tree relation having to be at some possibly later point in the construction of the tree being developed from $Tn(a)$ (this is the final step of MERGE[4] in Fig. 1.2); hence the potentially "long-distance" discontinuity effect.

In all tree developments, the closing stages invariably involve modalised function-application (beta-reduction) steps which compile up the content of all non-terminal nodes to finally yield a complete tree with no requirements outstanding (see Fig. 1.1).

1.2.3 Linking trees through term sharing

In addition to the incremental projection of predicate-argument structures, a freely available computational action licenses paired "LINKed" trees, which are in effect correlated through a conventionalised anaphoric device that results in a shared term appearing in both such trees. Formally, a transition from some node in the main tree onto the topnode of a new tree is licensed, this new tree-beginning having imposed on its development a requirement that it includes the term appearing on the node from which the transition was initiated. *Relative clauses* are the paradigm case: the *relative pronoun* triggers actions which reflect the LINK transition and some initial construction within the newly emergent tree of an unfixed node. The **WH**-metavariable then functions in a fixed anaphoric way to provide the required copy from the main tree, thus creating the resultant shared term in the two trees (see Fig. 1.3, which displays the outcome of processing the string *John, who smokes, left*).[5]

Such LINKed trees provide opportunities mid-sentence for NL processing to shift temporarily to a distinct structure for purposes of elaboration, expansion, explanation etc., of terms in the main structure. And this can happen either within a single individual's utterance, giving structures like relative clauses, Hanging-Topic Left-Dislocation, clausal and phrasal adjuncts, etc., or across speakers where the effects include clarifications, confirmations, continuations, etc. (see e.g. Gargett *et al.* (2009)). This is because LINK-adjunction allows indefinite iteration of adjunct extensions of arbitrary type, a common way of extending utterance exchanges:

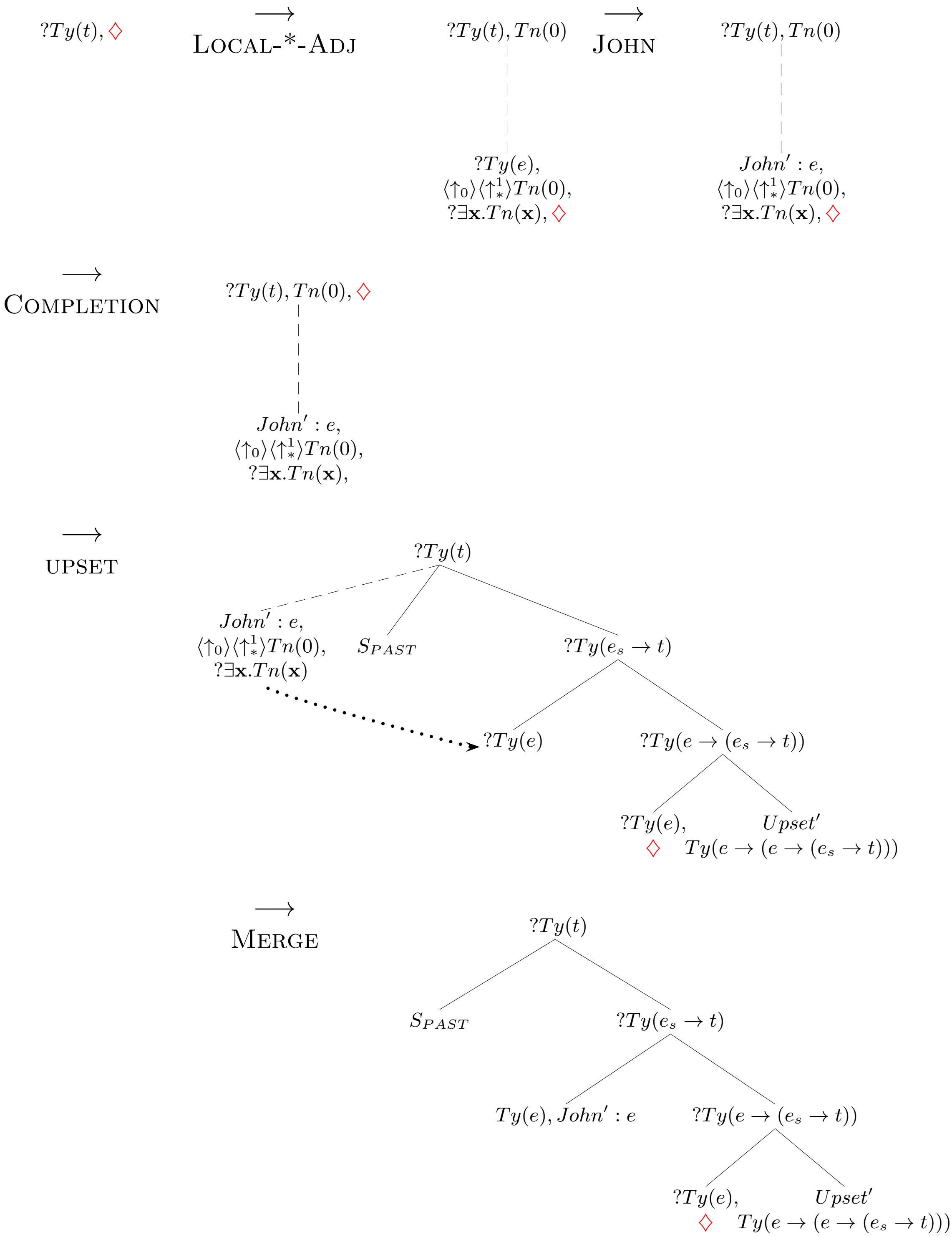

Figure 1.2. Unfolding structure for *John upset...*

(23) A: Sue is on her way back

B: from. . .

A: Paris

B: with the dogs?

A: and the parakeet. All in the car. Even Susie, the cat.

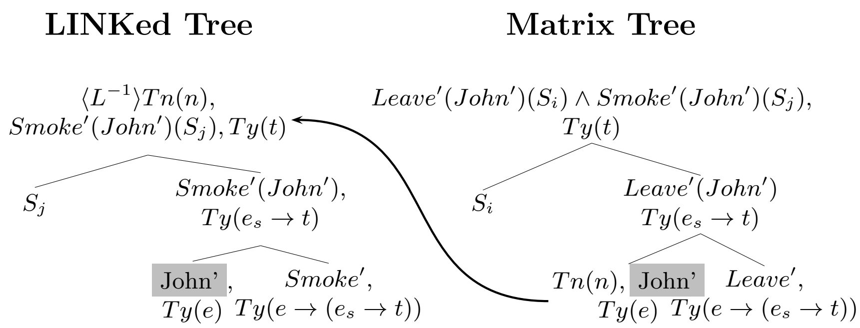

Figure 1.3. Result of parsing *John, who smokes, left*

The fact that LINKed trees temporarily shift processing to an independent adjunct tree to elaborate a term on the main tree provides the basis for a requirement of anaphoricity from the one structure to the other. It also explains why this form of tree relation is what is needed for modelling *sluicing* (see e.g. Merchant (2001)), amongst other structures which may be sensitive to island constraints as we shall see in detail below in section 1.3.7 for antecedent-contained ellipsis. In such cases, for example, where relative clauses constitute the LINKed "*islands*", the relative pronoun provides the copy that links the newly-introduced tree to the main tree. This copy-process creating the shared term is NOT island-constrained with respect to its antecedent. Nonetheless, since that copied term has to occur on an unfixed node as the new tree is being introduced, the resolution of its position within that new tree is domain-sensitive: it must occur within the construction of that very tree. In this sense, island constraints in DS emerge from the need to shift processing to another domain along with needing to complete this structure before resuming processing of the one temporarily interrupted.

1.3 The Dynamics of Ellipsis

With the formal underpinnings of its semantic tree construction process to hand, we now describe the DS model of ellipsis. We show how the incremental notion of DS context can account for the varying types of elliptical forms found in interaction.

1.3.1 Context in DS: mechanisms for recovery of content at the ellipsis site

The concept of context appropriate for a processing-oriented account is substantially richer than is expressible in either model-theoretic accounts or semantically blind syntactic accounts. For this reason, *context* in DS is conceived as a dynamic, multi-modally induced record of (a) words; (b) conceptual content notated as tree structures as described above; and (c) the sequence of actions in building the emergent strings and trees (Cann *et al.*, 2007; Purver *et al.*, 2010; Eshghi *et al.*, 2015). Since a DS grammar, through the imposition of predicted goals, models the recovery from memory of the range of options available for the next processing steps, this set of options is attributed psychological reality so it also constitutes part of the model of context. To model context time linearly, we follow Sato (2011); Purver *et al.* (2011) and Eshghi *et al.* (2015) in defining this range of options as a Directed Acyclic Graph (*Context DAG*) as in Fig. 1.4, where each node represents the current (partial) tree and each edge in the graph records the action taken. The entire DAG represents the search space for parsing/generation, which will also include any conceptual content derived from context. In Fig. 1.4, the top path from T_0 to T_{12} is the chosen one given the lexical input, and corresponds to the derivation outlined in Fig. 1.2.

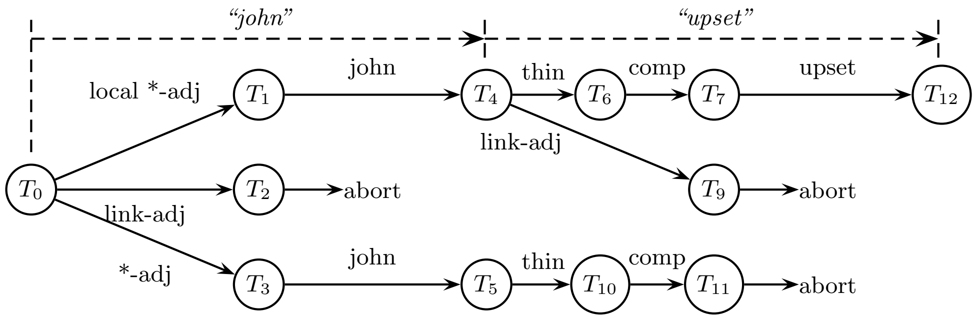

Figure 1.4. DS parsing context as a graph: actions (edges) are transitions between partial trees (nodes).

The *context of a partial tree* is then the path back to the root of this graph; and actions, as well as conceptual content notated in tree-form, are recoverable through a mechanism of *backwards-search* for re-iteration/re-use in creating new construals. As a result, there are three basic mechanisms by which an ellipsis site, being an underspecified element awaiting resolution, can exploit the Context DAG for content recovery:

(a) Re-use of content (semantic-formulae) from some (partial) tree on the Context DAG, which can include recoverability of information direct from the utterance scenario, yielding indexical construals.
(b) Re-use of sequences of actions from the DAG (sequences of DAG edges).
(c) Direct re-use of structure, i.e. extension of some (partial) tree in context.

1.3.2 Content underspecification and recoverability through copying or action replay

1.3.2.1 Forms of the ellipsis site

We take first the familiar cases of English VP-ellipsis. Under DS, these involve an initial content underspecification projected at the ellipsis site, with optional triggers for content recovery in the form of strings such as *do so*, *too*, and bare auxiliaries. Auxiliaries are taken, like pronouns, to project a temporary content place-holder of predicate type (e.g. $\mathbf{U} : e \rightarrow (e_s \rightarrow t)$) with an accompanying requirement $?\exists x.Fo(x)$ which triggers the context search.

1.3.2.2 Recovering predicate content

In such cases, two types of information are recoverable from context:

(a) a formula content copied from some tree,

(b) a sequence of actions to be re-iterated at the ellipsis site.

The two mechanisms fetching such information to the new processing task through backwards-search are implemented by the pair of computational actions *Substitution* and *Regeneration*.[6] Fig. 1.5 displays the identical substitution process (a) for a pronominal and (b) an elliptical expression as in (24):

(24) A: John upsets Mary.
B: Bill annoys her. / B: Bill does too

Fig. 1.6 then displays the regeneration process at an ellipsis site for cases like B's answer in (25):

(25) A: Who upset himself?
B: John did.

The new content in B's answer is derived through re-binding of the variable projected by the anaphor to the newly introduced subject. This is achieved by searching the DAG and then re-using the actions involved in constructing the question to flesh out the ellipsis site in the answer, as triggered by the metavariable placeholder projected from the auxiliary: The processing of the question in (25) involves parsing of the subject *who*, constructing a predicate as indicated by the verb, and constructing its object argument; these actions, having

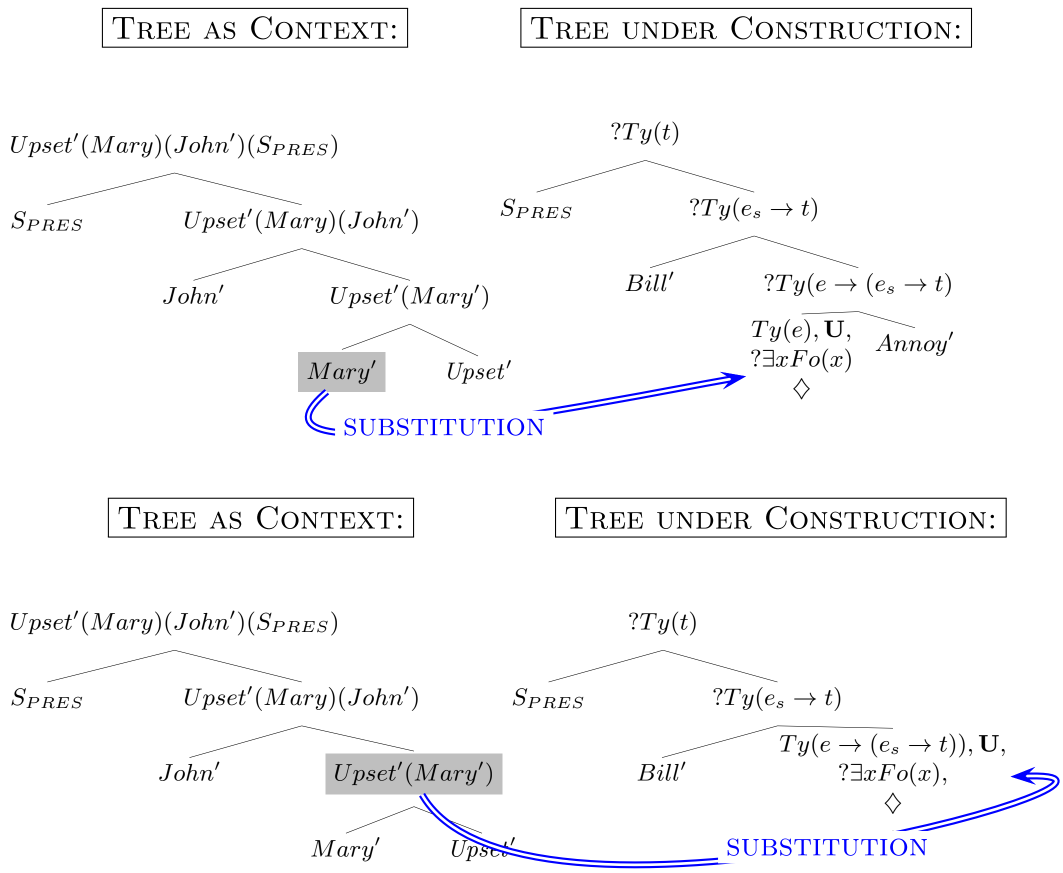

Figure 1.5. Substitution from context at the ellipsis site of (24): pronominal-anaphora (top) and VP-Ellipsis (bottom)

been stored as a sequence in context, can be re-used in the next stages. But with *John′* now annotating the subject node, these actions will now yield a re-binding of the object argument to the new local subject. The effect achieved is the same as the higher-order unification account of Dalrymple *et al.* (1991) but without anything beyond what has already been used for the processing of the previous linguistic input and, consequently, without any need to assign some distinct type of expression to the elliptical element *did* or the subject *John*. All that has to be assumed is that the metavariable **U** contributed by the anaphoric *did* can be updated by an action sequence taken from the DAG context.

This duality of mechanisms for content recovery provides a way of capturing all strict/sloppy ambiguities observed in several forms of ellipsis. Either content specifications or sequence-of-action specifications can be

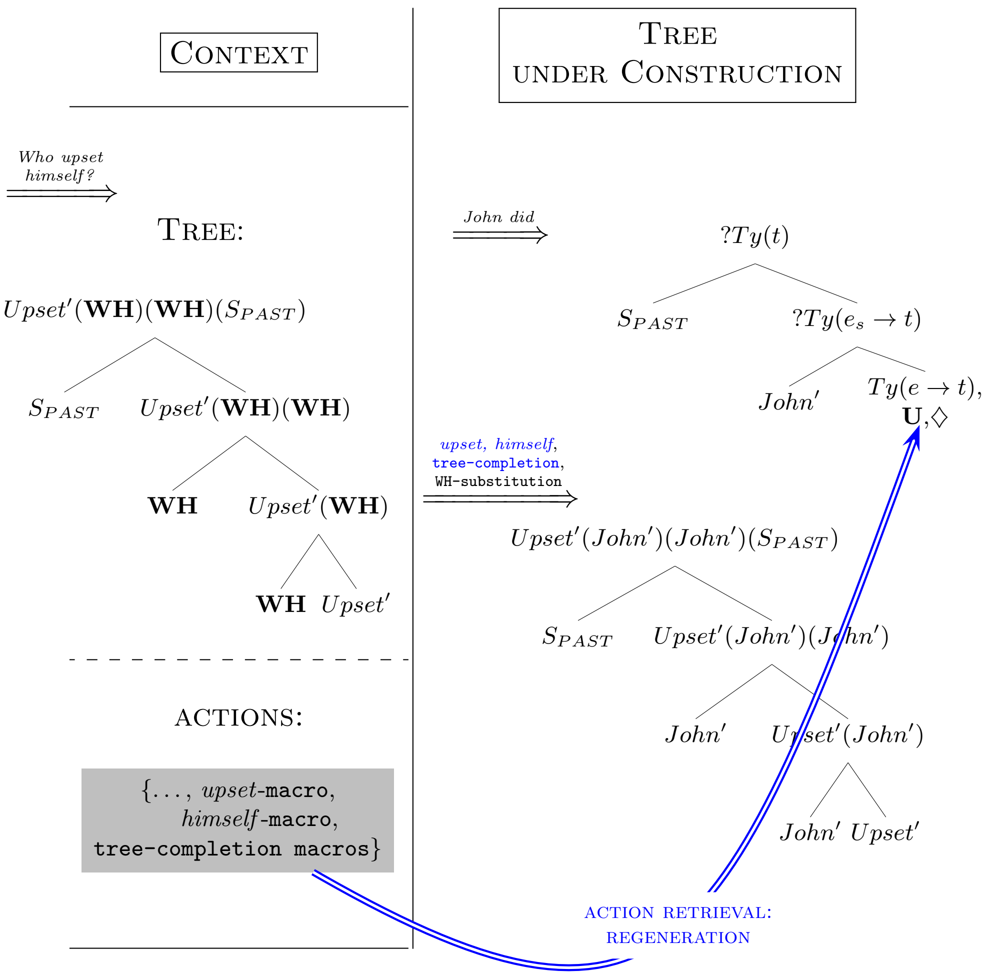

Figure 1.6. Action replay from context at the ellipsis site

searched for and reiterated, the first preserving some previous construal, the other preserving only the *pattern* of construal:

(26) A: Bill will help his students

B: John will too but less willingly.

This gives precisely the right basis for the ambiguity without having to invoke ambiguity of the antecedent. In (26), a strict construal $\lambda x.Help'(Students'(of - Bill'))(x)$, 'help Bill's students', is carried over as the fixed predicate content to be predicated of the subject $John'$. The sloppy interpretation involves the sequence of actions associated with processing $help + his + students$ in the first conjunct re-applied to the new subject $John'$.

This is not a mechanism identified specifically for ellipsis: the same type of analysis applies to the DS analysis of quotation (Gregoromichelaki (to appear)) and two subcases of pronominal-anaphora too, i.e., co-referentiality and so-called *lazy pronouns*. Coreferential construals constitute a replication of some antecedently-constructed content of individual type e:

(27) A: *John* came into the room.

B: *He* looked very sick.

Lazy construals involve recovery of actions to be re-run at the site indicated by the pronoun to yield some requisite term that is distinct from that picked out by the antecedent. In (28), *them* is resolved by rerunning actions used to process *his keys* in the previous clause:

(28) A: John always keeps *his keys* in the bowl.

B: Michael just dumps *them* down anywhere when he comes in.

Under this view, neither ellipsis sites nor pronominals deviate in any way from the usual processing mechanisms DS defines: like all other morpho-syntactic and lexical specifications, such elements impose predictive goals constraining the subsequent actions of the interlocutors as these unfold in the DAG model of context; general processing mechanisms like backwards-search, Substitution and Regeneration can then be employed, by either interlocutor, to achieve appropriate expansions of such potentially radically-underspecified content in ways that reflect their own purposes. Since the DAG unfolds and constrains these future processing options on a word-by-word basis, employing and resolving underspecification can be achieved both through the exchange of propositional contents, as seen above, or through the exchange of sub-sentential elements that exploit verbal or non-verbal actions for becoming integrated in the functioning of the participants' joint actions.

1.3.3 Licensing sub-sentential utterances: morpho-syntactic constraints

Use of sub-sentential utterances in dialogue shows how particular morpho-syntactic forms impose goals on interlocutors that curtail the processing paths compatible with further processing or backwards-search. For example, as we saw earlier, so-called *wh*-pronouns project a specialised metavariable requiring instantiation externally to the tree under construction, this in question-answer pairs being the answer to that question. On the other hand, the metavariable provided by reflexives is restricted to obtaining a locally-provided antecedent. These two types of constraint can combine leading to interpretations that are very finely constrained: *short-answers* to a *wh*-question, (as in (29)), need to be interpreted within the structure which that question projects; while the local substitution imposed by a reflexive as shown in Fig. 1.7 will lead to a cascading effect affecting all occurrences of the **WH**-metavariable, thus yielding an appropriate interpretation of the answer.

(29) Q: Who did John upset?

Ans: Himself.

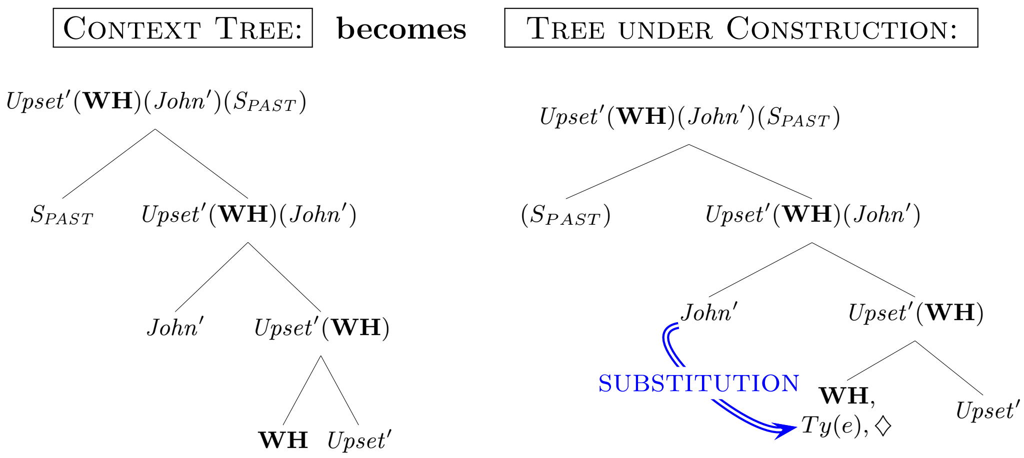

Figure 1.7. A short answer with binding restrictions

Subsentential utterances may also bear morphological features, which are expressed in DS via imposition of predictive goals to interlocutors to pursue processing paths that conform to some particular specification of the conceptual content being developed. Like indexical pronominals, imposing, for example, gender restrictions in English, *accusative case* marking, as in (9)-(12), introduces the requirement: $?\langle\uparrow_0\rangle Ty(e \rightarrow (e_s \rightarrow t))$, a restriction that a node so annotated be immediately dominated by a node of predicate type. Since backwards-search through the DAG will not fetch the appropriate content in this case, the imposition of such morphological constraints has the effect of imposing particular conceptualisations of the utterance situation becoming newly available as processing options in the DAG. Since the DS-DAG is not restricted to representing specifically linguistically-derived content, such morphologically-triggered context enrichment does not presuppose the mediation of any syntactic derivations. Nevertheless, unlike other frameworks (e.g. Ginzburg (2012)), any DS rules applicable to linguistically-derived content will be able to apply unchanged to the subsequent development of such contextually-derived content (as in e.g. (12)).

1.3.4 Licensing split utterances

Given that processing in DS is modelled as incremental and predictive, the licensing of sub-sentential utterances is achieved word-by-word without requiring necessary expansion to a propositional structure for a string to be interpreted or produced. So sub-propositional strings can be employed to perform speech acts as naturally as propositional ones as seen above in (19), (22). The DS explanation of the licensing of *split utterances* without having to assume inference of propositional intentions relies on the DS modelling of the tight coupling of parsing and production ("mirroring"). Parsing in DS incorporates aspects of production, i.e., the parser does not passively expect the scanning of input to produce structure, instead, the Context DAG is expanded at each word step with the generation of predictions (goals) in order to accommodate what will be encountered next. On the other hand, production in DS employs exactly the same mechanism and DAG as parsing with the only difference that, instead of scanning input, every step of articulation is licensed by a richer tree, a so-called *goal tree*. The goal tree is a tree at least one-step forward from the tree-under-construction, and a potential next processing-step through the DAG is licensed by the tree-under-construction *subsuming* the goal tree. Subsumption means that the partial tree that is being developed must be extendible into that goal tree by following the licensed actions of the system (Purver & Kempson, 2004) – put simply, whereas parsers have to follow what the speaker offers them, speakers have to have at least some partial idea of what they are going to be communicating at the next step.

So given this incrementality and predictivity of processing, first, there is nothing to prevent speakers initially having only a partial structure to convey, i.e., the goal tree may be a PARTIAL tree, perhaps only one step ahead from what is being voiced. Secondly, since the DS-grammar implements a notion of *predictivity*, if, at some stage during sub-sentential processing, an interlocutor has the ability to satisfy the projected goals via their own resources, e.g., via lexical-access or by extending the current tree with a LINKed-tree, it is perfectly sanctioned by the grammar for them to take over and continue extending the partial tree through DAG paths perhaps not foreseen by the original speaker (see e.g. (2), (14) above).

Moreover, since DS does not assume the mediation of any connected syntactic derivation in such cases, it is able to deal even with cases where, as we saw in (16), repeated modified here as (30), split utterances can take forms which would be ungrammatical under standard assumptions *(*Did you burn myself?)*:

(30) Mary: Did you burn

Bob: myself? No.

Figure 1.8 displays the partial tree induced by processing Mary's utterance *Did you burn*, which involves a substitution of the metavariable projected by *you* with the term standing for the current addressee, Bob. At this point, Bob can complete the utterance with the reflexive. This is because a reflexive, by definition, just copies a formula from a local co-argument node onto the current node, just in case that formula satisfies the person/number conditions of the expression, in this case, that it designates the CURRENT speaker.

Since sub-sentential/sub-propositional elements can perform various discourse functions ("speech acts") as seen above, e.g. (19), the DS analysis of split utterances applies equally to cases like (*reprise*)-*sluicing*, *reprise-clarifications*, *corrections* etc. without assuming that such sub-sentential-constituents need to be

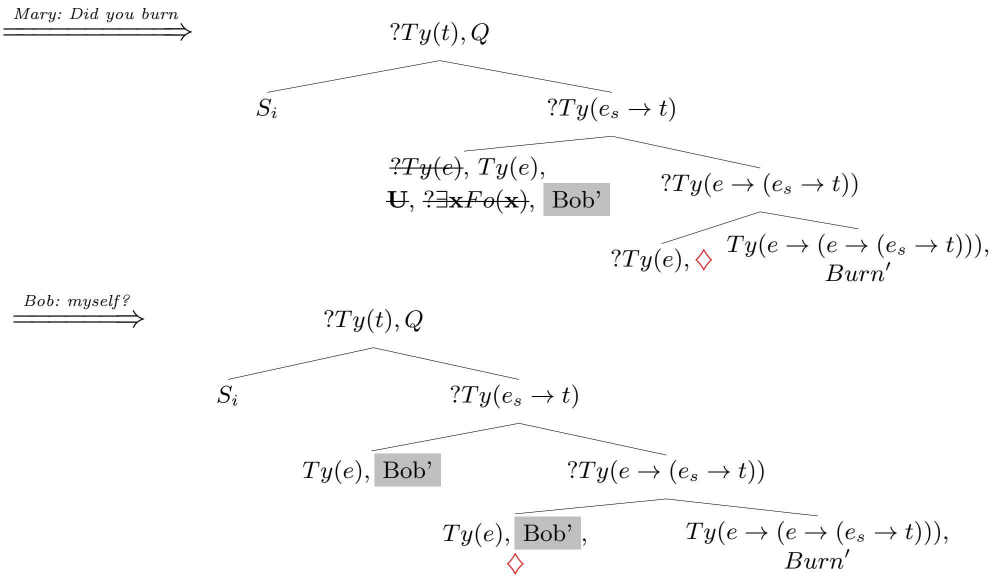

Figure 1.8. Incremental development of Mary's/Bob's context via processing words.

sententially/propositionally expanded (Kempson *et al.* (2007); Gargett *et al.* (2008, 2009); Gregoromichelaki *et al.* (2009); Eshghi *et al.* (2015)). For example, cases of elliptical clarification interaction, mid-sentence, as in (31) only involve locally-attached LINK-structures, with their discourse function modelled only as effects on the DAG (see e.g. Eshghi *et al.* (2015)):

(31) A: I had to go back to the hospital for a follow-up appointment. The doctor

B: Chorlton?

A: Mhm. He said I had a shadow on my lungs.

Such clarifications are construed relative to whatever constituent immediately precedes them, as in (31), where what is pertinent to the sub-sentential interruption is the immediately preceding DP *the doctor*. So such utterances are analysable in exactly the same terms as split utterances more generally, where the fragment is taken to directly extend its antecedent structure in context, here just the content derived from *the doctor* through the independently motivated LINK-adjunction. Fig. 1.9 shows the result of processing (generating for B, parsing for A) of the utterance *Chorlton*.[7]

1.3.5 Licensing the splitting of dependencies across turns

Having given a unified account of linguistic processing as mappings from context-to-context, making redundant extra machinery of idiosyncratic constraints applying to structure over strings, it becomes evident that the

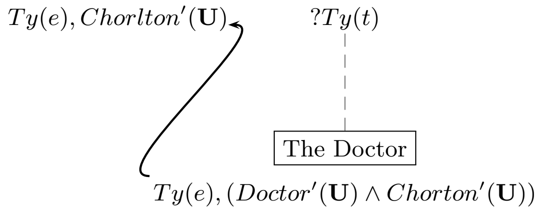

Figure 1.9. Processing *Chorlton?* in "A: *the doctor* B: *Chorlton?*"

phenomena "anaphora" and "ellipsis" are really part of the wider phenomenon of incremental licensing of NL-strings and interpretations. We therefore expect them to display parallel properties, and this is in fact what we find.

We first note the parallel potential between pronouns and ellipsis for anticipatory forward-looking resolution ("cataphora"). In English, only some pronouns licence this localised anticipatory function, with the clausal sequence following the predicate used to provide the value for the anticipatory *expletive* pronoun (for details, see Cann *et al.* (2005)).[8] Given our modelling of split utterances in terms of DAG options constraining the next processing actions of both interlocutors, as we would expect, the requirement of resolution of such an anticipatory device, can be taken over by another party to formulate according to their own context or to serve their own purposes (see also (2)):

(32) A: Even if *you* could ...

B: *I* wouldn't help you, that's right.

(33) A: *It* is obvious ...

B: that *you are wrong*

Further, as we show above (e.g. (4)), there is the parallelism between pronominal-anaphora and VP-Ellipsis in that they are both resolvable, indexically, from the utterance situation.

So ellipsis, like pronominal-anaphora, is resolvable either through backwards-search recovering content or actions from the Context DAG, or by just imposing a constraint for its resolution and restricting the available DAG paths for both interlocutors to those providing content for its resolution, or, indexically, by introducing in the DAG aspects of the utterance situation.

Now a generalisation missed by other frameworks (e.g. Kobele (2012)) but revealed through this modelling is that this three-fold parallelism extends to "syntactic" mechanisms, for example, those underpinning long-distance dependencies. First, in parallel to cases (32)-(33) above, the method of initially building an unfixed node and resolving its position later is the standard mechanism used in DS for long-distance dependencies. But, the structure that finally resolves the structural underdetermination of such unfixed nodes can equally be provided by backwards DAG search and reiterating actions from context. For example, *Mary* in (34), is uttered in a context where actions are available for repeated application:

(34) A: Sue, John upset.

B: Mary too.

Here, triggered by the presence of *too*, *Mary too* is interpreted as 'John upset Mary' via a sequence of actions in which $Mary'$ is taken to annotate an unfixed node, later unified to become the internal argument of $Upset'$, exactly following actions used in interpreting the preceding string. And given that DS parsing and production mirror each other, resolution goals imposed on the DAG by one interlocutor both constrain and are resolvable by the other:

(35) A: The books, I'm told that we needn't insure.

B: The Assyrian horse ...

A: we definitely must insure.

Completing the parallelism is the resolution of an unfixed node indexically. Of these, striking instances are children's one-word utterances in early language-acquisition where they rely on their interlocutor to provide some open structure into which their presented fragment can be incorporated, as in (20) repeated here as (36):

(36) A (pointing to an empty mooring site on the canal): Daddy

B: Yes, you were here with Daddy yesterday, clearing out the boat. That's right dear.

Thus, from this perspective, use of fragments in split utterances (see e.g. (15)-(17)) isn't merely an optional economy measure, it is an essential vehicle for coordination, which is crucially exploited during both language acquisition and in day-to-day human interaction. Moreover, this prediction of a parallel dynamics between pronominal-anaphora, ellipsis, and long-distance dependency resolution, inexpressible in other frameworks, provides meta-theoretical foundations supporting not merely the dynamic perspective on "syntax" proposed, but also the potential it provides for context-grounded interaction.

1.3.6 Licensing repair devices: self-repair and corrections

But even further than this, a unified account of linguistic processing as mappings from context-to-context, aiming to model action-coordination during interaction, can accommodate, in the same terms, the phenomena

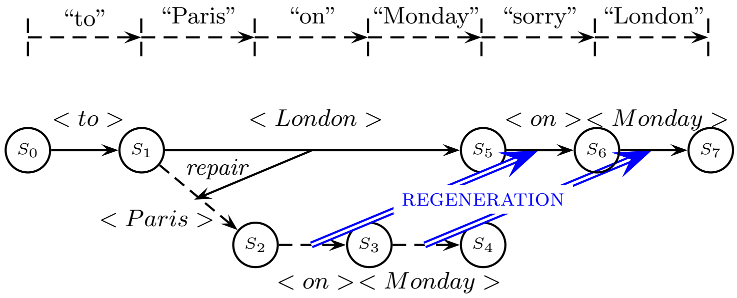

Figure 1.10. Incremental interpretation of self-repair by replaying DS actions in the Context DAG.

that arguably overtly promote coordination, namely, *repair* (see e.g. Schegloff (2007)), which has traditionally been rendered a performance phenomenon unworthy of interest for theoretical linguistics. For example, *self-repair*, a pervasive phenomenon in dialogue (Shriberg, 1994), is naturally accounted for given the DS notion of the DAG context and content recoverability employing backwards-search. The same backwards-search mechanism described above for various other ellipsis cases applies again in repair cases, however these are triggered by the current processing state being abandoned and processing resuming again from appropriate prior points in the context (see Hough (2011) and Hough & Purver (2012) for details). This strategy models common types of self-repair phenomena such as short stuttered repeats (*I, I go to Paris*) and substitutions (*John likes, uh, loves Mary*), but it can also deal with more complicated licensing phenomena where, as predicted, ellipsis interacts with the repairing of structure. In the following example, ellipsis reconstruction must operate across an interruption point + in a repair:[9]

(37) Peter went to [*Paris* on Monday, + {sorry,} *London*]

This is a case where the content of *London* repairs the content derived from *Paris on Monday*. However, under one interpretation, the speaker continues to describe the event as one occurring 'on Monday', and this requires elliptical resolution after abandoning the content of *Paris* and replacing it with the content of *London*. To model this, the action sequences triggered by *on Monday* must be replayed after the substitution of one argument content for another. Schematically, the incremental steps leading to this can be seen in Fig. 1.10 where the operation of Regeneration applies after processing has resumed from the point just before the DAG options including *Paris* are abandoned (characterised as state S_4 in the diagram), finally arriving at the revised interpretation at S_7.

This same backtracking with Regeneration mechanism naturally extends to *other-corrections*, where the repair is not of one's own utterance but another's. It is the fact that actions are first-class citizens in the DS context that allows this straightforward integration of parsing and generation to enable the direct reflection of incremental dialogue-level coordination across interlocutors.[10]

Nevertheless, as we will see immediately below, such an action-based framework remains capable of expressing even presumed arbitrary formal "syntactic" constraints as those applying to restrict the licensing of various forms of ellipsis, for example, antecedent-contained ellipsis as in (11).

1.3.7 Licensing in local processing domains: island restrictions

DS takes the grammar to be a model of the joint processing actions of speakers and hearers. From this perspective, standard syntactic constraints are reconceptualised as constraints on processing DAG options, expressed in the same vocabulary, and, as we saw, expected to interact with phenomena like pronominal-anaphora and ellipsis. We've already seen that standard, presumed sui-generis linguistic constraints, like *island restrictions* as displayed by, for example, relative clauses can be accounted for through the assumption of self-contained processing domains (see §1.2.3). Processing a relative clause, as we saw in §1.2.3, is taken to involve temporary shifting to a newly introduced tree structure in order to provide the context deemed necessary for proceeding with the processing of the main tree. For this reason, while processing goes on in the new domain, the fixing of an unfixed node initiated in the main tree has to await shifting of the processor back in the main tree (see Kempson *et al.* (2001); Cann *et al.* (2005)).

With this perspective on island constraints, the restrictions on *antecedent-contained ellipsis* emerges unproblematically:

(38) John interviewed every student [who Bill already had].

(39) *John interviewed every student [who Bill ignored a teacher [who already had]].

Simplifying for reasons of space here, in these cases, the DP is minimally made up of a determiner (*every*), a nominal (*student*) and a relative pronoun (*who*) initiating a relative clause which contains the ellipsis site (*had*). This relative clause is expected to provide an added restrictor to the variable bound inside the epsilon-term $\tau, x, Student'(x)$ which is the content contributed by the DP (see Fig. 1.11).[11]

The DP word sequence has to be processed under the usual principles governing the processing of relative clauses. First, processing the determiner phrase *every student* involves constructing an abstract ($\lambda y.\tau, y, Student'(y)$) that will result in binding a variable x introduced by the noun *student*. Second, a LINKed tree is constructed from the node occupied by x with the requirement to include this variable as one of the arguments of this new LINKed tree in order to furnish it with further restrictions. Because relative pronouns in English appear as "left-dislocated" elements, an unfixed node is introduced initiating the building of this LINKed tree in order to process the relative pronoun, *who*. Processing the relative pronoun, through anaphoric means, duly annotates this unfixed node with a second copy of the variable x. It is then the underspecified domination relation associated with the unfixed node, ($\langle\uparrow_*\rangle Tn(a)$), which determines the locality of that initially unfixed node as being within the domain of a single tree. As a result, this then precludes the possibility that this unfixed node could be unified as the argument of a further LINKed tree as, by definition, there are no dominance relations holding across LINKed structures (Fig. 1.11):

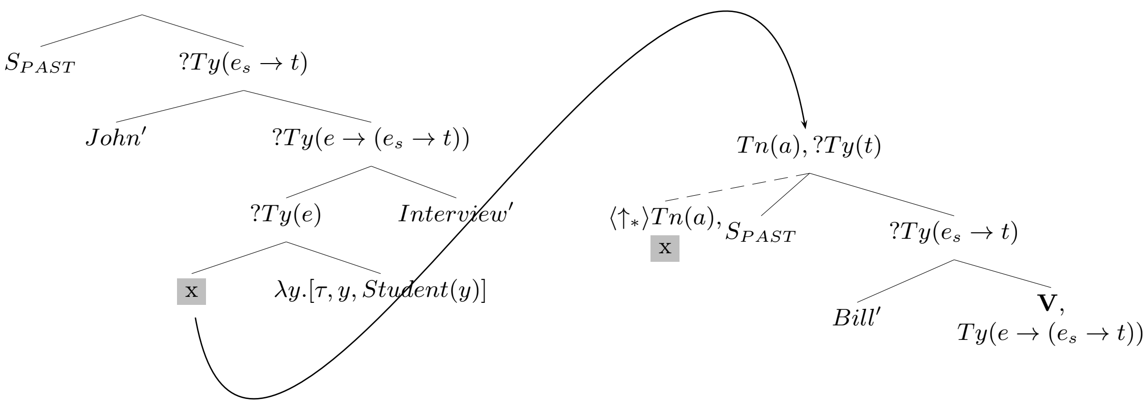

Figure 1.11. Successful processing of *John interviewed every student who Bill had*

Now, in coming to resolve the metavariable **V** which the ellipsis site *had* has contributed inside the relative clause, a sequence of actions from the context has to be retrieved that will result in a sub-tree of $Ty(e \rightarrow (e_s \rightarrow t))$. But now the choice of which sequence to select is constrained: the selected sequence that will resolve the ellipsis has to conform to the already mentioned independent restriction on unfixed nodes imposed on the partial tree already constructed from the relative pronoun. Hence the variable x can only appear in the local tree and cannot cross further to another LINKed one. This explains the island sensitivity yielding ungrammaticality in (39) where this constraint cannot be satisfied (Fig. 1.12).

Notice the significance of this result. In other frameworks, island constraints would be articulated within the component of syntax, independent of any interpretation/processing actions, hence not expected to interact with ellipsis/anaphora construal. In DS, however, with syntax defined in terms of update of the DAG content, such restrictions, being constraints on local processing domains, are directly predicted to also constrain ellipsis. This

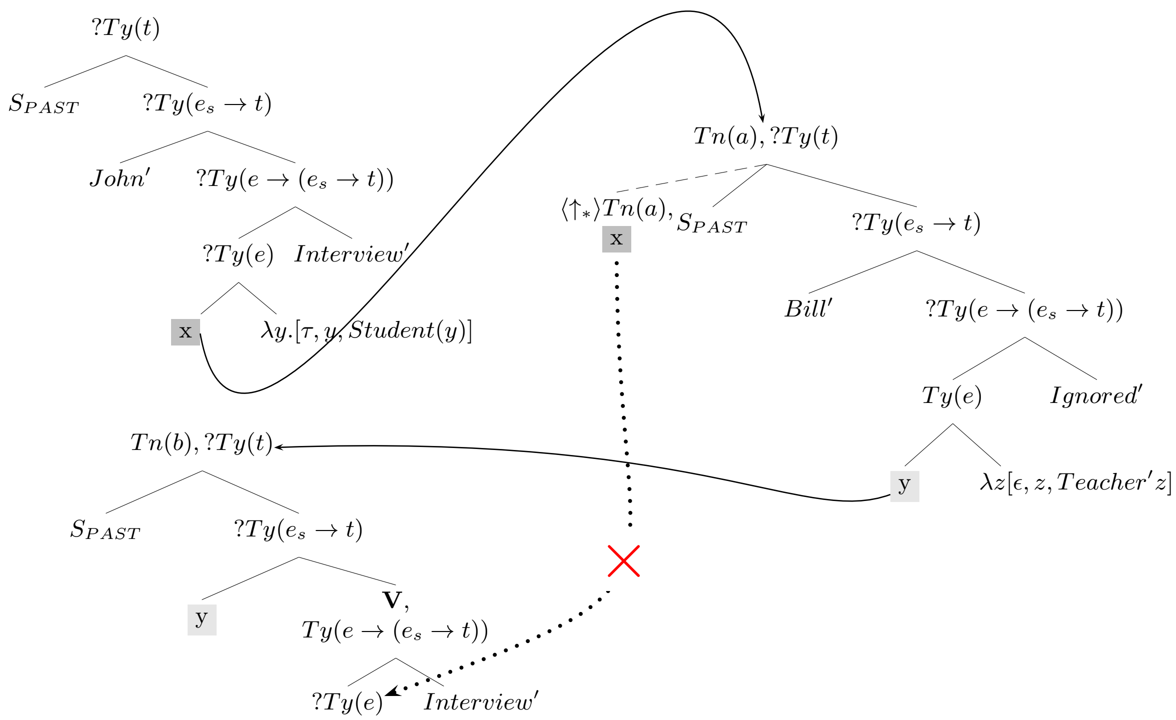

Figure 1.12. Ungrammaticality of (39) as impossibility to unify unfixed node with object of *interview* in second relative clause

is because ellipsis is also modelled as a process of contextual development, therefore required to conform to any restrictions applying independently to such processes.

1.4 Reflections: static vs dynamic perspectives compared

Stepping back from the details, we can see how the present account of ellipsis compares to standard accounts. Like earlier accounts, the present one also addresses the issues of the nature of the the ellipsis site itself, the recovery of its content, and licensing limits on that recoverability. However, the main explanatory tool for addressing standard cases of ellipsis here does not provide descriptions of decontextualised syntax-semantics mappings (*derivations*, e.g. Kobele, 2014). Instead, DS models directly the parser/generator actions involved in processing the skeletal information projected by some ellipsis sites. Such actions, as in routine anaphora resolution cases, include the ability to introduce, retrieve and reuse contextual resources. Replacing a competence model embodying propositional knowledge of sentence-proposition mappings, we take grammars instead to model the know-how of interpreting and producing language in context. As such, the grammar in general, and syntax in particular, does not involve sui-generis devices or representations, instead domain-general mechanisms like underspecification and update are the core notions. As in the general domains of perception and action, the conceptualisations afforded by linguistic elements proceed incrementally and predictively, and since participants' actions in an interaction form each other's context, actions and conceptualisations can interleave in jointly achieving coordination across sentence boundaries and across turns. From such a perspective, participants do not need to formulate hypotheses as to each other's intentions since the goal-directed subpersonal mechanisms of the grammar are adequate for enabling low-level coordination without having to explicitly derive propositional descriptions of each other's actions.

Notes

[1]Note that the claim here is *not* that a sentential structure or linguistically-based logical form needs to be recovered in order to interpret the case-marked NP (e.g. a verb like *rufen* in German); instead, as argued later, what is advocated here is that such morphological constraints restrict directly the role of referents within conceptualisations of events/situations (Gregoromichelaki, 2006; Hough, 2014), the latter conceived as non-linguistically-mediated, geometric-topological structures, as in e.g. Gärdenfors (2014), or perceptually-grounded type classifications, see e.g. Larsson (2013)). There is no necessary one-to-one mapping from such conceptual structures to the words of a particular language.

[2]Again the claim here is not that Accusative vs Nominative choice in Greek indicates the presence of linguistically-articulated but hidden structure; in contrast, as in (8)-(9), morphological case, like any other linguistic constraint, restricts the conceptualisation of the ongoing or envisaged event/situation, in this instance, the roles of the entities referred to, see also previous footnote 1. Our general claim in this chapter is that exactly this function of linguistic elements is the reason why linguistic structures routinely do not have to be completed up to a sentential level in order to be interpretable.

[3]In this exegesis we ignore quantification, merely noting that NPs (DPs) in DS project actions that lead to the construction of arbitrary names denoting a witness of type e, with scope variation expressed as anticipatory statements of term-dependency incrementally projected during the construction process (Kempson *et al.* (2001); Cann *et al.* (2005)). Proper names will be shown here in the abbreviated form $John'$, $Bill'$ etc. Tense/aspect/modality specification, defined as sortally restricted event terms, are indicated by $S_{i,j,...}$ (Gregoromichelaki, 2006; Cann, 2011).

[4]This use of the term *Merge* is a unification step, not to be confused with its use in Minimalism.

[5] The arrow linking the two trees depicts the so-called LINK relation and $\langle L^{-1} \rangle$ reads as 'linked to'.

[6]For formal definitions, see Kempson *et al.* (2015).

[7]Simplifying here, with definites taken to contribute anaphoric content needing resolution, the node marked with the box, 'the doctor', shows the incorporation of additional information identifying the individual sought to replace the metavariable **U**, namely, that he is a doctor and named Chorlton, this being the result of the conjunction of the formula annotating the root node of the LINKed tree, with that of that node - the operation associated standardly with evaluation of LINKed trees (see above section 1.2.3).

[8]Many languages display anticipatory as well as anaphoric uses, commonly called *Pronoun Doubling* (Gregoromichelaki, 2013).

[9]The bracketing and symbolisation follows Shriberg (1994) where the square bracketed material to the right of the interruption point + repairs the material to the left of it.

[10]For a more detailed account of contextual updates as a result of self-repairs, corrections, clarification interaction and their responses, and other forms of feedback in dialogue, see Eshghi *et al.* (2015).

[11]DS employs the *epsilon-calculus* (Hilbert & Bernays, 1939) with arbitrary names (*epsilon-terms*) as the content derived from quantified DPs.

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