Chapter X: Ellipsis

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1 Ellipsis: a window on context?

Ellipsis is a phenomenon in which what is conveyed, in some sense to be explained, doesn't need to be fully verbally articulated, as in the second clause in (1):

(1) I looked after John for all of 1976. His brother too.

The term *ellipsis* comes from the Greek: élleipsis, "omission", defined as picking out 'constructions that lack an element that is recoverable or inferrable from the context'.[1] In the light of this self-evident dependence on context, pretheoretically, the questions which such elliptical structures give rise to are:

(a) What kind of notion of *context* is needed to model the process of ellipsis resolution?
(b) What does ellipsis reveal about linguistic *content* and the nature of natural languages in general?

These questions are seriously in need of answer by any theory purporting to explain the structure and use of natural language (NL); and the purpose of this chapter is to propose answers to them. It should be said, at the outset, that this stance is not shared by all NL researchers. Those studying context-dependence in NL do not, in general, turn to ellipsis as providing clues for how to formally model context; and, until recently, theoretical linguists have largely ignored the data of conversational dialogue where ellipsis is pervasive.

The reason for the gulf between context-modelling and formal study of ellipsis is that ellipsis has been seen, very generally, as a phenomenon that is to be explained grammar-internally, either syntactically or semantically, while granting that there might remain recalcitrant data requiring pragmatic explanation. Following the standard methodology according to which grammars induce wellformed sentence strings with corresponding propositional semantics, with no reference made to the dynamics of how NL is processed in context, elliptical constructions are presumed to be incomplete sentences (*fragments*).Yet the striking mismatch between the surface string and its interpretation means that all ellipses constitute an immediate challenge for a standard methodological assumption: the *compositionality principle*, according to which sentence meanings are determined by the meanings of the words of the sentence and their mode of combination. But, as a result of the pervasive sententialist methodology, even pragmatists who have drawn attention to such problems and ellipsis data that lie beyond the remit of explanation available to sentence-based syntactic/semantic accounts have not attempted to suggest some alternative, more inclusive, account (Stainton, 2006).

In consequence, the phenomenon of ellipsis has been seen as irreducibly heterogeneous. In contrast, in this chapter, we will be bringing together various sets of data, conforming to the characterisation of "lacking" elements of

[1] http://www-01.sil.org/linguistics/glossaryoflinguisticterms/WhatIsAnEllipticalConstruction.htm

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surface structure, with interpretation available from context, and then arguing that an integrated account of ellipsis is possible with a shift of foundational assumptions to allow the on-line dynamics of processing to constitute the basis of core grammar.

1.1 Ellipsis in informal conversations

The conversational exchange in (2) illustrates some of the major ellipsis types that have been identified in the literature as underlyingly full-sentences/propositions despite incomplete surface realisation. As (2) shows, some of these form (part of) a subsequent conjunct in a compound clause, some form questions, others answers to questions, and yet others are extensions of what has just been said:

(2) a. A: Is there any chance of staying at your place in February?
b. B: John wants to stay on the 17th.
c. B: And on the 18th.
d. B: When were you hoping to?
e. A: The 19th.
f. B: OK, but Mary has also asked to. Maybe you could share?
g. A: I'll call her and ask whether she's willing to do so.
h. B: Please do.

Of these, perhaps the most well-known are the phenomena of VP-ellipsis and VP-anaphora. *VP-anaphora* involves overt ellipsis indicators, such as *do so* in (2g). In the strikingly similar phenomenon of *VP-ellipsis*, as in (2d) and (2f), the string may just come to a stop. However, the phenomenon of ellipsis is far broader than these. First, there is the general availability of providing fragment follow-ons to a preceding full assertion, as the *on the 18th* in (2c), which relies on the context, in this case the previous conjunct, for its interpretation. As a subcase of this, there are answers to questions, which are canonically just a single constituent, sometimes called *stripping* (Ross, 1967) or *bare-argument ellipsis*, as *the 19th* in (2e). There is also *gapping*, (3), *pseudogapping* (B's reply in (5)), and a whole set of phenomena called *sluicing*, (4), often treated as a special case of bare-argument ellipsis as in (5) (e.g. Culicover & Jackendoff, 2005):

(3) A: Jane will bring potato salad and Bill coleslaw.

(4) A: Who else is coming?
B: Someone else is coming but I don't know who.

(5) A: Probably Susan. By the way, is she suing the hospital?
B: She is, the doctor.

Yet, in our view, itemising such distinct types is misleading. In labelling and then analysing a small subpart of the overall phenomenon, it is suggested

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that there is no larger issue to be addressed. But this is very far from being the case: there is systemic context-dependence at work in the construal of ellipsis. As various researchers have recently demonstrated, a single type of element, e.g., a simple prepositional phrase as seen below, is subject to multiple interpretations, depending on whether it is understood as a *confirmation* (6), an *answer* to a question (7), a *completion* of what someone else has said (9), a *correction* to someone else's suggestion (8) (Fernández & Ginzburg 2002; Schlangen & Lascarides 2002; Purver 2004; see also Schlangen, this volume):

(6) A: I left it on the table. B: On the table!

(7) A: Where did you leave it? B: On the table.

(8) A: Should I put it back on the shelf? B: On the table.

(9) A: I think I put it er... B: On the table.

And even this display of variety is only an indication of the breadth of the challenge that ellipsis poses, of which (9) provides the first hint. (9) involves a change of speakers causing a split between the verb and its subcategorised complement, creating a so-called *compound utterance*. This problem is general: what informal conversations display in very broad variety is how such splits can bifurcate every dependency that syntacticians or semanticists have ever identified. (10) is a more complex example: the split between the parties bifurcates a question-providing environment, a quantifying expression, some pronoun to be construed as a variable bound by that quantifier, and a negative polarity item dependent on the question environment and the quantifier:

(10) A: I'm a bit concerned about the students. Has everyone handed in
B: his term paper?
A: or even any assignments?

In this way, individuals severally contribute to conversational exchanges, so that what appears as a single sentence may be produced across several contributors, without any one of them having entertained in advance what finally emerges through their interaction:

(11) A: We're going to London
B: to see Granny
C: with the dogs?
B: if you can control them.

And even the act achieved by such fragments may not be fully determined, for example, a single fragment may be able to function simultaneously as the completion of a question and the provision of an answer:

(12) A: Should I put it back on the shelf, or on ...
B: the table.

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If then we are to provide a characterisation of ellipsis across the span of variation, we must be able to model not only how overt ellipsis indicators such as *do so* license recovery of an interpretation from context, not only the way in which fragments depend on their function within a context as to how they are to be construed, but also the way they can extend what others offer in a conversation. The challenge of modelling ellipsis as a phenomenon in its own right is, then, the task of providing a formal account that is sufficiently rich to match the huge variety of types of construal, and yet sufficiently general to constitute an explanation.

2 Meeting the Ellipsis Challenge

2.1 Syntactic approaches to ellipsis

There is an intuitive first step in attempting to provide a theoretical account of ellipsis: one can start with the assumption that ellipsis occurs when the speaker, as a means of economy or some other reason, does not wish to repeat the *words/phrases* that have already been used. Leaving aside the characterisation of the full set of dialogue data,[2] seeing ellipsis as a strategy achieving economy of expression has led to analyses involving the (phonological) deletion of syntactic structure at the ellipsis site, under identity with structure in the antecedent clause (Chomsky, 1995; Lasnik, 1995; Merchant, 2004; Sag, 1976; Williams, 1977). Alternatively, other syntactic accounts have postulated rules that reconstruct the structure of the antecedent at the ellipsis site (Fiengo & May, 1994; Lappin, 1999). However, VP-ellipsis may result in the possibility of more than one interpretation depending on the context, even for a single construal of the antecedent clause, threatening the requirement for compositionality between syntax and semantics. For example, given the first conjunct of (13) as 'John checked his own mistakes', the second conjunct can be interpreted in two ways: one in which Bill checked John's mistakes (the *strict* interpretation), the other in which Bill checked his own mistakes (the *sloppy* interpretation):[3]

(13) John *checked his mistakes*, and Bill did too.

Furthermore, this time threatening the scope of syntactic well-formedness conditions, both the ellipsis site, and the antecedent clause from which it picks up its interpretation, can occur across different interlocutors in a dialogue (see earlier (2)) and at any level of embedding, see below (14)-(15):

[2] Syntacticians tend not to address conversational-dialogue fragments, seeing them as performance dysfluencies. For an exception regarding short answers, see Merchant (2004). For discussion of the extensiveness of fragments in conversation, see Fernández & Ginzburg (2002).

[3] In the following examples, the antecedent that provides the ellipsis-site construal is italicised, for clarity.

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(14) John was worrying that the woman [who had been *trying to persuade Mary to leave school*] shouldn't have been ~~trying to persuade Mary to leave school~~.

(15) John was worrying about the woman [who was trying to persuade Mary (to *leave school at 16*)]. Fortunately, she wasn't successful and Mary didn't ~~leave school at 16~~.

In fact, no *linguistic* antecedent is necessary for the occurrence of VP-ellipsis, (16), it can also occur non-locally, (17), cataphorically, (18), and there is no requirement for syntactic categorial matching between antecedent and the putative reconstruction at the ellipsis site, (19–20):

(16) [Context: Parent to teenage son with surf-board standing in shallows:] I wouldn't if I were you. The flag is flying, it'll be dangerous.

(17) I disagree with the writer who says funeral services should be *government-controlled*. The funeral for my husband was just what I wanted and I paid a fair price, far less than I had expected to pay. But the hospitals and doctors should be. (Brown Corpus, cited in Hardt 2003)

(18) I don't remember if you did, but has Sue *replied to Mary's invitation*?

(19) This problem was to have been *looked into*, but obviously nobody did. (from Kehler 2002)

(20) I wish I could *bring you good news*, but today I am *not*!
(BBC National Weather, 5 February 2014, 6.20am)

This potential for resolving VP-ellipsis from the non-linguistic context or freely and at arbitrary levels of embedding in a clause is fully parallel with pronominal anaphora. Such a link between ellipsis and anaphora then would seem to support more the "folk-linguistics" view of ellipsis as 'not said, because already available in context', which does not imply restriction to linguistically-encoded contents (see also Hardt 1993; cf Lappin 1999).

The justification for restricting some elliptical phenomena to a syntax-based characterisation, however, is that the freedom of its construal appears not to be completely unrestricted. This is shown in the subcase of VP-ellipsis, so-called *antecedent-contained ellipsis* (equivalently *antecedent-contained deletion*). This phenomenon appears to be subject to the "strong island" restrictions that are taken by many to be diagnostic of *syntactic* unbounded dependency constructions,[4] because they impose restrictions not expressible by semantic means alone. So, though (21) is well formed, (22) is not, being apparently a violation of the so-called Complex-NP Constraint (Ross, 1967)

[4] Island constraints have become subject to debate, see Hofmeister & Sag 2010; Phillips 2013, inter alia

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which precludes dependencies between a dislocated expression and an associated position in a clause embedded within a noun phrase, here a relative clause:

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

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

As a result, ellipsis and pronominal anaphora have not been analysed in similar terms. To the contrary, pronouns that are subject to grammar-internal explication have been analysed in terms of various licensed co-indexings, whereas VP-ellipsis is taken to involve (invisible) syntactic structure, with deletion or reconstruction of this structure (minus its associated phonological features) to derive the overt form (Lappin, 1996; Lasnik, 1999). And this type of analysis, employing standard syntactic rules and representations, is then extended to cover other constructions where the link to context is even more obvious. For example, Merchant (2004) analyses NP fragments that occur as answers to questions (*short-answers*, see (23)) as having an underlying full sentential structure. The fragment is treated as having moved from its base position, exactly as with the analysis of the *wh*-question. The remainder of the clause, now a constituent lacking the fragment answer, is then deleted, leaving a surface sentence string with just the fragment remaining as the sole overt expression:

(23) A: What did Bill manage to fix up for himself? B: A huge bonus.

This type of analysis aims to provide an explanation of the syntactic parallelism between overt and covert structures, hence the supposed sensitivity of elliptical fragments to the full array of case concord, binding theory requirements, and island constraints (see Fiengo & May 1994 and others following). This type of derivation is assumed to underlie *stripping*, as in (2), *sluicing*, as in (4), and similar phenomena like *pseudogapping* in (5) (see Depiante 2000; Merchant 2003, 2004, 2008).

However, a uniform explanation of all these constructions via inviolable syntactic restrictions runs into problems. Despite the island-constraint effects displayed in antecedent-contained ellipsis, there is contrary evidence for *short-answers* as in (23). Stainton (2006) provides data where the short-answer, according to Merchant's analysis, would have to originate internally to an island configuration (e.g. a coordinate structure, as in (25), out of which movement is supposed to be debarred):

(24) A: Bo likes coke and what? B: Tomato juice

(25) *Tomato juice$_i$ Bo likes coke and e_i.

The very same problem arises with *stripping*, another form of *bare-argument ellipsis*, which in most respects is just like VP-ellipsis. Like VP ellipsis, stripping licenses strict and sloppy interpretations, as in (26), where a sloppy

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interpretation of *her* is natural with 'Mary' becoming the indirect object of 'hand' and (27) where a strict interpretation of *his* is natural, as well as sloppy interpretations despite gender mismatch:

(26) Yesterday I had to hand Sue her end-of-contract notice. Mary too.

(27) Hospital nurse in charge of appointments:
I gave Mr Pinner a copy of his hospital letter. His wife too.

The only difference between VP-ellipsis and stripping is that the "stripped" NP fragment can be interpreted as one of a number of arguments because, unlike VP-ellipsis, the fragment lacks any auxiliary to help induce a subject construal. And, in stripping, like the short-answer cases, there is no evidence of any sensitivity to island constraints, which seems to counter-indicate movement analyses (Culicover & Jackendoff 2005):

(28) A: What kind of Scotch does Harriet drink?
B: Expensive.

(29) *Expensive$_i$ Harriet drinks Scotch e$_i$

(30) A: John has introduced me to a woman who speaks French
B: With an English accent?

(31) *With an English accent$_i$, John has introduced me to a woman who speaks French e_i

This is by no means the end of the problems for a syntactic account of ellipsis. Its immediate consequence is the need to recognise multiple ambiguities on a large scale not merely for the ellipsis site, but for the antecedent clause also. For example, in order to predict strict vs sloppy construals at the ellipsis site, structural ambiguity has to be attributed to both the antecedent clause and the ellipsis site in order to have available the appropriate matching structures that account for the distinct readings. But this invocation of ambiguity will have to be attributed to every sentence string containing the relevant pronominals, since any such sentence can be antecedent to both stripping and VP-ellipsis. Yet, even this assumption, that strict and sloppy construals be assigned distinct underlying structures, is unable to account for the data. There are sequences of elliptical fragments, as in (32), in which the first ellipsis site (in the second sentence) can be assigned a sloppy construal, but this in turn can be switched to yield a strict interpretation for the third sentence:

(32) John *thinks he's clever enough for the job.* (And) So does Harry/Harry too. But John's wife doesn't. She is much less sanguine, and thinks he should be trying for other jobs.

If each type of interpretation, sloppy vs strict, is derived from a distinct syntactic structure that can be attributed to the antecedent VP, *thinks he's clever*

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enough for the job, only one disambiguated structure will be represented as each clause is interpreted. Then the interpretation of the two ellipsis sites in (32) as a sloppy-strict alternation cannot be derived. This is because, once the structure that results in a sloppy interpretation has been assigned to the first elliptical clause, that same one has to be assigned to the subsequent ellipsis site. So, contrary to what the intuitive reading is, there will be no antecedent for a strict interpretation in the second ellipsis site.

2.2 Semantic approaches to ellipsis

With the mounting ambiguities facing syntactic accounts, semanticists took up the challenge of providing a semantic explication for ellipsis construal on the basis of some antecedently provided content. The assumption was that the fragment itself should be assigned a simple surface structure, with the possibility of deriving multiple interpretations without the need to posit underlying discrete syntactic structures. The influential semantic characterisation proposed by Dalrymple *et al.* (1991) involves defining a process of abstraction over the propositional content of some antecedent clause, to yield a predicate functor able to combine with the content of the fragment. This construal mechanism is taken to apply directly to the fragment expression itself under certain constraints. Consider (33):

(33) John sneezed and Bill did too.

The above sentence has a structure which involves a *parallelism* between the two conjuncts: whatever property P is predicated of John in the first conjunct is also predicated of Bill in the second. Simplifying somewhat, the core of the idea is that ellipsis involves the solution of an equation as regards the content of the antecedent clause. The interpretation of an elliptical element like *did (too)* as occurs in *John sneezed and Bill did too* is given by assuming that some identical property P holds both of Bill and of John. To resolve the ellipsis we must determine the value of P, which in (33) will lead to the following equation as regards the content of the antecedent clause:

(34) $P(John') = Sneeze'(John')$

Resolving what P can be involves applying an abstraction operation to the content of the antecedent conjunct, *John sneezed*, to yield a predicate abstract that could be applied to the parallel subject, *Bill*, in the second ellipsis-containing conjunct. In our simple case of (33), the value for P would be (35) which can then be predicated of $Bill'$:

(35) $P = \lambda x.Sneeze'(x)$

To reflect the strict/sloppy readings, this process of abstraction is said to take two distinct forms: (a) the position abstracted over is just that of the subject, so just one variable is bound by the λ-abstraction operator (strict

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reading); (b) abstraction occurs over the subject position plus all other occurrences in the antecedent clause of the variable in the subject position (sloppy reading). So for (13) earlier, the two readings will be given by constructing two distinct predicates, informally expressed as:

(36) $\lambda x.\ x$ *checked John′s mistakes* (strict)
$\lambda x.\ x$ *checked* x*′s mistakes* (sloppy)

The restriction to subjects (and the variables they bind) is not intrinsic to the abstract-construction process itself, which is wholly general, and has to be stipulated. Nevertheless, this account has the advantage of not invoking ambiguity intrinsic to the antecedent structure, as it is the distinct modes of predicate construction which yield the different interpretations, and not discrete underlying syntactic structures (for an updated version see Pulman 1997).

However, a number of empirical problems face the semantic account. Arguably the most pressing is evidence that fragments display syntactic sensitivities, which a purely semantic approach cannot account for. Firstly there is the island-sensitivity of antecedent-contained ellipsis, as indicated by (22). Then there is the fact that fragments display language-particular morphosyntactic restrictions. For example, in languages with rich case morphology, a fragment has to bear an appropriate case specification, as if the frame in which the fragment is construed had been fully explicit. B's fragmentary clarification *Esi?* in (37) below has to be expressed with the appropriate case, nominative, and not accusative, since the pronoun is construed as the subject (see also Ginzburg 2012; Schlangen 2003 and Schlangen, this volume):

(37) A: Tin ida 'I saw her' [Modern Greek]
B: Esi$_{2ndPersNom}$? / *Esena$_{2ndPersAcc}$? '*You* (saw her)?'

This phenomenon is robustly displayed across case-rich languages, so cannot simply be set aside as some language-particular idiosyncracy. A purely semantic account of ellipsis as in Dalrymple *et al.* (1991) (see also Gawron & Peters, 1990) will fail to extend to these phenomena, as such morphosyntactic restrictions are not reducible to constraints on semantic (denotational) contents: such constraints dictate the *form* of the fragment. So heterogeneity of ellipsis threatens to be irreducible, for it seems tempting to conclude without more ado that both syntactic and semantic accounts are needed.

2.3 Grappling with fragment heterogeneity

Addressing this ad-mixture of syntactic and semantic challenges, Ginzburg and colleagues set out a framework that takes seriously the challenge of defining a concept of context that is sufficiently rich to be able to account for the requisite morpho-syntactic, syntactic, and semantic, constraints (see e.g. Fernández & Ginzburg, 2002; Fernández, 2006; Purver, 2004). This

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empirically-oriented approach proceeds from detailed corpus analyses and classification of phenomena. Due to the observed idiosyncrasy of pairings of morpho-syntactic/semantic-pragmatic constraints, they argue against single unifying mechanisms. Instead, a constructionist version of HPSG was defined (Ginzburg & Sag, 2000), i.e., a grammar equipped with representations (in HPSG terms, 'signs') that specify various grammatical (lexical-syntactic) / semantic constraints and contextual specifications on a case-by-case basis. VP-ellipsis is, accordingly, treated as a separate construction in which forms of auxiliary verbs are specifically licensed to appear without the total set of their complements. For non-sentential fragments, like the *short-answers* in (23), (24), (37), this account, like semantic accounts of ellipsis, imposes no hidden syntactic structure. However, the constructionist version of HPSG, in effect, suggests a revision of traditional notions of headedness and constituency in syntax. The fragment in such cases, e.g., an overt noun-phrase, is allowed to project a sentential category in order to enable it to acquire a (quasi-)propositional reading in combination with material made available in an explicitly structured model of context. *Sluicing*, as in (4), equally does not involve movement or constituent-deletion so the fact that sluicing is not island-sensitive (Ross, 1967) is predicted. Instead, on this account, a separate construction is posited (*direct sluicing*): the *wh*-phrase fragment projects a sentential category (a "sluice-fragment-clause") whose content is retrieved by combining the content of the *wh*-element with an abstract derived from a proposition salient in the context (in the spirit of Dalrymple *et al.* (1991)).

As expected, this analysis relies on a detailed account (dubbed KOS) of the structure and dynamics of context in dialogue; and the model duly provides construction types for a number of non-sentential fragments (NSUs) in dialogue, over and above the ellipsis categories already identified by previous syntactic analyses. The role of the context in determining which of these is selected is modelled by explicitly defining various "coercion operations" on context representations. This enables otherwise homonymous fragments to receive a range of interpretations and speech act functions according to their current context of occurrence, e.g. short-answers, sluices, exclamations, and even "metacommunicative" interpretations such as clarifications, corrections, etc. The latter thus become grammaticalised, specialised constructions, rather than interpretations derived through pragmatic inferencing.

To achieve this range, KOS models each dialogue participant's context ("information state") as a data structure consisting of attribute-value pairs. Unlike standard accounts of context as in DRT and formal pragmatics, these information states record a whole range of semantic, syntactic, and even morpho-syntactic constraints. To model dialogue, information states include (i) the attribute FACTS, being a set of the mutually known propositions that constitute the usual notions of *common ground*; (ii) the attribute QUD (questions under discussion) which is a set, partially ordered by a precedence relation, of the current issues that the participants are discussing; (iii) the attrib-

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ute MAX-QUD which has as its value the most highly ordered question in the set of QUDs (the "topic" of the current stage in conversation):

(38)
$$\begin{bmatrix} \text{FACTS} & : & \text{set of facts } \{f_1, f_2, ...\} \\ \text{QUD} & : & \text{set of questions } \{q_1, q_2, ...\} \\ \text{MAX-QUD} & : & \text{question } \{q\} \\ ... & : & ... \end{bmatrix}$$

These complexes of information evolve as the conversation proceeds. For example, the speech acts of querying and assertion both involve a question (i.e. an issue) becoming maximal in the speaker's or hearer's QUD. This is because, in conversation, participants need to comprehend (*ground*) and accept each other's utterances and, in this model, this assumption has an effect on the shape of the grammar. Questions are modelled as propositional lambda-abstracts: a polar interrogative like *Did Bo leave?* will give rise to a 0-ary abstract, $?\lambda\{\}.Leave'(Bo')$, an assertion like *Bo left.* will result in MAX-QUD being updated with $?\lambda\{\}.Leave'(Bo')$, in that the issue of Bo's leaving has been raised for consideration, and *wh*-questions involve simultaneous abstraction over a set of restricted variables, e.g., $?\lambda\{x_{person}, y_{person}\}.Greet'(x, y)$ for *Who greeted who?* (for more details on this view of questions – see Chapter 8 this volume).

When an interlocutor uses an interrogative, as in (23) earlier, the conversational rules governing the dynamics of the participants' information states will enable the enrichment of subsequent non-sentential fragments (*short answers*) to propositional responses. Abstracting away from various details and complications (see Cooper and Ginzburg this volume; Schlangen this volume), use of interrogatives has the effect of introducing in context both an illocutionary force declaration (*ask(Speaker, p)*) and an update of MAX-QUD with a propositional abstract p that reflects the content of the question:

(39) A: Who finagled a raise? $\Longrightarrow$

(40)
$$\begin{bmatrix} \text{SEM} & : & ask(\ A,\ \ ?\lambda x.Finagle'(x, Raise')\ ) \\ \text{MAX-QUD} & : & ?\lambda x.Finagle'(x, Raise') \end{bmatrix}$$

Occurring in such a context, short-answer fragments, e.g. bare NPs, are analysed as a construction mapping the NP to a root clause with a propositional content and the illocutionary specification of an assertion. The rule licensing the construction specifies that its propositional content arises by combining the question in the current MAX-QUD attribute of the context with the uttered fragment's content:

(41) B: Bo. $\Longrightarrow$

(42) $\left[\text{SEM} : \quad assert(B,\ P(Bo')), \text{where current MAX-QUD} : ?\lambda x.P(x)\right]$

Given the MAX-QUD value available in the context, (40), this will derive the content of (41) as:

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(43) $\left[\text{SEM}: \quad assert(B,\ Finagle'(Bo', Raise'))\right]$

More recently, Ginzburg and colleagues have adopted Type Theory with Records (TTR) (Ranta 1994; Cooper 2005, Ranta, this volume, ch.12), as an appropriate representational language to express the grammar and context specifications (Ginzburg, 2012); see Cooper & Ginzburg ch. 10 this volume). In TTR, *records* are data structures consisting of sets of ordered pairs ('fields') of attribute ('label') - value assignments, i.e., they record the assignment of entities to variables or discourse referent-like objects. These records are conceived as representing 'situations'/'events' (Barwise & Perry, 1983). As such they can be taken as providing the articulation, not only of the situations that participants describe in a conversation, but also the actual speech events that occur in the conversation, and the role of such speech situations as contexts.[5] In order to enable the grammar to manipulate such situations, *record types* are defined that classify situations under types. These types reflect the interface of the external world with cognition: for example, record types can classify events as falling under categories that express perceptual judgements, meaning relations, grammatical information, speech act assignments etc. Because record types are extendable to more specific types, the underspecification that permeates such type judgements is naturally handled.[6]

Ginzburg (2012) takes full advantage of the expressive power of TTR by recasting HPSG in a TTR format (HPSG-TTR) so that all restrictions on ellipsis, comprising (morpho-)syntactic, semantic and pragmatic effects, can be defined. With utterance types ('signs') modelled as record types and actual utterance tokens, speech events, modelled as records, the grammar and the conversational mechanisms are provided with means to articulate constraints at both the type (grammar) and the token (context) levels. Most notably, this has the advantage of making it possible to model metacommunicative interaction, i.e., participants talking about the conversation itself. In these cases, utterances can refer both to previous utterances and to utterance types, for example, in cases where somebody is asking for the meaning of a word just used. It also covers forms of ellipsis construal which involve comment upon aspects of some previous utterance, for example, *clarifications*, *acknowledgments*, *corrections* etc. In (44) for example, the clarification request of B listed as (44a.(i)) has a reading which queries which individual named 'Bo' A is talking about ('intended content reading'), but it may also be a query as to what kind of a name *Bo* is (note that this is a natural type of construal when the query concerns the verb *finagle* in (44a.(ii)):

[5] For an alternative DRT-like representation of such information see the PTT model, Poesio & Traum 1997; Poesio & Rieser 2010.

[6] TTR, unlike AVM-based HPSG (Ginzburg & Sag 2000), has the further advantage of naturally allowing dependencies between types and includes the full power of the lambda calculus plus the license for multiple abstraction across any parameter (see Cooper 2005). It is therefore ideal for allowing multiple interactions across both syntactic and semantic forms of information.

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(44) a. A: Did Bo finagle a raise? B: (i) Bo? / (ii) finagle?
b. Intended content reading: Who is Bo? / What does it mean to finagle?
c. Clausal confirmation reading: (i) Are you asking if BO (of all people) finagled a raise / (ii) Bo *finagled* a raise (of all actions) [examples from Ginzburg 2012]

Yet, as Ginzburg points out, these readings also seem to need to be distinguished from what he calls 'clausal confirmation readings' in (44c).

If the grammar and the model of the participants' information states afford the possibility of reference to actual utterance events and their types as assigned by the grammar, it becomes possible to explicitly model this full array of interpretation types. In effect, then, this model provides the potential for all interpretive possibilities to be enumerated and disambiguated within the grammar by assigning distinct utterance types to the fragment for each reading that is licensed in a particular context, including a particular illocutionary force. For example, in (44) above, distinct coercion operations and distinct utterance types are assigned to the fragment *Bo* depending on whether the appropriate reading is some variety of 'intended content' or 'clausal confirmation' or, even more broadly, a correction, confirmation, acknowledgement etc. as in the following (examples from Gregoromichelaki 2012):

(45) A: Did Bo finagle a raise?
B: Bo.... Lets see, I can't remember.

(46) A: And you saw Bo.
B: Bo.... Yes, I remember it well.

(47) A: And you saw Bo.
B: Jo. I said Jo.

(48) A: And I saw Bo going... Bo? Jo... Who did I say?
B: Jo. You said Jo.

(49) A: And you saw ...
B: Bo?
A: Bo, yes

(50) A: And you saw ...
B: Bo.
A: Bo, eh?

The expressivity of the HPSG-TTR model presented thus promises to provide a complete characterisation of ellipsis that includes the full array of fragments in language use. However, as already witnessed by (44)-(50), it is not clear that all fragment construals are amenable to definitive sentential/propositional paraphrases (notice e.g. (45), (46) where the fragment is used as a delaying device to allow the speaker to plan), or that interlocutors perform such

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fine-grained disambiguations while participating in a conversation. The question then is what constitutes a distinct reading of an expression in use: for a constructionist approach the answer opens up the potential of linguistically-encoded multiple ambiguity.

Even setting aside such worries, there are fragments whose content is recovered wholly from the situation within which the fragment is uttered (Stainton, 2006):

(51) A: Covent Garden?
B: Right at the traffic-lights, then straight up the hill.

The HPSG-TTR account deals with such cases through the enrichment of the context model with specifications for *genre*-recognition which then accommodates an appropriate proposition in QUD allowing for the licensing of such fragments. However, this accommodation mechanism cannot license all the relevant cases because the grammaticisation of fragment constructions allows licensing only on the basis of prior occurrence of specifically linguistic events. But, for all construction types specified, clarifications, corrections etc., fragments can occur without linguistic antecedents and displaying all the morpho-syntactic restrictions evoked to justify handling such constructions in the grammar (Gregoromichelaki 2012). This is evident in languages with, e.g., rich case specifications:

(52) [Context: A is contemplating the space under the mirror while rearranging the furniture and B brings her a chair]
A to B: tin karekla tis mamas? / *i karekla tis mamas?
the$_{ACC}$ chair$_{ACC}$ of mum's? / *the$_{NOM}$ chair$_{NOM}$ of mum's?
(Ise treli?) (Are you crazy?)
[clarification] [Modern Greek]

As they stand, the HPSG-TTR context-coercion rules licensing use of clarifications handle such constructions only when an utterance (characterised by a "locutionary proposition" with full phonological/syntactic specifications) is "pending" in the context. But there is no such utterance event occurring in cases like (52) above, and it seems implausible to coerce the pending of a whole utterance as well as a proposition in QUD. So these cases threaten to remain unaccounted for. It is notable that such cases are parallel to the VP-ellipsis cases in (16), and, in general, to anaphora, where a pronoun, with appropriate grammatical specifications, can be used freely without a linguistic antecedent. But the parallelisms with anaphora are not easily recoverable in any framework where the forms of explanation involve differentiation, and distinct structural projections.

2.4 Compound utterances and the challenge of incrementality

For HPSG-TTR, as with other frameworks, the modelling of compound utterances remains an open problem. Even though HPSG-TTR is able to deal

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with subsentential constituents in so far as sentential paraphrases are appropriate, it does not implement a fully incremental grammar. So, as a further consequence, it cannot deal naturally with cases like (9), (11), (12), (49)-(50), and *compound utterances* in general, the analyses of all these requiring incrementality to be expressed within the grammar formalism. Rather, each part of such shared utterances will have to be assigned the syntactic status of a (non-canonical) sentence in order to be assigned a (quasi-)propositional interpretation and illocutionary force. But, even if such multiplication of syntactic category types were made possible, the one-to-one syntactic/semantic/pragmatic correspondences that have to be postulated under such an analysis cannot be maintained. This is because occurrences of compound utterances in conversation do not require that an interlocutor provides a continuation that matches what the previous speaker had mind. For example, syntactic continuity does not guarantee that the interlocutor takes over the intended illocutionary force or semantic content of the previous speaker (see e.g. (9), (12), (49), (53)):

(53) A: What this shows is
B: that you have completely missed the point.

To the contrary, there is an open-ended negotiable nature to speech act performances in dialogue (Schegloff, 1988), which requires that no antecedently fixed content or illocutionary force be presumed. Indeed, the emergent nature of the content demands that underspecification be allowed as an option in the processing of such fragments in order to reflect this potential for extension or modification at all stages of the exchange, no matter who the speaker is. From such a perspective, it can then be seen that fragments can be used in the (implicit) performance of speech acts by exploiting their own syntactic dependencies to yield so-called *grammar-induced speech acts* (Gregoromichelaki *et al.* 2013a). For example, any syntactic dependency can be left pending by the speaker to induce the hearer to respond:

(54) A: Thank you mister ...?
B: Smith, Tremuel [natural data]

(55) A: And they ignored the conspirators who were ...?
B: Geoff Hoon and Patricia Hewitt
(BBC Radio 4, Today programme, 06/01/10)

As this incompleteness is possible at any point, any case-by-case constructionist approach would have to fully define any subsentential constituent as capable of bearing (quasi-)propositional readings and specific illocutionary forces of their own. However, even then many cases will not be covered because fragments can occur so early during a sentence under construction that there is no appropriate full proposition in the context to provide the requisite interpretation (as is required by a Dalrymple-style of account). Rather, such fragments are construed relative to whatever constituent immediately precedes them, as in (56), where what is pertinent to the fragment interruption is the immediately preceding NP *the doctor*:

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(56) 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.

This radical context-dependency of fragment construal due to the incrementality of processing is manifested by the hurdles posed by compound utterances for sentence-based syntactic formalisms which are conservatively amended as operating incrementally in order to splice the two parts together to derive a joint "complete" sentence-proposition (see e.g. Poesio & Rieser 2010; cf. Peldszus & Schlangen 2012). The data show that such joint syntactic structures cannot be what underlies the licensing of such fragments. For example, a local referential dependency can be established across a speaker-change, even though the required dependency involves specification of speakerhood:

(57) (Context: smoke coming from kitchen, B emerging)
A: Did you burn
B: myself? No fortunately not.

In this case, there is no well-formed *sentence* made up of the two halves of the compound utterance: **Did you burn myself?* is ungrammatical. However, if it is the representation of content that is significant here, there is no problem: *you* identifies speaker B and this is straightforwardly picked up by the speaker of the reflexive *myself*.

The challenge compound utterances pose is thus wholly general: for any structure and at any point, a speaker can add on something to what has so far been said, without either the partial structure in context or the provided add-on having to be of sentential type; and such add-ons are invariably extensions of the content established in the immediate context, whether by linguistic or non-linguistic means. All syntactic and semantic dependencies can be split; and no anticipated fixed propositional content presumed to be antecedently available is necessary.

There is, finally, a further problem that is not addressed by syntactic or semantic accounts of ellipsis and is only partially addressed by the HPSG-TTR account. Syntactic or semantic accounts of ellipsis do not make it possible to bring out the parallelisms there are between anaphora and ellipsis as context-dependent phenomena, for the characterisations provided are wholly distinct, and severally distinguished within these accounts as different bases for ambiguity, so wholly unlike the context-leaning property intrinsic to anaphoric expressions. And the pragmatic account of Stainton (2006), in allowing there to be syntactic and/or semantic types of ellipsis captured grammar-internally, is not offering an integrated characterisation of ellipsis either. So we turn to the framework of Dynamic Syntax (Kempson *et al.*, 2001; Cann *et al.*, 2005b; Gregoromichelaki *et al.*, 2011), in which context-dependency is captured at

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a fine-grained subsentential level, in which reflection of the incrementality of processing is taken as central in the formulation of the grammar.

2.5 A Grammar for incremental information growth

Dynamic Syntax (DS) is a formalism based on the psycholinguistically-inspired action-based modelling of NL strings-interpretation mappings in context. As a result, NL syntax is reconceptualised, not as a level of representation, but, instead, as a set of licensing mechanisms for inducing semantic content, incrementally, on a word-by-word basis. The mappings are defined in terms of semantic tree-growth reflecting real-time processing, both for NL parsing and NL production. As both parsing and production are defined as incremental and have to operate in tandem, the modelling of compound utterances emerges as an immediate consequence. Similarly, both parsing and production exploit context which, in DS, is modelled intuitively as a record of all the actions and outcomes of incremental NL processing. Accordingly, context records not merely partial structures as these are incrementally built up, but also the mechanisms used in constructing them. This richness of context is at the heart of the DS account of ellipsis construal. Like the direct reflection of parsing-production dynamics in compound utterances, the availability of strict and sloppy interpretations for a whole range of ellipsis and anaphoric devices is a direct reflection of this recording of actions and resulting content: both actions and content, once used, become available for recall and reiteration. Strict interpretations involve recall and re-use of exact contents; sloppy interpretations involve recall and reiteration of actions to yield distinct contents. So a unified account of ellipsis emerges, as we shall see, from the dynamics of the mechanisms underpinning the language system.

2.5.1 NL string - semantic representation mappings

We now turn to the details of these structures and the mechanisms that induce them. Processing is taken to involve either building (parsing) or linearising (production) a tree whose nodes incrementally come to reflect the context-enriched content of some utterance. For example, in processing a propositional structure (see Figure (2.5.1)), the first step is a tree that does nothing more than state, at the root node, the goal of the interpretation to be achieved, namely, to derive a formula of appropriate propositional type. This is indicated by the *requirement* $?Ty(t)$. The query, ?, indicates that this is a goal not yet achieved.[7] The eventual complete tree to the right of the $\mapsto$ in Figure (2.5.1) is a tree in which the propositional formula itself annotates the top node, and its various sub-terms appear on the dominated nodes, rather like a proof tree in which all the nodes are labelled with a formula and a type.

[7] The representation includes a Davidsonian event/situation argument S of type e_s, (details suppressed, see Cann 2011).

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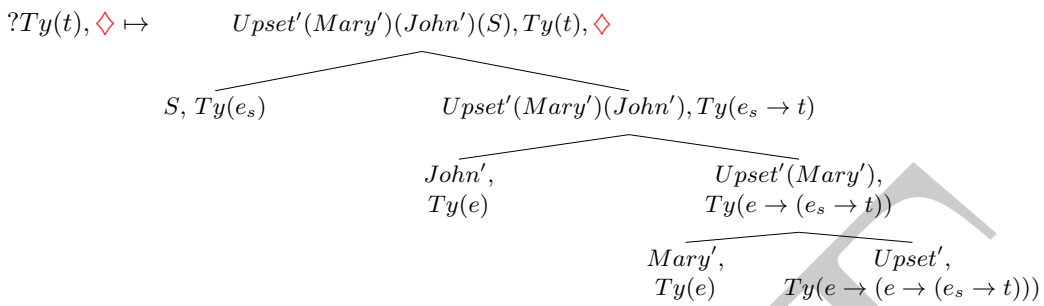

Figure 1. Processing *John upset Mary*

The parsing/linearisation task uses both lexical resources, actions and information from context to progressively enrich the one-node tree (parsing) or generate an NL word-string incrementally, corresponding eventually to the full tree on the right of $\mapsto$ (production). These DS trees are invariably binary, reflecting functor-argument structure, and, by convention, the argument always appears on the left branch, and the functor on the right branch (a *pointer*, ♢, identifies the node under development). Each node in a complete tree is annotated not with words, but with terms of a logical language, these being subterms of the resulting propositional representation.

2.5.2 Formal properties of trees and tree growth

In order to talk explicitly about how such structures are constructed incrementally, trees are formally defined, together with a vocabulary for describing actions that induce the requisite tree growth. Following Blackburn & Meyer-Viol (1994), DS adopts a (modal) logic with two basic modalities. There is $\langle\downarrow\rangle$: $\langle\downarrow\rangle\alpha$ 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 its inverse $\langle\uparrow\rangle\alpha$ which holds at a node if α holds at its mother, with argument ($\langle\uparrow_0\rangle$) and functor ($\langle\uparrow_1\rangle$) variants indicative of the status of the daughter relation so identified. *Actions* for tree growth are then defined as procedures for building such tree relations, involving a procedural vocabulary with actions defined as sequences of $\texttt{make}(X)$ for creating new nodes, $\texttt{go}(X)$ for moving the pointer, and $\texttt{put}(Y)$ for annotating nodes, where X and Y are tree relations and node-annotations (labels) respectively. Defined using this basic procedural vocabulary, *computational actions* in DS are generally available strategies for tree-growth without any lexical trigger; they perform movement of the pointer ♢ around some partial tree under construction; they remove requirements once they are satisfied; and they perform beta-reduction operations when possible. On the other hand, *lexical actions*, defined in the same way, are conditional actions associated with words, which, given a certain trigger, induce an unfolding macro of tree-growth actions that lead to some tree update from the partial tree containing that trigger:

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(58) IF ?(X)...; THEN `make`(Y), `go`(Y), `put`(Z),...; ELSE `ABORT`

The core pair of concepts driving forward the tree growth process is that of underspecification, of which there are various types: underspecification in terms of content, where the output of semantic processing has to be enriched from context; underspecification of type of tree or node to be built; and even underspecification of the relation of that node to others in the tree. For every node, in every tree, all aspects of underspecification are twinned with a concept of *requirement*, ?X, for some annotation X; and these are constraints on how the subsequent processing steps must progress. Such requirements apply to all types of annotation: there are type requirements, ?$Ty(t)$, ?$Ty(e)$, ?$Ty(e \rightarrow t)$ etc; treenode requirements, ?$\exists \mathbf{x} Tn(\mathbf{x})$ (associated with underspecified tree-relations in need of update); formula requirements ?$\exists \mathbf{x} Fo(\mathbf{x})$ for any expression which, though typed, is only a placeholder for the content to be fixed independently of its lexical projection; and modal requirements expressing future developments, for example ?$\langle\uparrow_0\rangle Ty(e \rightarrow t)$, which defines the contribution of accusative case-marking as a requirement that a node so annotated be immediately dominated by a node of predicate type. In each case, these requirements drive the subsequent tree-construction process: unless they are eventually satisfied, the parse will be unsuccessful.

2.5.3 Content underspecification and update

As we saw, words are associated in DS with lexical actions. Of these update actions, verbs are central to the emergent compositionality on the resulting tree. They construct a skeletal propositional template projecting a node for a predicate and nodes for the arguments as determined by the adicity and typing of the predicate. Nominal expressions are invariably of type e as part of an *arbitrary name* account of quantification.[8] So argument nodes are annotated with either the requirement ?$Ty(e)$ (to be satisfied by the processing of further overt linguistic input) or with a typed place-holding annotation like the one provided by anaphoric expressions (for nodes whose value doesn't need overt input-processing, *pro-drop*). Anaphoric expressions themselves can be of various types, projecting a metavariable content place-holder triggering either indexical construal or identification with content from elsewhere on the tree or the processing actions. The notation involves defining anaphoric expressions as projecting a formula metavariable ($Fo(\mathbf{U})$) with the accompanying requirement for formula update, ?$\exists x Fo(x)$. For example, expressions which encode the projection of an ellipsis site, such as *do so*, and, in English, bare

[8] *Arbitrary names* are the logical tool manipulated in predicate-logic natural-deduction proofs. Hilbert & Bernays (1939) defined *epsilon terms* within the *epsilon calculus*. In DS, such terms, being of type e, are interpreted as an arbitrary witness of their associated predicate (see Kempson *et al.* (2001); Cann *et al.* (2005a); Cann (2011), for details.)

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auxiliaries, are similarly characterised, projecting a metavariable of predicate type ($Fo(\mathbf{U}_{pred})$).

Since "syntax" is seen in procedural terms, and not as a separate level of representation, structural patterns normally identified as "syntactic" are expressed through the action vocabulary. For example, to identify the requisite concepts of locality constraining antecedenthood for both reflexives and pronouns, all that is needed is a characterisation of the steps that the pointer is allowed to make in seeking a potential antecedent. This characterisation derives as an epiphenomenon a notion of "co-argument": any formula value that can be found by moving up one argument-relation step plus a (possibly empty) sequence of function-relation steps (expressed through the Kleene Star operator $*$) and then one argument step below. *Reflexive anaphors* can then be characterised as projecting the action specified in Fig. (2):

IF	$?Ty(e)$,	
THEN IF		$\langle\uparrow_0\rangle\langle\uparrow_*^1\rangle\langle\downarrow_0\rangle Fo(\alpha)$
	THEN	$\mathtt{put}(Fo(\alpha), Ty(e))$.
	ELSE	ABORT
ELSE	ABORT	

Figure 2. Sample actions for reflexive anaphora

Conversely, the substitution process for regular pronominals can be defined as precluding as antecedent any formula decorating a node standing in such a local relation.

2.5.4 Structural Underspecification and Update

What is more striking within a grammar system is to view long-distance dependencies as the structure-building analogue of the content underspecification intrinsic to anaphoric expressions. In DS this is expressible because the grammar mechanism reflects the processing dynamics. Accordingly, amongst the computational actions are processes inducing underspecified structural relations, local and non-local, again defined using the $*$ operator . They also come with an associated requirement for future provision of a fixed tree relation, i.e. a fixed tree node address: $?\exists x Tn(x)$. For example, $\langle\uparrow_*\rangle Tn(a)$ is defined as holding at a node when there is at least one future development in which the node with address a bears a sequence of zero or more mother relations to the present node. This relatively weak tree relation is taken to express long-distance dependency effects in terms of structural underspecification and update. As can be seen in Fig. 3 below, when first processing the word *Mary* at step (i), it is initially construed as providing a term whose role isn't yet identified. This is achieved through the application of a computational action which introduces from the initial root node annotated with $?Ty(t)$, a relation

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to that top node which is *underspecified* at this juncture, identifiable solely as dominated by the top node (indicated by $Tn(0)$), and requiring type e, specified by a $?Ty(e)$ annotation (an *unfixed node*). This enables the expression *Mary* to annotate this node. The accompanying requirement for a fixed tree node position eventually induces the update of this underspecified tree-relation. In this derivation the update takes place after processing the verb which provides the two-place predicate structure in step (ii) of Fig. 3. Provision of a formula value for the object argument node and update of the unfixed node initially introduced is given by the *unification* step indicated there, an action which satisfies the update requirements of both depicted nodes.

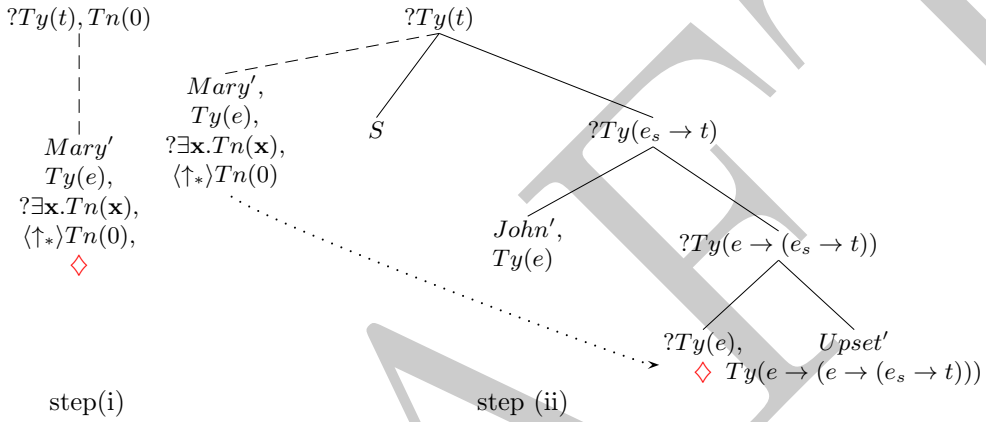

Figure 3. Parsing *Mary, John upset*

2.5.5 Compounding trees through term-sharing

In order to reflect the full array of NL compound structures DS employs a license to build paired trees, so-called LINKed trees. These are associated through the sharing of some term. This sharing is established through, for example, encoded anaphoric devices such as relative pronouns. Consider the structure derived by processing the string *John, who smokes, left* (omitting details of tense specification):

(59) Result of parsing *John, who smokes, left*:

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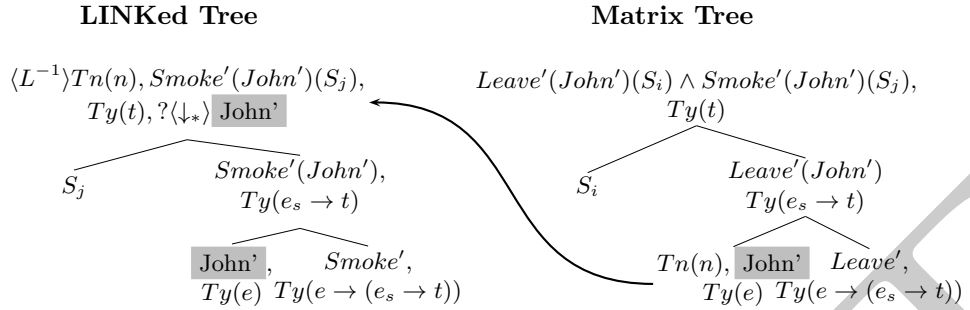

The arrow linking the two trees depicts the so-called LINK relation. The tree whose node is pointed by the arrow is the LINKed tree (read $\langle L^{-1}\rangle$ as 'linked to'). Such LINKed trees, provide opportunities mid-sentence for NL processing to shift temporarily to a distinct structure for purposes of elaboration, expansion, explanation etc. of terms in the main structure. And this can happen either within a single propositional turn, 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. of linked structures is definable type-generally, and has very general application, across Accordingly, as we shall see, LINKed trees provide an appropriately weak form of correlation between structures needed for modelling bare-argument ellipsis.

In addition, this articulation of compound structures as independent LINKed trees is what provides a natural basis for expressing the so-called syntactic *islands*: an unfixed node, cannot be resolved across a LINK relation. This is because the relevant address requirement imposed on it, e.g., $\langle\uparrow_*\rangle Tn(a)$), would not be satisfied given that the steps linking this node to $Tn(a)$ would necessarily include an intervening LINK relation (L), not just steps over mother relations as specified by $\langle\uparrow_*\rangle$ (see Kempson *et al.* 2001; Cann *et al.* 2005b).

2.6 Re-using context: ellipsis dynamics in DS

We now turn to looking at ellipsis from a dynamic perspective, where grammar is seen as a set of procedures for the incremental construction of semantic content. On this view, the concept of context is expected to be as dynamic as content, with an evolving record not merely of words and structure but also the individual steps in building these structures. This unfolding of options is represented in (Sato, 2011; Purver *et al.*, 2011) as a Directed Acyclic Graph (the CONTEXT DAG), where each node represents the current (partial) tree and each edge in the graph records the action taken. The context for any single partial tree is then the path back to the root of this graph. Thus there are three basic ways whereby current processing interacts dynamically with the context DAG, enabling the construal of the wide range of context-dependent phenomena reviewed above:

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(a) Re-use of content (semantic formulae) from some (partial) tree on the context DAG.
(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.

2.6.1 Content/action re-iteration: VP-ellipsis

As we shall now see, this enriched concept of context has the advantage of capturing the parallelism between ellipsis (*bare argument ellipsis* and *VP-ellipsis*) and pronoun construal with their joint display of strict/sloppy ambiguities. For strict interpretations of VP-ellipsis, it is copying of content from elsewhere on the tree which provides a substituend for some place-holding metavariable, $Fo(\mathbf{U}_{pred})$, occupying the ellipsis site. For sloppy interpretations, it is a sequence of actions selected from those that were used in building the antecedent that can be retrieved from the context DAG and reiterated at the ellipsis site. This will provide the appropriate interpretation, giving rise to a result that is parallel to the interpretation of the antecedent but discrete:

(60) Bill will help his students, though whether John will, is less clear.

In (60), on a strict construal, it is the predicate derived from processing 'help Bill's students' which is copied over as the predicate to be applied to the new subject *John*. On a sloppy interpretation, it is the sequence of actions that has been used in processing $help + his + students$ in the first conjunct that is carried over and re-applied to the subject *John*. This is achieved through the lexical specification of the elements indicating ellipsis in the fragment. For example, English auxiliaries are defined as a pro-VP expression projecting a predicate metavariable ($Fo(\mathbf{U}_{pred})$), which is duly enriched by taking some value from context (either by directly copying some formula value or by the re-running of actions). This analysis applies equally well to cases of VP ellipsis where syntactic dependencies have to be reconstructed at the ellipsis site as in (61):

(61) A: Who hurt himself? B: John did.

The DS processing for the question in (61) involves the following actions after parsing of the subject *who*: constructing a two-place predicate as indicated by the verb; the construction of an object argument; and then, because this object contains a reflexive pronoun, obligatorily identifying its value with that of the subject. Now, if these actions are stored as a sequence in context, they will then be accessible in that sequence for re-use in the next stages of the parse. Re-applying these very same actions on the new tree at the site of the elliptical fragment is triggered by the use of the auxiliary *did*. With *John* having annotated the new subject node, this then leads to the construal of the answer as involving a re-binding of the object argument (the reflexive pronoun) to the provided new subject ('John'). The effect achieved is the same as the higher-order unification account of Dalrymple *et al.* (1991) but

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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 to the elliptical element *did* or the subject *John*. All that has to be assumed is that the metavariable contributed by the anaphoric *did* can be updated by suitable selection of some action-sequence taken from the context, with the immediate bonus of identifying this process as anaphoric in kind.

2.6.2 Interaction of action reiteration and structural constraints: antecedent-contained ellipsis

A construction exploiting all the resources that DS makes available is *antecedent-contained ellipsis* (ACE, see (21), (22)) with its apparent sensitivity to strong island restrictions, the Complex-NP constraint. This emerges for free, as a side effect of the analysis of relative clauses as LINKed trees (see section 2.5.5), together with an account of relative pronouns in English as decorating an unfixed node, due to their left-peripheral position (see section 2.5.4). As we said earlier, the unfixed node, here introduced by the relative pronoun, cannot be resolved across a LINK relation. In cases of ungrammatical ACE constructions, the processing of the second relative clause contributes a second LINKed tree with the ellipsis site within it. As a result, the unfixed node created by the first relative pronoun cannot be unified across this second LINK relation. This is because the relevant address requirement imposed on the unfixed node ($\langle\uparrow_*\rangle Tn(a)$) would not be satisfied. So it is the dominance relation always associated with unfixed nodes which determines that the ellipsis site must be local within the LINKed tree that contains the unfixed node constructed by the relative pronoun. No ad hoc constraints or stipulation of particular constructions is necessary to ensure the effect of island sensitivity for the fragment.

2.6.3 Action reiteration for bare-argument fragments

This style of analysis can be expected to apply directly to those b*are-argument ellipsis* cases which, like VP-ellipsis, give rise to strict/sloppy ambiguities, again with either content or sequence of actions reiterated from the immediate context:

(62) John proofread his paper carefully. Bill too/And Bill/But not Bill.

Here the challenge is that despite the similarity to VP-ellipsis, construal of these fragments appears *not* to be island sensitive, as witness (63), where the fragment can be construed as a further assertion about John that he also plans to read all articles that appeared in the Telegraph last week:

(63) John plans to read all the articles [that appeared in the Times last week]. And the Telegraph too.

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The flexibility displayed in (63), is explained because the fragment is taken to annotate a LINKed structure (see section 2.5.5). This enables the relation between the term constructed from the fragment and some term in the emergent structure to be a structurally-unrestricted anaphoric dependence (since there is no unfixed node to be unified). Building of the LINKed structure involves re-iteration of actions, as in VP-ellipsis, but with one difference: one term in that sequence of re-iterated actions is replaced by a place-holder metavariable. This metavariable is subsequently identified relative to its new context, i.e., as replaceable by the content derived from processing the fragment, which is LINKed to the tree containing the metavariable. Modulo this one substitution, the parallelism of construal between the fragment site and antecedent structure is exactly as in VP-ellipsis. Notice that this strategy is not available to ACE because, in that case, ellipsis resolution is initiated from within an emergent LINKed structure within which the relative pronoun has induced an unfixed node. Thus, the locality restriction on that unfixed node imposes independently the island sensitivity. In bare-argument ellipsis, no such unfixed node is involved.

2.6.4 Ellipsis-anaphora parallels

This use of both content and actions reiterated from context applies equally to pronouns. Coreferential construals involve copying some already derived content of individual type e:

(64) *John* came into the room. *He* looked very sick.

On the other hand, so-called "lazy" construals involve a re-run of a set of previous actions at the site indicated by the pronoun:

(65) John, who is the more systematic, always keeps *his keys* in the same place. Michael just dumps *them* down when he comes in, and so is always losing them.

Here, interpretation of the pronoun *them* is achieved by rerunning the actions used to process *his keys* in the previous clause in the new context provided by the second sentence. This has the effect that 'Michael' becomes the new term binding the metavariable contributed by 'his'. As in sloppy construals of ellipsis, the denotational content of antecedent and anaphoric device under this construal are not the same: it is the process of establishing that content which is identical. So the pattern clearly suggests the possibility of an integrated account of pronouns, as long as anaphoric expressions are not simply carved up into discrete homonymous forms.

2.6.5 Rules for Ellipsis and Pronoun Construal

We now turn to the specification of the DS mechanisms for the retrieval of content (formulae) and action sequences from already-processed structures in

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context (we will not go into the full details of the formalism and the computations here, see for details Eshghi *et al.* 2011; Purver *et al.* 2011; Kempson *et al.* 2011). These are the contextual computational actions (see section 2.5.2) SUBSTITUTION and REGENERATION respectively.

SUBSTITUTION allows re-use of terms/formulae (semantic content) from some tree stored in context to provide fully specified semantic content/formula for some underspecified metavariable introduced when parsing a pronoun, an auxiliary, or a VP anaphor. This mechanism enables the *strict* interpretation both for VP-ellipsis / VP-anaphora, and the non-lazy, co-referential interpretation for pronouns.

SUBSTITUTION	IF	$Ty(X), ?\exists x.Fo(x),$
		$T \in \mathcal{C},$
		$\{Ty(X), Fo(Y)\} \in T$
	THEN IF	$\uparrow_0\uparrow_*^1\downarrow_0 Ty(X), Fo(Y)$
		THEN ABORT
		ELSE $\texttt{put}(Fo(Y))$
	ELSE	ABORT

X and Y are place-holders which range over type and formula values respectively. The context $\mathcal{C}$ is a Directed Acyclic Graph, made up of partial trees as nodes and DS actions as edges, thus making available both previous partial trees and the action sequences that lead up to them; $T \in \mathcal{C}$ is thus a tree on a node in that DAG. SUBSTITUTION checks for an antecedent of the correct type, $Ty(X)$, in context and that there is no violation of locality restrictions on non-reflexive pronouns, the $\uparrow_0\uparrow_*^1\downarrow_0$ test. If an appropriate antecedent is found it is used to provide a fixed value Y. This satisfies the requirement $?\exists x.Fo(x)$ originally introduced by parsing either a pronoun or an auxiliary, and acting as a trigger for retrieval of both formulae and actions from context.

The requisite mechanism for action re-running to yield sloppy interpretations of ellipsis and (lazy) pronouns is an equivalent to the SUBSTITUTION rule, as it allows for the provision of fully specified values for metavariables by re-use of actions (rather than by re-use of semantic formulae):

REGENERATION	IF	$Ty(X), ?\exists x.Fo(x),$
		$A = \langle a_i, \ldots, a_{i+n}\rangle \in \mathcal{C}$
		$a_i = \langle \textbf{IF}\ \phi_1\ , \textbf{THEN}\ \phi_2\ , \textbf{ELSE}\ \text{ABORT}\rangle,$
		$?Ty(X) \in \phi_1,$
	THEN	$\texttt{do}(\langle a_i, \ldots, a_{i+n}\rangle)$
	ELSE	ABORT

As specified, REGENERATION enables the processor to take a sequence of actions A from context (a path in the context DAG) and re-use them, provided that they were triggered by the same type-requirement ($?Ty(X)$) as is imposed on the node currently under development. Any such re-use of actions from context will be successful if and only if the result of applying these actions

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in the new context is suitable, i.e., it yields an output in which all requirements are now satisfied, or it allows actions of any immediately subsequent lexical expression to lead to a complete tree. A variant of the REGENERATION action is used for the characterisation of bare-argument ellipsis with its island *in*sensitivity and lack of an explicit trigger (such as the auxiliary in the VP-ellipsis case).

2.6.6 Direct re-use of structure: compound utterances and fragments

We now come to address one of the principal ways in which context is re-used: that of direct extension of some partial tree in context. And it emerges that this is what is needed to characterise not only the vast seemingly heterogeneous array of compound utterance data, but also some of the fragment types identified in Fernández & Ginzburg (2002), such as *short answers*, *sluicing*, and *reprise fragments*. For modelling these, we need to consider the tight coupling of parsing and production as modelled in DS. Given that the grammar is common to both, the only additional assumption underpinning production is that at every step of tree-growth there must be some richer tree, a so-called *goal tree*, which the tree under construction must *subsume*, i.e., the tree under construction must be able to be developed into that goal tree by following the licensed actions of the system (Purver & Kempson, 2004). To put this informally, parsers have to follow what the speaker offers them, whereas speakers have to have at least some partial idea of what they are going to be communicating. But otherwise, the dynamics of the two activities is shared so each processor simulates the actions of the other (Gregoromichelaki *et al.*, 2013b). In this respect, shift of roles from parsing to production and vice versa are directly predicted to be unproblematic (Gregoromichelaki *et al.*, 2011; Howes *et al.*, 2011). Due to the modelled incrementality of processing, two properties of the NL production (generation) mechanism are pertinent for compound utterances. 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. This is unproblematic, as the subsumption check with the goal tree is equally well defined over partial trees.[9] Secondly, via use of requirements, the DS grammar implements a notion of *predictivity*, i.e., the parser is defined simultaneously as a producer, constantly generating predictions as to what will follow next. As a result, if, at some stage in the processing, an interlocutor has the ability to satisfy the projected requirements 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 under construction in any direction they require. Consequently, DS is able to

[9] Cases where change in the goal tree occurs are modelled via backtracking along the context DAG, giving rise to overt repair (see Hough 2011).

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deal even with cases where, as we saw in (57), repeated modified here as (66), compound utterances can take forms which would be ungrammatical under standard assumptions *(*Did you burn myself?)*:

(66) Mary: Did you burn
Bob: myself? No.

Given that in DS only representations of semantic content are derived, not structures over strings of words, the switch of person mid-utterance is straightforward and leads to a wellformed result. Fig. 4 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.

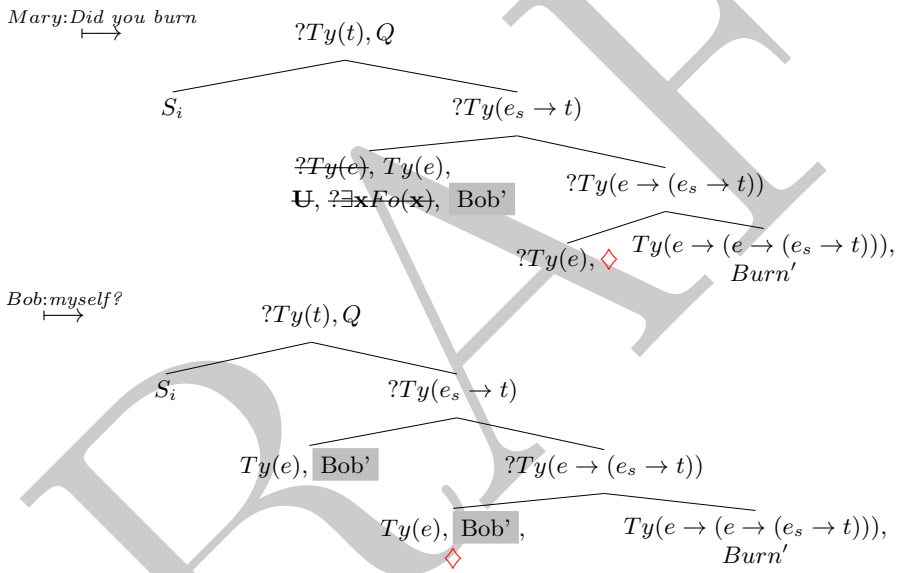

Figure 4. Incremental development of Mary's/Bob's context via processing words

This illustration is only of the simplest type of compound utterance, but the point is entirely general. These seamlessly achieved shared utterances can apparently separate off any expression from the syntactic environment it needs for its wellformedness because both speaker and hearer incrementally mirror each other in applying the same mechanisms. Moreover, one and the same individual, whether as speaker or as hearer, will invariably have a grammatically-licensed partial structure on which to rely at the point of participant switch.

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It is notably the absence of a "syntactic" level of representation distinct from that of semantic representations (put together with the fact that grammatical mechanisms and the lexicon are taken as procedural, context-dependent instructions for update) which allows the direct modelling of such fragments as genuine continuations rather than necessitating their analysis as sentential ellipsis. This phenomenon of speaker switch in the middle of a dependency under construction is a major challenge for sentence-based grammar frameworks even to express at all and potential analyses of each part as fragmental with subsequent reconstruction misses the discourse significance of an interlocutor presenting their offering as a continuation/interruption etc. (Gregoromichelaki *et al.* 2013b).

Finally, we turn to some of the fragment types identified in Fernández & Ginzburg (2002) as needing to be assigned discrete types for their resolution: *short answers* to *wh*-questions, *sluicing* and *reprise fragments*. The strategy needed to model these is that of introducing a LINK transition (see section 2.5.5), directly extending the tree constructed for the antecedent and available in context.The result is the construction of a pair of nodes matching in type, a transition that is independently motivated for the construction of adjoined or coordinated terms. This will then allow the parsing of the fragment as providing a term on the LINKed tree. In the case of short answers to *wh*-questions, as in (67), the answer provides a type e term LINKed to the type e node containing the **WH** metavariable introduced by the *wh*-word in the antecedent structure:

(67) A: Who did Microsoft hire?
B: Tim

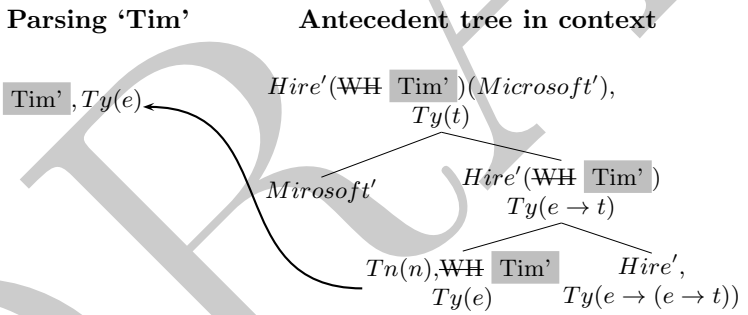

Figure 5. Re-use of structure from context: Short Answers to WH-questions

In such a case, the NP fragment *Tim* is parsed to provide a type e term (Tim') on a tree LINKed to the node containing the specialised **WH** metavariable, contributed by *who* and now available in context (see figure 5). The full term on the LINKed structure subsequently provides the substituend for the **WH** metavariable.

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For *sluicing* (e.g. as in "A: Bo left. B: Who? A: Bo"), and so-called *reprise fragments* (e.g as in "A: Bo left. B: Bo? A: Yes"), the same strategy of extending the antecedent structure through a LINK transition of the same type (type e) provides the requisite characterisation. We do not discuss these further here (see Gargett *et al.* 2009; Gregoromichelaki *et al.* 2009), but note that this strategy of directly extending the antecedent structure is distinct from what was needed above in the bare-argument ellipsis case (62) where the NP fragment was taken to trigger the construction of a full proposition using some reiterated sequence of actions from context. In (67), the local structure within which the fragment is construed is wholly provided by the question, so no reiteration is warranted. The difference between the two types thus lies not in any discrete underlying syntactic structures, but in how the provided fragment is processed: either as extending a structure already provided in context; or as re-using actions from context to create a novel structure.

2.6.7 Recovering type-incomplete action sequences: gapping

From our point of view, one further notable phenomenon, illustrating the multi-modal, unencapsulated nature of processing, is *gapping*, whose mode of interpretation turns, we suggest, on the trigger provided by its highly marked intonation:

(68) John is interviewing the Linguistics candidates, Harry the Philosophy ones.

(69) John is being interviewed for the Linguistics position today, Harry tomorrow.

Here we take due note of the often observed lilting intonation that such paired noun-phrase sequences carry. This simultaneously presents the two expressions as (a) providing the basis for a phrasal unit, but (b) by the equally strong stress prominence assigned to both of these, contrarily indicating that each has a separate role to play in that unit. We take this to be an indication that the first member of the pair provides the left edge of some action sequence to be reiterated, whereas the second member of the pair provides a pointer to what is the right edge of the action sequence to be selected. This means that the two NPs are processed by distinct modes of interpretation construction, as suggested by the intonation, the first as a LINKed (or unfixed-node) structure, the other updating some structure just induced. In (68) the action sequence to be selected from the first conjunct is that which was used to process *is interviewing*. Parsing of *the Philosophy ones* then fulfils the object requirement of the reiterated actions associated with the auxiliary-plus-verb sequence . On this view, the second NP is processed as directly extending the current action sequence rather than having to have some additional structure projected specific to its construal.

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Details aside, the general story to be derived from these illustrations and attendant specification of context-reiteration mechanisms, is that the combination of a rich and evolving concept of context, and a defined array of tree-growth actions is sufficient to encompass the different types of construal that can be assigned to fragments without need of individuated operations for each functional role they play in the interpretation process. Even the cases where the construal of the fragment, ellipsis site, or pronoun, is provided from a nonlinguistic context are unproblematic and expected for this framework. The domain-generality of the DS vocabulary allows that the action-based processing system can interface with other cognitive sub-systems (see also Larsson 2011), so cases where there is a feeding relation between the modalities, as in indexical construals, are expected.

3 Reflections

With "syntax" conceived of as a set of processing actions, an integrated explanation of ellipsis becomes achievable despite the wide diversity of effects. This is because there is a unified notion of context where each parse state contains a string of words, a partial tree, and the actions used to update some immediately previous parse state to yield that tree.

The heterogeneity of elliptical fragments then arises through the license they provide for any re-use of contextual resources – representations of content (for strict construals of VP-Ellipsis), tree-structure (for compound utterances, adjuncts, clarification requests, confirmations etc.), or actions (for sloppy construals, bare-argument ellipsis, gapping etc.). And the bonus of the account is how this display of possibilities is parallelled by anaphora.

A number of further issues arise from this perspective. The NL processing mechanisms (the grammar) as set out here do not necessitate recovery of any intentional attitudes underpinning the ellipsis production/interpretation process. In this connection, Gregoromichelaki *et al.* (2011) argue that recognising the content of a speaker's intention (mind-reading) is not essential to linguistic processing. A similar approach is taken by Ginzburg (2012), where the contextual contribution is grammaticalised in the form of constructions, in effect treating all fragments as indexicals. This view is also implied by various syntactic/semantic accounts whose sententialist-compositional orientation leads to a "minimalist" conception of semantic content (Borg, 2012; Cappelen & Lepore, 2005). However, both the constructionist and the minimalist approaches do not in the end reduce mind-reading: by having to postulate various syntactic/semantic types to be assigned to homonymous fragments, invocation of inferential mechanisms is required for the necessary disambiguation before grammatical licensing can even apply. Instead, we have suggested an alternative: a grammar modelling intrinsically the incrementality/predictivity of processing deals with context-dependency at a subsentential level, thus reducing drastically the unnecessary multiplication of options, hence the inferential

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burden. This is because employment of clause-medial fragment interruptions, when resolved incrementally, enables interlocutors to immediately address issues with a previous utterance, at any relevant point in the construction process (a form of "externalised inference", Pickering & Garrod 2004; Mills & Gregoromichelaki 2010). And, as the point of difficulty is pinpointed and resolved at the particular moment it arises, the occurrence of fragments, or any other context-dependent expression, does not result in the accumulation of multiple analyses for a single string leading to multiple propositional structures (for the significance of incrementality in language acquisition, see Eshghi *et al.* 2013 who set out an account of learning DS grammars from fragmental child-directed utterances). So this is an an intermediate position which endorses the minimalist assumption that a mechanistic system, the grammar, provides the route to semantic content, but by taking a radically contextualist view of the grammar mechanisms themselves. From this perspective, a grammar specifies knowledge of "how to go on" (Wittgenstein, 1980) in interaction with other people or the environment, knowledge that is not encapsulated but, nevertheless, efficient and domain-general (see Orwin *et al.* 2013 for a range of papers addressing parallelisms between music and language, in particular, Kempson & Orwin 2013; Chatzikyriakidis 2013; Gregoromichelaki 2013). So addressing issues raised by explaining the systemic use of elliptical fragments in ordinary conversational dialogue opens up wholly new horizons for exploring concepts underpinning languages and their use.

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