Talking and Listening: Dialogue and the Grammar-Pragmatics Interface

Ruth Kempson (KCL), Ronnie Cann (Edinburgh), Matthew Purver (Stanford)

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Ever since the the early 1980's, it has been a corner-stone of work in natural-language semantics and pragmatics that any model of interpretation of natural-language has to reflect the way in which understanding of words systematically depends on aspects of the context in which they are produced.[1] Throughout this period, however, syntacticians, semanticists and pragmatists alike have sought to retain a clear competence-performance distinction in which a grammar formalism is seen as a pairing of wellformed strings of the language with interpretation to be defined in some sense independent of considerations of use; and pragmatic theories and performance theories of parsing or production have had to be presumed to take some core formalism as the point of departure for their own explanations of aspects of language use. Even those individuals who have played a central role in promoting the importance of articulating concepts of underspecification in understanding the relation between natural language expressions and their interpretation in context have in general remained committed to the view that the grammar formalism articulates some pairing of syntactic structure for a sentential string and some representation of content for that string, in some sense sui generis. Amongst these are relevance theorists, and they have consistently advocated that the grammar articulates a pairing of sentences with logical forms as output, these being incomplete representations

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[1] This general stance emerged, in part, from study of the semantics of negation and the stance that the semantics of negation systematically underspecified its mode of interpretation in context: Wilson 1975, Kempson 1975, Atlas 1977, and others. But the development of the importance of developing general accounts of how interpretation of natural language expressions systematically required some function both of the intrinsic content of the expression and aspects of context took off in the early 80's and subsequently through the work of Kamp 1981, Sperber and Wilson 1982, 1986/1995, Kamp and Reyle 1993, and many others.

of content that constitute the input to the process of utterance interpretation, providing the evidence on the basis of which the hearer constructs an assumption of the proposition intended to be expressed (Sperber and Wilson 1995, Origgi and Sperber 2002, Carston 2002). In attacking all those they deem to be contextualists, Cappelen and Lepore (2005) have sought nevertheless to buttress this familiar dichotomy, and the distinctiveness between semantics and pragmatics as a reflection of it, by arguing that the extent of the context-dependence of natural language is much less than others have argued for, there being some minimal proposition that constitutes its interpretation that is independent of many aspects of use.

There has however been evidence accumulating in syntax and in semantics quite independently of the Cappelen and Lepore vs contextualists debate which demonstrates that the clean division of labour which Cappelen and Lehore promote between what the grammar formalism provides and what constitute pragmatic processes of interpretation in context is not sustainable. On the one hand, internal syntactic constraints and processes have been argued to reflect processes of parsing/production (Hawkins 1994, 2004, Phillips 1996, Kempson et al 2001, Cann et al 2005). On the other hand, semantic explanations have been argued to require some reflection of pragmatic processes while nevertheless themselves constituting a subpart of the grammar (Chierchia 2004, Ginzburg and Cooper 2004). Any of these modifications to the otherwise universally adopted dichotomy between competence models and performance models might be countered by arguing that its proponents have slipped into the trap of providing a code model of utterance interpretation (see Orrigi and Sperber 2002); but what is clear from these several debates is that detailed articulation of the interface between syntax, semantics and pragmatics is urgently needed.

An apparently unrelated challenge has been presented in psycholinguistics (Pickering and Garrod 2004) that formal models of language and language processing should be evaluated by how good an explanation they provide of conversational dialogue, this being THE central use of language. This might seem of little concern to debates within pragmatics and philosophy of language; but in this paper we argue to the contrary that responding to this Pickering and Garrod challenge opens up a new perspective on these ongoing debates. We shall argue for a grammar formalism that reflects the incremental way in which context-dependent interpretation can be built up online, presenting as evidence the unitary explanation of ellipsis it provides, otherwise analysable only as a heterogeneous bunch of un-related processes. We shall then see that this framework provides a basis for a formal account of dialogue that provides a direct reflection of the range of data characteristic

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of conversational dialogue, while nevertheless retaining a relatively conservative assumption about the relation between grammar formalism and model of dialogue, that a natural-language grammar does not itself constitute a grammar OF dialogue. But the consequence of adopting such a framework will be that concepts of sentence-meaning and logical form for a sentence sui generis have to be abandoned. So the construct on which the Cappelen and Lepore analysis rests will turn out to be a chimera.

1   The Dialogue Challenge

Arguably the most striking property of everyday dialogue is how easily we shift between the roles of producer and parser. We ask and answer questions in rapid succession:

(1)   A: Who did you see?
        B: I saw Mary.
        A: Mary?
        B: Yes, with Eliot.

We extend what the other person has said, presuming interlocutors can reconstruct the overall content whether as speaker or as hearer:

(2)   A and B talking to C:
        A We are going to London.
        B. Tomorrow. Because Mary wants to.

We may even interrupt, and finish each other's utterances:[2]

(3)   A: What shall I give...
        B: Eliot? A toy.

(4)   *Daniel:* Why don't you stop mumbling and
        Marc: Speak proper like?
        Daniel: speak proper?

(5)   A: That tree has, uh, uh, ?
        B: Tentworms.
        A: Yeah.

Such shifts between speaker and hearer can take place at any point, not necessarily at constituent breaks, and all forms of dependency may be distributed across the role-shift:

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[2]4 from the BNC, file KNY (sentences 315–317).

(6) *Ruth:* What did Alex …
     Hugh: Design for herself? A kaleidoscope.

(7) Ruth: Have you contacted
     Hugh: any doctors yet? No, not yet.

And, far from being an esoteric and peripheral phenomenon, switch between speaker and hearer roles is something which even children with newly emergent language skills do with ease, as their invariant pleasure in the Old Macdonald game clearly demonstrates:

(8) Ruth: Old MacDonald had a farm. Ee-ai-ee-ai-oh. And on that farm he had a
     Eliot: pig.

   But this is by no means all. In addition, there is extensive cross speaker-hearer parallelism in dialogue. Speakers and hearers prefer to retain parallel strategies in shifting from the one application to the other, despite all the prescriptivism discouraging repetition in writing. So words are repeated, the particular interpretation ascribed to them, and the structural environment in which that word is used (Pickering and Branigan 2001, Pickering and Garrod 2004):

(9) Mary: What did you give the children?
     Ruth: We gave Eliot a teddy-bear.
     Hugh: I gave him a music-box.
     Ruth: And we gave Susie a kaleidoscope.

Indeed, such patterns are not restricted to lexical subcategorisation frames associated with particular lexical items. Over the last thirty years of linguistic pedagogy, working syntacticians have been familiar with the problem that to get robust judgements of wellformedness of long-distance dependency effects, contexts need to be set up to induce the parallelism effects that make such sequences natural:

(10) Bill, I think Sue is proposing as President. Tom, I am certain she is proposing as Treasurer.

Such parallelism is striking too in language acquisition, where it is more familiarly known as mimicking (Tomasello 2003).

1.1 The Split Utterance Challenge

These data pose a challenge for linguists and psycholinguists alike. Conventional grammar formalisms provide no basis for modelling parallelism effects, and no means of getting a principled handle on split utterances. Question-answer pairs are almost invariably assigned, by syntacticians at least, a footnote indicating that such sequences are to be treated as a single sentence;[3] and split utterances aren't treated at all. Parallelism effects might arguably be dismissed as performance phenomena, a rhetorical preference which is no more than a discourse constraint (see Kehler 2003, Asher and Lascarides 2004); but no such easy dismissal of the split utterance phenomenon is justifiable. That such data have been largely set aside is perhaps not surprising, since they are problematic for all theoretical or computational approaches in which parsing and generation are seen as separate disconnected processes, even more so when modelled as applications of a grammar formalism whose output is the set of wellformed sentences. Both the interrupted utterance and its follow-on completion may fail to be well-formed on their own, and so not apparently characterisable by the grammar formalism; yet the parsing and production mechanisms must be able to license their use. In semantics, question-answer pairs have not received such short shrift: fragments in question-answer pairs have in particular been analysed by Ginzburg and colleagues (Ginzburg and Sag 2000, Ginzburg et al 2001, Ginzburg and Cooper 2004, Purver 2004).[4] Yet even in these analyses, the fragments are analysed as having complete syntactic and semantic constituents which must correspond in type to some abstracted/abstractable element in a contextually given (or inferrable) question/proposition, but this leaves no room open for extension to an account of split utterances; and furthermore it isn't clear how the first part of such utterances, being incomplete, can allow a parser to infer the required contextual question.

As a first preliminary in addressing such mixed-speaker utterances, notice that a simple denial that either party's contribution to such utterances should be characterised by mechanisms of the grammar formalism is not an acceptable move. Consider the case of (6) with the need to establish both *wh*-gap and anaphor-antecedent relations across interlocutors:

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[3]One exception is Schlenker 2003, who analyses question-answer pairs as full paired sentences with PF deletion, committing himself also to a correlative bi-clausal account of pseudo-cleft structures.

[4]Sclangen 2003 has a similar style of analysis within SDRT. Schlangen assumes that fragments are complete constitutents associated with complete sentential contents that are underspecified and reconstructed from context, though for him such reconstruction is via rhetorical relations.

(6) *Ruth:* What did Alex . . .
   Hugh: Design for herself? A kaleidoscope.

Presuming on some performance mechanism unrelated to grammar-internal principles would mean that in order to explain how they could be parsed or produced, the production or parsing device would have to involve a system that was able to bypass the grammar formalism altogether, in such cases relying on some grammar-external reasoning device. But this would mean that some yet-to-be-formulated performance model would have to presume that there are two underlying language-processing devices, one which as the competence model is well understood but which doesn't correspond to the facts of dialogue performance, and the other which by assertion does match such elliptical forms of utterance but which remains a total mystery.

   With this alternative set aside, as long as what is assumed is that the remit of the grammar formalism is to characterise all and only the wellformed sentences of the language, the only alternative seems to be to assume that all such fragments are treated by both the parsing and production devices as in some sense syntactically complete, with empty categories postulated that, for the parser, get filled in by the context, and for the producer, do not need to be uttered aloud (following Schlenker 2003). The initial HEARER of (6), parsing *What did Alex*, would, on this view, have to parse an input which is not a standard constituent, indeed may not be licensed as a wellformed string at all, so he would have to assign the string he hears a (partial) interpretation, presuming on some completion of the string despite lack of appropriate input. In shifting into a speaker role, he would then have to be seen as going on to generate an output, *design for herself?* from which some previous words and their syntactic form are taken into account but are not produced. The initial SPEAKER, must also be able to integrate these two fragments, but in this case she is switching from some generation module, which maps (representations of) content onto strings, over to some parsing module, which treats her own output as in some way parsed even though, up to this juncture, it has been characterised by the production module only. Such invocation of the necessary empty-category devices, whether in the completion of incomplete fragments by the parser, or as not needing to be said by the producer, is a standard enough manoeuvre in accounts of ellipsis; yet it is highly problematic, not least because it involves positing empty categories which which not only are not independently required in the grammar formalism, but indeed must not be freely available.[5]

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[5]See Stainton forthcoming for the same criticism of Stanley 2000 and Ludlow forthcoming, though Stainton only takes his arguments to apply to a restricted set of fragments.

Things are not much better for constraint-based systems which impose a weaker criterion of success on their grammar formalism of merely articulating a set of constraints to be met by strings of the language, allowing sub-sentential strings to be characterised as wellformed within some larger structure that is not (see Pullum and Scholz 2001). But with participant switch being able to take place constituent-internally, the advantage is not so very great. It is in such systems that correlated parsing and generation systems have been defined (see eg Neumann 1994). Yet even though parsing and production devices might be treated as related applications of the same neutrally- defined system of constraints, they must nevertheless be independently defined, with each having to be closed off before the other is invoked, each then having to treat the output of the other as in some sense parsed (or conversely produced), even though it is the OTHER mechanism that has just been being activated. And, though many (non-minimalist) parsing systems are strictly incremental (Pritchard 1996, Sturt and Crocker 1996), generation systems are invariably head-driven (Stone et al 2003), making the generation of utterances such as the first in (6) especially problematic. Furthermore, in neither case is there reason to expect parallelism effects across such inverse applications of the use-neutral grammar device.

The alternative might be to handle split utterances by some pragmatic mechanism following the analysis of Stainton 2004 for data such as (11), for which he argues no syntactic account is possible:

(11)   A (stepping out of lift) Mr McWhirter's?

   B Not that way. Over there.

But any such move would raise more questions than it answers, at least if the grammar-pragmatics feeding relation is preserved unaltered. First, there is the question as to the nature of the input to an enrichment device (eg one constrained by relevance) if what is provided by a string is incomplete, as in the utterance of "What did Alex .." in (6)? If in order to be able to assign the string a propositional structure equivalent to that provided by the encoding mechanism associated with the grammar, there has to be some device which freely provides structure from null phonological input wherever not to do so would constitute a failure of the parsing system. But this is the problem already facing the syntactic approach to ellipsis, now re-analysed as a much less constrained pragmatic enrichment device. Viewed within the remit of pragmatics, the problem is that nothing that pragmatic theories provide give us sufficient structural detail to characterise the process with the particular limitations on it that are required. What is required is neither

an ad-hoc concept construction process nor free enrichment, as there is no incomplete lexical schema presented by null morphological input.[6]

There is then the problem of how in the shift from hearer to speaker, the new speaker can take some representation of propositional content constructed as a result of some partial parsing task, and extend it in the attempt to establish whether that expressed content constitutes what his interlocutor intended to convey. In (6) again, repeated here, this would involve the respondent, Hugh, leaping by hypothesis given the context onto some representation of content, say 'Alex design WH for Alex' and trying to establish whether what he has said is what the speaker had intended him to recover:

(6) *Ruth:* What did Alex . . .
     Hugh: Design for herself? A kaleidoscope.

He does this by uttering the words *design for herself* presuming, one might suggest, that the remainder of the expressed content does not need to be uttered on the grounds that his audience, by herself having already produced a string from which HE could construct a representation at least overlapping in structure with what he himself is now presenting, will, now, in her shift into a parsing role, have both a context and a structure over which she can define locality constraints associated with the anaphor to determine the content of the proposition expressed. But an additional problem emerges for this putative pragmatic account of split utterances, for the account of (6) requires reconstruction of both *wh*-gap binding and establishing an antecedent for the anaphor *herself*. By assumption, the binding principles which determine these correlations are defined at the level of logical form, as articulated within the grammar formalism, and this, by assumption, constitutes the interface of the grammar-formalism and the application of pragmatic enrichment processes. Yet the structure which has to be checked for such constraint satisfaction by either party is not recoverable just from the string which they have severally parsed or produced: it is a composite structure recovered in part from what each one has contributed and in part from what the other has contributed. But how is this possible, given that the constraints on interpretation which make the relevant interpretation possible are provided by some interface level that is defined as holding at a

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[6]We note the suggestion made by Carston in passing and attributed to Breheny, that free enrichment processes are in principle reducible to ad-hoc concept construction(Carston 2002, chapter 2, footnote 54). See Marten 2002 for a Dynamic Syntax account of all verbs as underspecified with respect to their adicity, an analysis which would provide a formal basis for fleshing out this proposed unification of ree enrichment and ad-hoc predicate construction processes.

level prior to any such pragmatic processing? One possible way out might be to argue that the level of logical form is merely an interface which constitutes some concept of sentence-meaning as articulated by the grammar, with implementations of that grammar formalism able to side-step such a level in realising what in performance is incremental word by word update of interpretation (Carston 2002). But this merely serves to suggest that any explanatory account of utterance-interpretation does not involve any such level.

The problems for pragmatists continue with the construal of the fragment answer in (6) that follows up the apparently collaboratively constructed question, but with an extra difficulty. This second answer to the question also needs to be assumed to be associated with a complete syntactic structure: this at least is an uncontentious move, in so far as such fragment construal is standardly analysed as a syntactic form of ellipsis. But if so, then the utterance of *a kaleidoscope* will have to be taken to constitute an utterance of the sentence *Alex designed a kaleidoscope for herself*, without any context-dependent form of construal specific to the ellipsis itself, because the so-called PF deletion which underpins syntactic accounts of ellipsis requires such constructs as input). Most of this has to be re-calculated by the speaker, Hugh, as not needing to be said on the basis that his hearer Ruth, by assumption, has a logical-form tree constructed over which the binding principles are again defined as licensed – again, not that provided by the proposition which their split utterance might actually be taken to be expressing, for this is external to the grammar formalism. The specific problem here is the relation of the fragment *a kaleidoscope* to the *wh*-question to which it provides an answer. Carston, in passing, suggests that answers to questions may involve direct use of some propositional form recovered from the question, with the fragment replacing the *wh* term in argument position (Carston 2002: 174). Maybe, but such a process would have to be seen as quite independent of the otherwise adopted grammar formalism, since such an account is not matched by either movement or constraint-based accounts of *wh* expressions, for these invariably analyse the *wh* expression as a propositional variable-binding operator.[7] So this move appears to be heading into

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[7]There are several extant analyses of *wh* expressions, in some semantic accounts as an abstraction operator hence of predicate type (See Dayal 1996, Groenendijk and Stokhof 1991) but in all syntactic approaches (Minimalism, LFG, HPSG), the *wh*-expression is a variable-binding operator for which a truth-theoretic characterisation constitutes the set of possible answers, each of these being a full truth-value-denoting proposition (Schlenker 2003). See Kempson et al 2001 for an alternative view in which *wh* expressions project specialised place-holders, to be replaced by substitution of a term provided by the answer,

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uncharted territory in which pragmatic assumptions need to invoke types of structure for which orthodox grammar formalisms provide no basis.

In the face of these problems, a wise pragmatist might seek to leave the challenge of explaining ellipsis data to syntacticians wherever arguments have been provided for its syntactic basis, as indeed Carston does. But this isn't a legitimate move, even setting aside such data as (11), since ellipsis construal isn't blindly syntactic. In particular it isn't analysable at a level of logical form associated with the words in the string, neither in the completion of some interrupted string, nor in its fragment continuation, as the indexicals in (12) show:

(12)   A: Where have you got to with..
       B: your book? Up to Chapter 4.

In (12), no level of logical form independent of the fixing of interpretation of pronouns is appropriate, for the role of hearer essential to appropriate fixing of the pronoun, has altered in the middle of the exchange. The form of the pronoun indeed remains the same, as though appropriately completing the string of words initiated by the first speaker, but such a completion would not correspond to the interpretation intended, or successfully recovered.

Of course, without either pragmatists or syntacticians having addressed split utterance phenomena directly, these attempts at constructing either type of account are nothing more than hypothetical straws. Semantic accounts of ellipsis manipulating higher-order abstraction might seem to offer more hope, but since any form of syntactic dependency can be split across interlocutors, any such account faces the implausible commitment to the view that ALL structural dependencies can be re-analysed in exclusively semantic terms, all syntactic dependencies being able to be realised across the speaker-role switch, a stance which is implicitly denied by all frameworks with independent syntactic and semantic specifications (see Partee (ed.) 1976).[8] At the very least, the feeding relations between grammar-internal and pragmatic processes of reconstruction which these fragments demand remain an open problem.

In the rest of the paper, we take up this challenge and show how the use of ellipsis in dialogue, the split-utterance, and other dialogue phenomena set out by Pickering and Garrod can all be naturally explained by adopting the Dynamic Syntax (DS) framework in which words in a string are mapped

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an analysis much more commensurable with the Carston suggestion - see section 3.1.

[8]See Dalrymple et al 1991 for the observation that higher-order unification accounts are over-liberal in not being able to exclude variable-binding abstractions across structural configurations which syntactic restrictions are defined to debar.

incrementally onto representations of context-relative content; and, as part of this, we offer a structured concept of context from which a unitary account of ellipsis becomes available. What we shall show is that progressive word-by-word construction of propositional form provides exactly what we need to reflect the dynamics displayed in dialogue both from a parsing and a production perspective. The result in all cases matches representationalist assumptions, but with a twist: the Dynamic Syntax accounts of ellipsis and dialogue phenomena succeed in virtue of NOT positing the relevance-theoretic level of logical form, indeed not positing ANY semantic concept of sentence-meaning. To the contrary, elliptical fragments may depend on context directly as input to their construal, using either previously established representations of content, or the actions used in establishing those representations: the result of such context re-use is a new propositional formula without any possibility of invoking an intermediate level corresponding to some putative "linguistic content" expressed by the ellipsis site independent of context.

2   The Dynamics of Language Parsing

Dynamic Syntax is radical in being a grammar formalism which models the stepwise way in which interpretation is built up in context during a parse as progressive construction of a tree-structure represent of content, and in positing that as the sole basis for syntactic explanation (Kempson et al 2001, Cann et al 2005). The point of departure for the Dynamic Syntax program was the goal of defining a formal architecture under-pinning language processing in context, as a means of enabling formal study of constraints imposed by relevance-theoretic assumptions: the general methodology is to adopt a representationalist stance vis a vis content (Fodor 1983) but, further, to argue that concepts of underspecification and update should be extended from semantics/pragmatics into syntax, where the concept of progressive update of partial trees totally replaces the semantically blind syntactic specifications characteristic of such formalisms as Minimalism and HPSG. Phrase structure rules, lexical specifications, and all concepts of movement or analogous feature passing devices are replaced by procedures for updating partial representations of content (see Kempson et al 2001, Cann et al 2005, Purver et al 2007 for formal details).

The general process of parsing can be seen as successive processes of update from an initial one-node tree simply stating the goal of the interpretation process (the first tree in figure 1), to an output, the second tree in

figure 1, which is a fully decorated tree whose topnode is a representation of some proposition expressed, and whose individual nodes are decorated with subterms of that formula. Each node in the tree has a concept formula, e.g. $Fo(John')$ representing some individual John, and an indication of what semantic type that concept is (*Fo* for *Formula*). The primitive types are types e and t. Type e is for expressions that denote individuals (e for "entity", *Ty* for *Type*); type t is for propositional formulae, that denote truth values (t for "truth-value"). All other types are functions defined on these.[9] The tree reflects solely predicate-argument structure, with no order of words reflected in the tree: by convention functor terms decorate a node on a right branch, argument terms a left branch node. There is invariably one node under development in any partial tree, as indicated by the pointer $\diamondsuit$:[10]

(13) John upset Mary.

$$?Ty(t), \diamondsuit \quad \mapsto \quad Ty(t), Fo(Upset'(Mary')(John')), \diamondsuit$$

$$Fo(John') \qquad\qquad Fo(Upset'(Mary'))$$
$$Ty(e) \qquad\qquad\quad Ty(e \rightarrow t)$$

$$Fo(Mary') \qquad Fo(Upset')$$
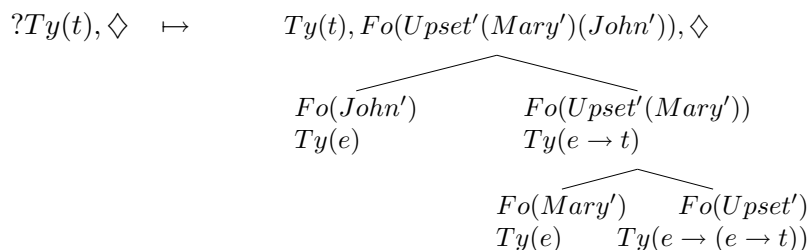$$Ty(e) \qquad Ty(e \rightarrow (e \rightarrow t))$$

Figure 1: Parsing *John upset Mary*

The concept of requirement ?X for any decoration X is central. Decorations on nodes such as $?Ty(t)$, $?Ty(e)$, $?Ty(e \rightarrow t)$ etc. express requirements to construct formulae of the appropriate type on the nodes so decorated (propositions, terms and predicates respectively), and these drive the subsequent tree-construction process. The general dynamics is to unfold a tree structure imposing such requirements by a combination of general rules for tree growth and lexical actions contributing concepts and other aspects of structure, and then compositionally to determine the combination of those concepts in a strictly bottom-up fashion to yield the overall interpretation, leaving no requirements outstanding. In this case, a combination of general

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[9]The list of types is highly restricted: unlike categorial grammar formalisms (see eg Morrill 1994), there is no recursive definition of types, no type-lifting or composition of functions.

[10]Throughout this paper, and indeed elsewhere in the development of DS to date, a highly simplified account of proper names is assumed, with no attempt to address the substantial issues in addressing the context-sensitivity specific to linguistic names.

tree growth principles and more specific tree update actions provided by the words *John*, *upset* and *Mary* together dictate the successful outcome.

Just as the concept of tree growth is central, so too is the concept of procedure for mapping one partial tree to another, with its associated concept of underspecification, essential to reflecting the input to such procedures. Individual transitions from partial tree to partial tree are all defined as *procedures* for tree growth, whether these are generally articulated constraints or specific tree update actions constituting the lexical content of words. Syntactic and lexical specifications are very tightly coordinated, differing primarily in that the former are optional constraints on tree development, the latter obligatory macros of tree-growth given the presence in the string of that word. For example, the word *upset* induces a sequence of actions that updates a predicate-requiring node, adding to this node two further nodes and the two-place relation $Upset'$, leaving the pointer at the constructed object-requiring node awaiting further development:[11]

upset

IF	$\{?Ty(e \rightarrow t)\}$
THEN	$\mathtt{make}(\langle\downarrow_1\rangle); \mathtt{go}(\langle\downarrow_1\rangle);$
	$\mathtt{put}(Fo(\lambda x\lambda y.Upset'(x)(y)), Ty(e \rightarrow (e \rightarrow t)), [\downarrow]\bot);$
	$\mathtt{go}(\langle\uparrow_1\rangle); \mathtt{make}(\langle\downarrow_0\rangle)$
	$\mathtt{go}(\langle\downarrow_0\rangle); \mathtt{put}(?Ty(e))$
ELSE	ABORT

The intrinsic contribution which a word makes to utterance interpretation is thus invariably more than just a specification of some concept.

Of the various attendant concepts of underspecification, two are of particular importance, that associated with anaphoric expressions and that associated with left-peripheral expressions, in other frameworks "extracted" from some clause-internal position. Anaphoric expressions are defined as adding to a node in a tree a place-holding metavariable of a given type. The value of such a metavariable is driven by the associated requirement $?\exists x Fo(x)$ which has to be satisfied either by selection of a value from con-

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[11]The action predicates are transparently tree-building predicates. The formal system underpinning the partial trees that are constructed is a logic of finite trees (LOFT: Blackburn and Meyer-Viol 1994). There are two basic modalities, $\langle\downarrow\rangle$ and $\langle\uparrow\rangle$, such that $\langle\downarrow\rangle\alpha$ holds at a node if α holds at its daughter, and the inverse, $\langle\uparrow\rangle\alpha$, holds at a node if α holds at its mother. Function and argument relations are distinguished by defining two types of daughter relation, $\langle\downarrow_0\rangle$ for argument daughters, $\langle\downarrow_1\rangle$ for functor daughters (with their inverses $\langle\uparrow_0\rangle, \langle\uparrow_1\rangle$). So the instruction $(\mathtt{make}(\langle\downarrow_0\rangle)$ is an instruction to build an argument daughter node, and so on. Kleene * operators are also defined over these relations, so that $\langle\uparrow_*\rangle Tn(a)$ is a decoration on a node, indicating that somewhere dominating it is the node $Tn(a)$.

text or from the construction process (all aspects of underspecification are associated with a *requirement* for their update). In consequence, though pronouns contribute to the monotonic tree growth process like all other words, they do not introduce a fully specified concept.

	IF	$?Ty(e)$	
	THEN	$\texttt{put}(Ty(e));$	Type statement
		$\texttt{put}(Fo(\mathbf{U}_{Male'}));$	Metavariable and Presupposition
he		$\texttt{put}(?\exists x.Fo(x));$	Formula Requirement
		$\downarrow[\bot])$	Bottom Restriction
		$\texttt{put}(?\langle\uparrow_0\rangle Ty(t))$	Case Condition
	ELSE	ABORT	

Of the decorations provided by the pronoun, $\mathbf{U}_{Male'}$ is the metavariable, $\downarrow[\bot]$ is the restriction that the node it decorates must be a terminal node in the tree in all developments.[12]

In similar style but pertaining to structure, long-distance dependency effects are by definition associated with a introduction of an UNDERSPECI- FIED structural relation whose value, equally, must be provided either from context or the construction process.[13]

(14) Mary, John upset.

So in (14), for example, the word *Mary* is construed as providing a term to be used in deriving the resulting logical form, but the node which it decorates does not have its relation within the overall structure yet fixed (Fig.2) - formally the construction of a new node within in a partial tree is licensed from some node requiring a propositional type (annotated as $?Ty(t)$), with that relation being characterised only as that of domination (weakly specified tree relations are indicated by a dashed line).

$\langle\uparrow_*\rangle Tn(0)$ is the characterisation that the constructed node is dominated by the rootnode along a succession of mother relations, allowing an arbitrary

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[12]This restriction is lost by expletive pronouns, whose interpretation can be provided by subsequent composite structure built up during the interpretation process, a property also shared with triggers for ellipsis, as we shall see. The characterisation $?\langle\uparrow_0\rangle Ty(t)$ is the nominative specification.

[13]See 3.1 for an argument that the type of fragment ellipsis argued by Stainton forthcoming to be intransigent for syntactic explanations of ellipsis, constitutes a context-provided enrichment of such a relation.
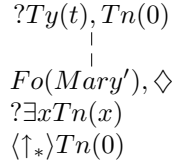
$$?Ty(t), Tn(0)$$
$$Fo(Mary'), \Diamond$$
$$?\exists x Tn(x)$$
$$\langle \uparrow_* \rangle Tn(0)$$

Figure 2: step (i) in parsing (14)

number of such relations between the node so introduced and the root.[14] Like all forms of underspecification, such underspecified nodes are always associated with a requirement for update.[15] The position of this unfixed node is subsequently determined, following an arbitrary number of intermediate steps in the interpretation process. In the parsing of (14), this point comes after processing the word *upset*, when the opportunity to update a requirement for an internal argument provided by the parse of the word *upset* will arise. At that juncture, there will not only be the unfixed node, but also a structure with the concept $Fo(Upset')$ labelling a functor node, and a node introduced to provide its internal argument, this needing to be completed: so there will be two terminal nodes of the tree both with requirements in need of resolution (Fig.3). Both these requirements can be resolved at once
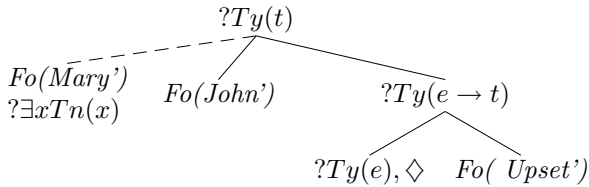
$$?Ty(t)$$

$$Fo(Mary')$$
$$?\exists x Tn(x) \quad Fo(John') \quad ?Ty(e \to t)$$

$$?Ty(e), \Diamond \quad Fo(Upset')$$

Figure 3: After processing *upset'* in (14)

if the relation between the node which the formula $Mary'$ decorates and the topnode is taken to be that of "grand-daughter". Hence the unification of the node decorated by $Fo(Mary)$ and the $?Ty(e)$-decorated node where the pointer is. From then on, the process is one of combining the concepts $Fo(Upset')$ and $Fo(Mary')$, and then the predicate $Fo(Upset'(Mary'))$ and

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[14]This is a standard tree-theoretic characterisation and is formally identical to that of *functional uncertainty* of LFG, differing from it only in the concept of update that maps it into a richer structure of the same type (see Kaplan and Zaenen 1988).

[15]This takes the form of a decoration $?\exists x Tn(x)$: Tn is a predicate of the description language, whose arguments range over tree nodes).

$Fo(John')$ to yield the logical form $Fo(Upset'(Mary')(John'))$, the very same tree as expressed by *John upset Mary*.

What this simple example illustrates is that strings with the same interpretation may be assigned the same tree representation as output content, in which case any syntactic differences between two such strings will have to be reflected solely in the sequence of actions that lead to that output.[16] Hence the claim that syntactic properties of natural language are to be explained in terms of the propositional structure corresponding to interpretation as built up relative to context PLUS the process of establishing that interpretation.[17]

It might seem that all such talk of trees as representations of content could not in principle simultaneously serve as both a syntactic explanation and a basis for semantic interpretation, because of the problems posed by quantification, universally assumed to necessitate a globally defined process expressing scope dependencies between quantifying expressions. But such scepticism isn't warranted. In adopting a representationalist and syntactic perspective on inference, this framework presumes a proof-theoretic characterisation of inference and so casts all NPs as projecting type e expressions. Quantified expressions are taken to map onto arbitrary names of type e following the natural-deduction proof-procedure for predicate-logic as formulated in the epsilon calculus,[18] with quantifying determiners analysed as a procedure for constructing such terms. The mechanism for projecting these terms involves the incremental accumulation of constraints on scope dependency as variously derivable from linear order effects and idiosyncratic lexical specifications: these scope statements are collected at the local type-

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[16]Here we have only introduced strategies for developing individual trees. However in DS, linked trees can be constructed, induced by an adjunction process which though a freely available transition in itself imposes a requirement for a token-identical copy of the formula decorating the head from which the transition is defined. This device is presumed to underpin relative clause construal, clausal adjuncts, enabling a characterisation of strong island constraints in terms of required resolution of structural underspecification associated with unfixed node relations within an individual tree.

[17]This style of analysis, with long-distance dependency effects and anaphora resolution expressed in the same terms of tree growth, can be applied to a broad range of syntactic puzzles facing conventional grammar formalisms, in particular to the range of interactions between anaphoric and structural processes, which can be expressed while preserving the unitary nature of any individual anaphoric expression in a way that escapes other formalisms: expletives, resumptive pronouns, restrictive vs nonrestrictive relatives, scrambling,and the E-type effects associated with head-internal relatives, (mismatching) agreement phenomena (Kempson et al 2001, Cann et al 2005).

[18]The epsilon calculus constitutes the formal study of arbitrary names (Hilbert and Bernays 1939). The details of this account of quantification will play no role in the arguments in this paper. See Kempson et al 2001 for a formal specification, and Purver et al 2007 for discussion of scope effects in ellipsis.

t-requiring node, and an algorithm then applies to the resulting predicate-argument structure spelling out how these statements determine the particular interpretation in question. So though final evaluation of dependencies between quantifying terms is defined for predicate-argument structure as a whole, hence in this sense globally, the method of collecting the necessary statements on which the articulation of such scope dependencies will depend is strictly incremental. The overall process is thus growth of a single level of (semantic) structure from phonological input. It isn't strings that have structure, but only the progressively accumulating interpretation that is built up from them. The syntax is the process by which such structures are built and this provcess is given by the set of actions induced by parsing the words of an utterance in strict linear order.

3 Ellipsis construal

With these tools for describing tree-growth to hand, we can now explore in more detail the concept of context on which the account of dialogue will turn; and this is where ellipsis comes in. Considered pretheoretically, one would expect that ellipsis should provide a particularly good window on what constitutes context, as it constitutes nothing other than re-use of what context makes available. We shall immediately see that the DS account enables us to characterise this phenomenon as a structure-building mechanism, hence syntactic, while nevertheless preserving this informal intuition, and in doing so providing a unitary basis for ellipsis construal despite its disparate effects.[19] As we now see, construal of ellipsis can be seen as involving re-use of formulae, structure and actions from the (immediate) context). So pragmatic processes too can be explained in terms of manipulating (partial) tree structure representations of content.

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[19]This account of ellipsis as a central instance of the context-dependence of natural language is not matched at least by syntactic accounts of ellipsis, since the assumption that the explanation is syntactic necessitates its analysis grammar-internally, hence not as a context-dependent phenomenon (Fiengo and May 1994). This leads to the paradoxical situation in which despite convincing arguments that some fragment construal must be seen as able to be controlled directly from the context (Stainton 2004), this account is not extended to fragment ellipsis in general. The effect is an otherwise unmotivated distinction between those types of ellipsis whose construal yields a structure that is characterised grammar-internally and those types of ellipsis whose construal, despite being no less internally structured, is not characterised by a grammar-internal process.
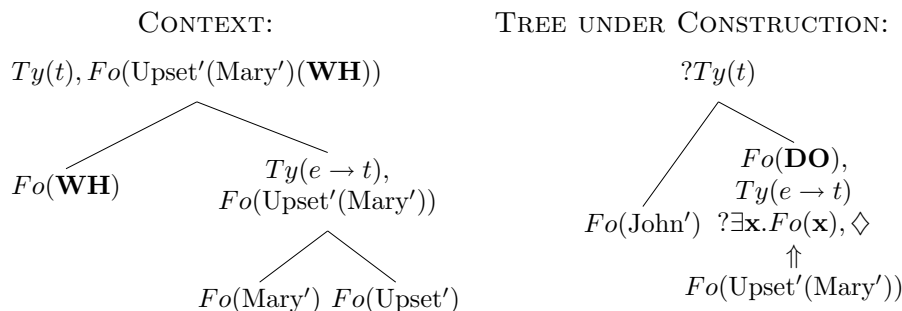
3.1 Use of context-provided formulae

First, elliptical phenomena demonstrate the ability by language-users to pick up on terms as made available in some context tree, re-using a predicate formula just established by a simple substitution process. This is illustrated with the anaphoric use of VP ellipsis, via the projection of a predicate meta-variable provided by the auxiliary *did*, and identification of that variable from formula values made available in the immediate context got from parsing previous strings. The result is the so-called strict reading of ellipsis, the exact analogue of pronominal construal.[20]

(15) Q: Who upset Mary?
   Ans: John did.

   Parsing *John did*:

CONTEXT:

$Ty(t), Fo(\text{Upset}'(\text{Mary}')(\mathbf{WH}))$

$Fo(\mathbf{WH})$ $\qquad$ $Ty(e \to t),$
$\qquad\qquad$ $Fo(\text{Upset}'(\text{Mary}'))$

$Fo(\text{Mary}')$ $Fo(\text{Upset}')$

TREE UNDER CONSTRUCTION:

$?Ty(t)$

$\qquad$ $Fo(\mathbf{DO}),$
$\qquad$ $Ty(e \to t)$
$Fo(\text{John}')$ $?\exists\mathbf{x}.Fo(\mathbf{x}), \diamondsuit$
$\qquad\qquad$ $\Uparrow$
$\qquad$ $Fo(\text{Upset}'(\text{Mary}'))$

We assume here an account of *wh* expressions as providing a particularised metavariable that acts as a place-holder for the answer (incidentally just the structure Carston was invoking in her suggestion for *wh*-construal (Carston 2002: 174).[21] The answer in reply then provides a value for this metavariable, and the VP pro-predicate is analysed as provided a value by the predicate formula $Fo(Upset'(Mary'))$.

This account commits us to saying that indexical interpretations of VP ellipsis are available, since metavariables by definition can be provided values from contextually provided representations of content, and these are by no means restricted to representations established from linguistic processing (see Hankamer and Sag 1976 for the contrary view). Consider the case of a

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[20]$Fo(\mathbf{DO})$ is a metavariable whose substituends are restricted to denoting actions, or more generally eventualities.

[21]Unlike other analyses, the DS account does not analyse the *wh* expression as a quantifying operator binding over a propositional domain. See Kempson et al 2001 ch.5 for detailed argumentation that *wh* question-words are not scope-taking expressions in the manner of regular quantified expressions. There are various forms the very weak term projected by a *wh* expression might take (see Cann et al 2005 for discussion).

mother and teenage son standing at the shore's edge looking at the size of the waves, with the mother deciding how best to dissuade her son from surfing. A mere command "Don't go now" would surely risk the very action she is hoping to dissuade him from. A much less confrontation-risking comment might take the form:

(16) I wouldn't if I were you. There are severe rip tides round here.

All that is required for the success of this utterance on this view, is that the context for utterance interpretation can be presumed to contain representations of content established from other forms of input than linguistic processing.

Not all ellipsis is this simple, since not all elliptical forms involve a VP pro-form, for example, question and fragment answers. In these, the expression which provides the answer is updating the very structure provided by the parse of the question.
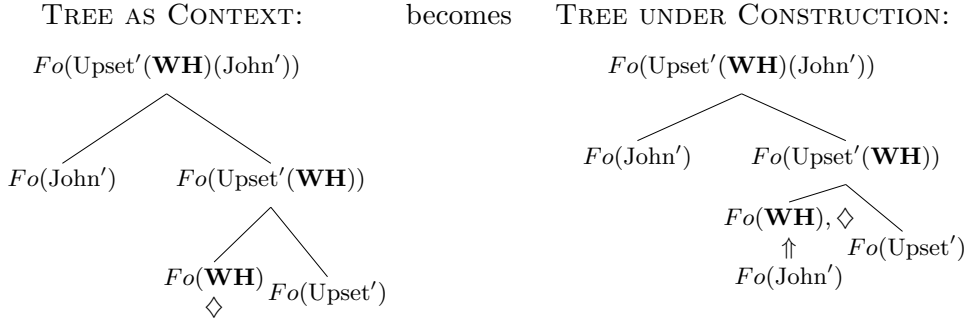
(17) Q: Who did John upset?
       Ans: Himself.

In taking up these within a DS perspective, what has to be remembered is that though all supposedly fronted expressions are analysed as projecting an initially unfixed node, this structure is updated by the time the interpretation process is complete. So the output of the parse of the QUESTION will be a structure in which the metavariable provided by the *wh* expression will be decorating an in situ object node.[22] In the case to hand, the problem that presents itself is that the interpretability hence wellformedness of the elliptical answer, *himself*, depends on there being available the structure which provides the antecedent whereby the reflexive can be locally identified. This the structure set up in parsing the question itself provides, as long as some optional final step in parsing a *wh* question is presumed, that moves the pointer back to the node decorated with the metavariable. The parse of the fragment thus takes that very structure as input and updates it to a structure in which the object argument has a fixed value (as displayed in (18)).

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[22]There are consequences to this account of *wh* expressions as specialised variables, rather than binding operations. Since with this metavariable as its formula, the *wh* expression will not be able to project an associated scope dependency, the resulting structure cannot be evaluated as having a complete set of scope statements. Some requisite complete set of scope statements will only be available once that underspecified term is replaced. The need for a substituend, i.e. an answer, follows immediately.

(18) Parsing *himself*:

TREE AS CONTEXT:　　　becomes　　TREE UNDER CONSTRUCTION:

$Fo(\text{Upset}'(\textbf{WH})(\text{John}'))$

$Fo(\text{John}')$　　$Fo(\text{Upset}'(\textbf{WH}))$

$Fo(\textbf{WH})$　$Fo(\text{Upset}')$
$\diamondsuit$

$Fo(\text{Upset}'(\textbf{WH})(\text{John}'))$

$Fo(\text{John}')$　　$Fo(\text{Upset}'(\textbf{WH}))$

$Fo(\textbf{WH}), \diamondsuit$
$\Uparrow$　　$Fo(\text{Upset}')$
$Fo(\text{John}')$

This example provides our first ellipsis-related evidence that construal does not involve building any construct corresponding to a linguistic specification of sentence-meaning. Here the fragment takes as context some open structure with a place-holder for the formula value at the object-argument node, but all other values are fixed. The only underspecified term in the context is the variable projected by the actions given by the *wh* expression. This the fragment itself updates with a procedure provided by the anaphor that obligatorily identifies the object argument value with the subject argument, here provided by the context.

Confirmation that fragments provide a license to construct a propositional form directly from the fragment itself comes from the problems that face the contrary presumption that decoding the fragment yields only some weakly specified sentence-meaning. In principle, one might consider the possibility of positing an account of fragments in terms of invariably introducing decorations on some unfixed node dominated by the type-*t*-requiring node as a general context-independent strategy for fragment construal while otherwise preserving DS assumptions, with the context being taken to provide an open propositional structure (on the representational analogue of the abstraction account of Dalrymple et al 2001). This might be thought to have the additional advantage of providing a single process of construal for all forms of ellipsis, on the one structure/one analysis methodology familiar in other formalisms. However, from a DS perspective, any such abstraction process would be unattractive. It would have to be defined as a special operation on contexts, since it would directly conflict with the assumption of monotonic tree-growth processes of construal. Such a move might be warranted when local inconsistency between speaker and hearer contexts subsequent to some parsing process forces some revision of context, but used as a general mechanism for ellipsis construal, there would be no such warrant for a move so contrary to the regular process of interpretation build-up.

There are, in any case, as Stainton (forthcoming) points out, problems with such a process. Since the fragment, by assumption, is taken to decorate an unfixed node, the context-abstracted predicate would have to yield a structure with which the unfixed node would unify, exactly as though a long-distance dependency structure. However, in (19), this is not problem-free:

(19) A: The Pope likes bagels and what?
      B: Frankfurters.

The island-effect of coordinate structures is modelled in DS as requiring the building of paired quasi-independent structures (so-called linked structures: Cann et al 2005): and these are said to preclude the resolution of an unfixed tree relation across in the second structure. This is the basis of the ungrammaticality of

(20) *What does the Pope like bagels and?

The consequence of such an account of conjunction, however, is to preclude the possibility of interpreting the fragment in (19) as involving the construction and decoration of an unfixed node in terms of introducing an open propositional structure with an unfixed node to be resolved is precluded.[23] However on the contrary view that the actions encoded in the fragment may directly update some fixed node in the structure indicated by the *wh* expression as provided by the context, is straightforward. Just as the *wh*-in situ expression in the question can be taken to decorate a linked structure and then be incorporated into the decorated tree (the procedure needed for conjunction), so too can the reply.

3.2 Use of context-provided actions

It might be counter-argued that this account of ellipsis as involving context-relative parsing of the fragment is unsustainable since linguistic forms can be re-used to yield a new interpretation rather than simply matching that provided by the context, as in all sloppy ellipsis construals, where linguistic forms are in some sense re-used to yield a modified interpretation:

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[23]The argument is a direct extension of Stainton's argument against Merchant 2004 that any analysis of ellipsis in terms of a Move-and-Delete process will yield the wrong results (Stainton forthcoming). The characterisation of an unfixed node is in terms of a disjunction across sequences of daughter relations, $\langle\uparrow_*\rangle Tn(n)$ from some node n, precluding a transition across from one tree to a distinct structure.

(21) Q: Who upset his mother?
      Ans: John.

In these cases, since the interpretation of the question standardly allows binding of any pronoun in the VP, here *his*, by what is taken to be the *wh* operator, the sloppy ellipsis construal seems again to warrant an abstraction process, here a retraction of content from that provided by the immediate context to establish $\lambda x[\text{Upset}'(\epsilon, y, \text{Mother}'(x)(y))(x)]$ in order that this created predicate can be applied to the term provided by the fragment. But, as we have already seen, this form of analysis runs contrary to DS assumptions. There is however a simple alternative, which has the advantage of preserving the intuition that context itself determines ellipsis construal. This is to presume that the actions used in establishing that construal of the first utterance are themselves available in the context, and so can be re-used just as structure can be. The actions that have to be applied in the construal of *John* in (21) as 'John upset John's mother' are identical to the actions which have just been used in the parse of the question, hence which the context makes available. This sloppy ellipsis construal arises because amongst the actions so reiterated from the context is the projection of a metavariable to be identified as before from the subject argument, which in the new context provided by the just parsed subject expression *John* will give rise to the new predicate 'upset John's mother'.[24] So here we have identity of actions, analogous to identity of structure or formula value, an analysis which applies to all parallelism effects in ellipsis involving rebinding. Hence this account of sloppy construal of elliptical form retains a concept of identical re-use of some context-provided construct, despite the non-identical resulting interpretation.

A bonus of this analysis is that it strengthens the parallelism between anaphoric expressions and ellipsis without any reshuffling of syntactic or morphological features to preserve some requisite concept of linguistic identity (as argued for by Fiengo and May 1994 and adopted by many others):

(22) John has washed his socks and so has Sue.

(23) A: You're sitting on my chair.
      B: No I'm not.

___

[24]See Cann et al 2005 for extensive justification, and Purver et al 2007 for a detailed specification of how such re-application of actions yields parallel results in the new context, including the interaction of ellipsis and quantification. The particular derivation of (21) assumes an analysis of the genitive as inducing a dependent epsilon term, with a predicate of which one argument is a bound-variable, the other an argument filled by the NP contained in the determiner.

On this account of ellipsis, no such stipulation is necessary: fragments are simply parsed using structure or actions which the context provides.[25] The re-use of actions selected from some minimal context is expected, with variation relative to the new context in which they are re-applied. Actions from context will moreover only be available as a record of previously parsed/produced utterances; so the report that at least some forms of ellipsis construal require a linguistic antecedent (Hankamer and Sag 1976) is matched in the analysis. The account thus directly reflects the intuition that ellipsis involves reconstruction from context in direct parallelism with anaphora, despite its tighter association with what is traditionally thought to be a grammar-internal process of syntax.

The effect of this account is that all ellipsis construal is now seen to follow Stainton's proposal for pragmatic construal of elliptical fragments of being an intrinsic part of the process that builds up the proposition expressed, though unlike Stainton's account, this process is taken as the general mechanism, duly formalised, rather than being some mysterious add-on to an otherwise syntactic account. This might seem to risk the down-side that there is no basis for characterising what is distinctive about cases such as (11) which constituted Stainton's particular challenge for syntactic accounts of ellipsis:

(11) A (stepping out of lift) Mr McWhirter's?
     B Not that way. Over there.

But, to the contrary, the Stainton type of case simply falls into place, to complete the picture of parallelism between structural and anaphoric underspecification. In this type of case, it does indeed seem that the only available DS strategy is to invoke the building of an unfixed node and construct some predicate with an open term-requiring node with which that node might unify. But this is the analogue of movement, which is the very strategy which Stainton correctly argues is not applicable to this type of case, since it would allow, wrongly, also (20). But no such problem arises, given a DS perspective, for nothing requires a unique sequence of actions for a given string or type of string. The essence of a parse system is its flexibility, providing a number of ways in which interpretation can be built up. All that is required for wellformedness of a string is that there be at least one sequence of actions leading from the starting point via the action sequence

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[25]Pronoun construal that involves re-use of actions provided by context is given by the paycheck examples of Kartunnen 1968:
(i) John puts his paycheck in the bank, but Bill keeps it under his bed.

imposed by the words in the order given. So in the one type of case, (19) and (21), a fragment can be construed by identifying it as providing a decoration to a node already provided in context by a previous parse, but in that sequence of actions left incomplete, as *wh* expressions specifically allow. In another type of case, (11), a fragment might be used to decorate an unfixed node and this time, its structural relation be updated by constructing the appropriate predicate not from any previous linguistic processing but from the visual scenario, as with indexical construal of anaphoric expressions. It is notable that this strategy of updating NP fragments from context without any linguistic antecedent from which to construct the appropriate interpretation is only available in highly routinised exchanges, such as request for directions, ordering food, buying tickets, etc. This is not evidence of there being a freely available abstraction device, but merely evidence that people may store fixed open structures as input for interpretation processes to complete them, analogous to the storing of routinised actions. Furthermore, given the claimed formal parallelism between anaphoric underspecification of content and structural underspecification of tree-node relations, we would expect there to be cases where the construction of underspecified relations can be updated from context in addition to its update from within the construction process itself: indeed this analysis brings these Stainton cases into the general form of explanation. The problems that arise for the Merchant-style movement account do so because such an account defines ellipsis over natural-language strings, whose properties must therefore match properties independently observed of natural-language strings. No such problems arise for the present analysis, where ellipsis construal, like all other construal, is defined as the building up of conceptual structure. To the contrary, we expect the strategy of building an unfixed node to be used as the means of providing initial structure for the fragment in the absence of any already provided structure or linguistic processing, as long as it could then be enriched indexically from representations culled from the discourse scenario itself. And since recovering information from the entities existing in the discourse scenario, by assumption, may involve the construction of conceptual representations without the use of actions, these being specific to the parse process, we also expect that the building of partial trees may involve the recovery of stored partial structures. Indeed, as we shall see when we turn to dialogue, the account we propose will have the effect that information culled from the context will be used in ALL language processing as long as commensurate with the words to be processed.

This account of ellipsis has the leading edge over other accounts. This is an area which, notoriously, has been split between proposed syntactic and

semantic analyses, neither type providing a comprehensive explanation of the phenomenon. By defining syntax as the progressive incremental growth of logical structure, the DS perspective, as a first bonus, unifies the various apparently heterogeneous "syntactic" forms of ellipsis. It gives substance to the Stainton account of indexical construal of fragments by providing a formal account of context; and it adds to it a detailed articulation of the process involved in establishing context-relative interpretations. Furthermore, what Stainton analyses as two mutually exclusive forms of ellipsis construal become complementary parts of a larger perspective in which language input is interpreted relative to context: there is simply no dichotomy between those processes of ellipsis which are grammar-internal and those which are not.

4 Production - The Dynamic Syntax Account

Ellipsis is a central tool in dialogue; and the account of production needed to turn this account of ellipsis into one that that can apply in the to-and-fro of speaker-hearer exchanges of dialogue is surprisingly straightforward (Purver and Otsuka 2003, Otsuka and Purver 2003, Purver et al 2007). Given that the parsing procedure constitutes, by assumption, the grammar formalism, the first working assumption might be that the very same rules apply in production also; and it turns out to be remarkably successful.[26] The essential difference between parsing and production is that, while the parser may not know in advance the interpretation to be constructed, the producer in contrast must do so, at least in part.[27] Reflecting these informal statements, we assume that in generation, the very same computational actions initiate the development of some tree, but this time, each update step has to meet the severe restriction of not merely being an enrichment as in parsing, but of being a precise form of enrichment – a sequence of progressive enrichments towards yielding a particular tree – the selected so-called goal tree representing the interpretation to be conveyed (formally a subsumption relation being required to hold between the parse tree and the goal tree). So in (24) for example, the production task is taken to start with a zero string, the input to the parse process, and a regular tree representation of content (figure 4)):

(24) John snores

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[26]Thanks to Matthew Stone, who suggested this.

[27]In principle the so-called goal tree which corresponds to the representation of intended content may be only partial, but we do not develop this here.

		Goal Tree
String	Parse Tree	$Fo(Snore(John)), Ty(t)$

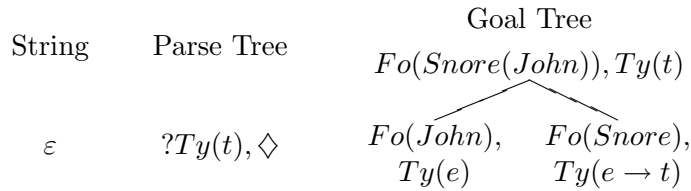|		$Fo(John),$	$Fo(Snore),$
ε	$?Ty(t), \diamondsuit$	$Ty(e)$	$Ty(e \rightarrow t)$

Figure 4: The input to producing *John snores*

From this, parse sequences lead to the progressive unfolding of a tree exactly as before except that at each point, including steps of lexicon-search, the only successful update candidates are those which are commensurate with the provided goal tree. With this sketch, we have the beginnings of a basis of an incremental account of production

Lexical search There is however a considerable problem to confront in proposing an incremental account of production.[28] Search in the lexicon on this account in principle involves incremental item by item search, a task which, given the size of the lexicon, threatens to be intractable. It is a task made worse by the fact that the goal tree relative to which the update check is made and the words to be selected are members of discrete systems, the items on the tree being items in a conceptual system, the items in the string being natural-language words. So the search is for an appropriate pairing of terms in two discrete systems.

4.1 The context-sensitivity of production

However, keeping psycholinguistic considerations uppermost, we propose that production, like every other cognitive activity, is context-dependent, much of the time not involving search of the lexicon, but merely, as does parsing, the context. This immediately reduces the size of the problem which incremental full lexicon search poses. Consider the production of *He upset her* in the context of having uttered *John ignored Mary*:

(25) John ignored Mary. He upset her

In producing the sentence *He upset her* in the context of either of the participants having said *John ignored Mary*, the speaker will, just as in pars-

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[28]This involves the so-called Logical Form Equivalence Problem that there is no deterministic route from semantic representation onto string. The threatening intransigence of this problem was brought to light by Shieber 1993, and it remains a recognised puzzle confronting putative models of generation, despite the increasing and uncontested evidence that generation is just as incremental as parsing (Ferreira 1996 and others following).

ing, have as the immediate context the tree with topnode decorated with $Fo(Ignore'(Mary')(John'))$. The production of *He upset her* then allows choice of the word *he* on the basis that in the immediate context is an appropriate occurrence of $Fo(John')$ a copy of which, substituting the metavariable lexically associated with the actions of the pronoun, will indeed meet the subsumption requirement with the goal tree. So, still just as in parsing, producing a pronoun depends on there being a suitable *Formula* value in context: the only difference between parsing and production is that there is in production, the subsumption requirement.[29]

The advantage of pronouns in language for the production task is immediate. As long as pronouns are presumed themselves to be easily available as a lexical expression, their selection bypasses the general lexicon search, replacing it with search in the immediate context. Thus in saying *he upset her* in an utterance of (25), the only word for which the general lexicon has to be scanned is *upset*, a big reduction in the lexical search task. According to this account, furthermore, this selection of a value for the pronoun from context is driven solely by checking on the immediate context available to the speaker, driven by the urgency of minimising the production task. It is not, or need not be, the result of a high-level planning decision about what is most likely to be easily retrievable by the hearer.

This account will immediately extend to ellipsis. We expect in the linearisation process mapping some propositional structure onto a string of words that if the speaker can use structure or actions which have already been established in context, they will do so. As in the case of anaphora, this is not driven by the construction of higher-order assumptions about manifestness of the necessary assumptions for the hearer - all that is required is to use the constructs one has in one's own context, since it is these which can enable the search through the mental lexicon, in the case of ellipsis totally. This leads us to expect correctly high frequency of elliptical constructions in language use in context both in parsing and production.

5   The Dynamics of Dialogue Modelling

With this outline of a generation model as including reference to context as the major cost-saving device, we now have the basic tools to address the

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[29]The mimicking of the parsing routine by that of production is important as, otherwise, the production of a pronoun, given its lexical specification as providing a meta-variable as Fo value, would trivially satisfy the subsumption constraint, apparently without any reflex of the parsing step whereby it might be interpreted.

dialogue patterning that Pickering and Garrod observe. Recall the ease with which producer and parser roles switch in dialogue, a phenomenon which might seem to buttress the Clark view of dialogue (Clark 1996), that interpretation of a string is a collaborative enterprise, against this model. But recall that, on this DS account, the goal of production and perception tasks that are carried out across a role switch between speaker and hearer is not so much to complete some linguistic string, but to complete the structures which the added words will be providing a completion of, as witness the single shared utterance in which the pronouns have to be interpreted to reflect whatever incremental switch of speaker-hearer may take place:

(26) A: You're working on...
      B: Your book?
      A: Yes, my book. Have you got to the
      B: 7th chapter, where you go into quantification?

The phenomenon of rigid indexicality of first and second pronouns is familiar. But its significance here lies in the inapplicability of any purely encoded logical form as a representation of some sentence meaning as input to whatever pragmatic processes enrichment that may then be invoked to determine the proposition expressed. As we would now expect, given the DS perspective, the complete sentence *You are working on your book* apparently constructed in collaboration in (26) does not provide the intended meaning: its logical form can't be the point of departure for subsequent pragmatic identification of the anaphoric expressions. What is being constructed is the progressive construction of some representation of content, via the incremental processing of words, with identification of values for attendant aspects of under-specification as the interlocutor's OWN context makes them available.

This re-use of one's own context is central to the apparent extensive coordination between speaker and hearer roles displayed in what Pickering and Garrod label 'alignment' between speakers. If one interlocutor has used a certain structure, word or choice of interpretation, then the respondent is much more likely to use the same structure as in (27), rather than a switch of structure as in (28):

(27) A: Who has Mary given the book?
      B: She has given Tom the book.

(28) A: Who has Mary given the book?
      B: ??She has given the book to Tom.

In so far as possible, interlocutors will go further and use the same words; and if these words are ambiguous, their interpretation must be shared across the various occurrences:

(29) A: Who was at the bank yesterday?
      B: Sue was at the bank until lunchtime, and Harry stayed at the bank all afternoon.

This might be seen as a form of mimicry, the second speaker copying what the first has done, and indeed in language acquisition contexts, where such alignment is rife (Tomasello 2003), it is often seen as exactly this, according to Tomasello involving emergent recognition of high-level personal inter-relationships very early on in the acquisition process. The DS perspective, however, gives us a different take on this. On the assumption that the actions used in building up structure constitute part of the immediate context, this apparent mimicry is yet a further instance of economy on the part of the speaker in cutting down on full-lexicon search. If in engaging in the task of searching for an appropriate word, the first search is through those macros which form part of the context, and these macros provide a suitable candidate in this production task, there will simply be no need to access the full lexicon - this macro of actions can be used again, both in the parsing task, and in the production task as part of the license for the string uttered. Such selection will not have necessitated some complex assessment of manifestness to the hearer, and it does not have to be checked as to whether it constitutes part of some common ground shared by both participants: it is based solely on one's own immediate context. An advantage of this style of analysis is the immediate expectation that repetitions of ambiguous words will pick out the same interpretation, as in (29): whichever macro of actions was triggered by the first use of the word will be called up again with the repetition of that word, again for the same reason. It is the "mini"-lexicon which presents the store of word-action pairs in the immediate context which is searched first.

In similar vein, syntactic alignment occurs in the use of a word such as *give*, said to have discrete syntactic properties for a single semantic content (double-object or indirect-object constructions being equivalent), where responses to some question involving one form of question with regularity induce replies using the same structural form (as in (27)), rather than switching to the alternative subcategorisation frame (as in (28)). This turns out to be straightforwardly reflected by exactly the same reasoning. All that is exceptional about a word such as *give* is that it is associated with two such sequences of actions. But this is all we need to predict this so-called

syntactic alignment. For once either of these specifications gets selected, it is that particular update-specification that will get entered into the context, to be retrieved by the second occurrence of the word.[30]

Finally, the phenomenon of shared utterances is anticipated, without any additional stipulation. Both in parsing and production of some selected string, the same tree is constructed because, in both tasks, the parsing procedure is central. And, if the communication task is successful, speaker and hearer may coincide on building the same structure, each doing so in virtue of applying the same set of rules to the unfolding of a structure relative to the context of what has just been parsed/produced before. But if this is so, it is not only the structure under construction which is shared between the two of them; it is the context too. If then before completion, the hearer can leap to the conclusion of what is being said, he can complete the partial tree he has up till then constructed as a parser, and shift into being a producer where the task is to complete that tree against an already completed goal tree. Equally, the speaker can shift into being a parser, as she, too, has a construction of whatever partial tree she had taken to match her goal tree. On this view, this is merely a shift from PROVIDING the input for updating some partial structure, to analysing some PROVIDED input with which to update that very same partial structure. Unlike in other frameworks, the phenomenon of shared utterances is strikingly natural. Apart from the abduction step of anticipation made by the interrupting interlocutor, nothing new needs to be added; and even this is no more than establishing the proposition expressed as quickly as possible, hence optimising its relevance.

Despite the apparent sharing of context, this approach allows speaker and hearer NOT to share the same structure, as there is no high-level negotiation as to which structure to use: in all cases the construction of context and structure for the proposition expressed whether as hearer or as speaker turns on what is contained in what each has separately constructed. Speaker and hearer may have quite different concepts associated with the words used. But whatever sequence of actions they have just used, whether as speaker or as hearer, can be used again, whether in the same role, or across a shift. So the very assumption that the mechanism of context and proposition construction involves the building of predicate-argument arrays allows the process to be an entirely private, internal, one.

This is not to deny that the abductive step itself may involve an act of mind-reading: finishing off someone's utterance with words she herself would

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[30]In so far as all characterisations for some given phonological form are stored together, we might expect some latent triggering of alternative specifications (Swinney 1979).

choose has to involve a search for what one might take to be her lexicon to find the appropriate completion. But what the shift from hearer to producer does NOT involve is the construction of an entirely new structure from which to initiate that search. To the contrary, it involves a continuation of the very same structure, as the playing of the Old MacDonald game makes clear (the happily cooperating child is certainly not mind-reading). And even the selection of words chosen is because, by presumption of relevance, the hearer will have been establishing the proposition intended as swiftly as possible, in this case as it happens, by a step of enrichment before the speaker gets to finish the utterance herself. Thus what might at first glance seem evidence for the highly coordinated view of dialogue such as that of Clark and others,[31] turns out to favour a more individualistic approach in which parallelism between interlocutors is the result of cost-saving decisions made by each party to the dialogue severally.

6   The Grammar-Pragmatics Interface: a new look

This paper has set out a sketch of language processing as the progressive building of semantic representations as established in context. Anaphora and ellipsis in particular were analysed in parallel, both as triggers for re-using contextually provided constructs, reinstating the intuition that ellipsis, like anaphora, is a device for building up interpretation from context directly. Production is defined in terms of the same tree growth processes, differing only in the addition of a checking constraint between partial tree and intended (representation of) content. With these albeit tiny sketches, we saw how the Pickering and Garrod challenge could be met, with the dynamics of the Dynamic-Syntax architecture matching dialogue patterns in a way that no other grammar formalism can match. We thus have the beginnings of an account of language which directly reflects the actions it enables hearers (and speakers) to carry out in real time.

In closing, we put this account back into current theoretical perspectives, and consider the degree to which this formalism provides a formal basis from which pragmatic explanations can be given, and the nature of the grammar-pragmatics interface that we can glean from it. The DS system is commensurate with general Fodorian assumptions about language in so far as syntax is defined as a progressive word by word mapping from phono-

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[31]Clark 1996 and elsewhere argues that communication is a coordinated activity involving ongoing signalling between interlocutors of their common ground and its progressive, successful update.

logical sequences onto an emergent semantic representation (Fodor 1983); and explanations are grounded in a presumption of a pervasive processing-cost constraint reflecting relevance-theoretic assumptions. However, this stance diverges from these assumptions in a number of ways. First, the encoded system is a set of procedures for proposition construction, so while there is a concept of conceptual content, as provided by specifications of formula values that the words may project, ALL words encode procedures, and not merely those words that are associated with the drawing of context-dependent inferences (Blakemore 1990). There is no basis for distinguishing formally between procedures which, being encoded, apply first as an encapsulated sub-system, and procedures of a more general sort all of which follow on afterwards. So, unlike Relevance Theory, there is no intrinsic distinction between lexical content of those words which project conceptual content, and those which project procedural constraints on interpretation.

There is also no level of linguistic meaning defined as the output of the grammar constituting a sentence meaning, this notoriously the basis on which Cappelen and Lepore raise the charge of incoherence against contextualist views of language (Cappelen and Lepore 2005: chapter 9), and the point of departure for their own account. Their charge of inconsistency, the most serious of the objections they raise against contextualists, turns on there being both indefinite diversity of interpretation of a string relative to context but nevertheless a single maximally general singular logical form constituting the sentence's meaning. With the abandonment of any such level, both the charge and the coherence of the alternative minimalist conception of semantics which they espouse melt away.[32] On this view, to the contrary, the sole interface between representation of the string itself and articulation of some denotational semantics is the level representing the propositional content expressed by the string in a particular context. It is at this juncture that all aspects of underspecification must have been resolved, satisfying whatever requirements may have been imposed. All forms of update are part of the construction algorithm, long-distance dependency, anaphora construal and ellipsis alike, with relevance-driven choices having to be made as part of this construction process. Within this conception, there is no intermediate level of logical form marking the output of some encoded system that constitutes the necessary point of departure for subsequent enrichment processes. It is under-specification and growth of information all

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[32]Even the cases where particular construal of a predicate seems able to shift between some occurrence of an expression and some subsequent elliptical fragment as in (i) can be captured by assuming re-use of actions, rather than recovery of identical output structure:
(i) John said his kettle was blue and so did Mary.

the way. This has the consequence that, in addressing the particular challenge of explaining ellipsis phenomena in a maximally general way, there is no place for saying that some forms of ellipsis construal are within the domain of grammar, and others outside it:[33] all forms of ellipsis construal are determined directly from context, for each new input is interpreted against the context provided by what has previously been processed. There is also no basis for saying that some forms of ellipsis construal can be defined off linguistic strings as part of an encapsulated system at some level prior to their interpretation in context: seen in the terms suggested here, such a distinction makes no sense.

A bonus is the ease with which the system can be used to provide an incremental model of production. All that this required was to assume that relevance considerations, specifically minimisation of cognitive costs, apply in production just as in parsing. And it is by presuming this constraint that dialogue patterns became predictable, parallelism effects and switch-utterance phenomena all falling into place without any stipulation. It is worth re-emphasising how the proposed dialogue account could not be sustained if one brought back in the problematic intermediate construct of logical form corresponding to sentence meaning as a necessary interface in the mapping between propositional content and linearisation of words to express it. With that assumption back in place, the problems facing an incremental account of production would return in full, for the reliance on accessing context as a source of LEXICAL choices was essential to explaining success in production, as in parsing. In this, the Dynamic Syntax account is essentially contextualist. The Cappelen and Lepore dismissal of ellipsis as irrelevant to the contextualist debate as syntactic (Cappelen and Lepore 2005: 42) can be countered with the riposte that ellipsis construal is both essentially pragmatic AND syntactic, providing swathes of evidence for defining natural-language content relative to its role in establishing context-bound interpretations. Indeed, the intrinsic content of natural language expressions, on the account promoted here, is a system of procedures for mapping from one contextually-provided structure to another.

Perhaps surprisingly, a relatively orthodox feeding-relation between syntax and pragmatics remains intact. With lexical content defined as procedures for interpretation which the word encodes, the parsing of any word to retrieve that procedure must itself be prior to any interaction with context

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[33]See Cann et al forthcoming for a characterisation of context-dependent wellformedness, enabling fragments from which some complete propositional structure is derivable given some context to be characterised as wellformed with respect to that context.

to determine the enriched interpretation to be provided (eg by substitution). But such procedures, being context-relative functions, lead to enriched values as the words are successively processed relative to whatever structure is available at that point in the construction process.[34] The result is that for any one string there characteristically will be more than one possible sequence of transitions, hence multiple context-relative interpretations. Yet this constitutes the end-point of the remit of the DS explanation. Defining a selection-mechanism for capturing which interpretation is selected in which context is not part of the model: this requires implementation of constraints on memory retrieval and general reasoning devices, which we take to be the remit of pragmatic theory. [35]

In the end, then, the success in explaining dialogue patterns is not due to assumptions of the DS framework alone, but in its conjunction with relevance-theoretic assumptions. The framework itself merely presents a formal articulation of the architecture within which relevance considerations may determine how individual choices are made at different points in constructing any one such propositional representation from a given string. The procedural, hence meta-level stance with respect to language processing, is however ineliminable. It is the use and re-use of interpretation procedures which form the heart of DS explanations of ellipsis, dialogue, indeed language interpretation in general. Procedures for language processing both constitute the vehicle for establishing interpretation and form part of the context relative to which further interpretation is built up. And so we conclude: knowledge of language is not some abstract set of axioms usable only in conjunction with parse/production mechanisms yet to be separately defined, but a set of procedures for going about the task of communication.

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[34]Some leeway on the incrementality of such enrichment steps is licensed given the distinction between setting out structure and establishing over it conceptual values for all non-terminal nodes of that structure, but any delay in building up interpretation is only relative to conforming to the compositionality constraint imposed by the logical system onto which the natural language expressions provide a mapping (see Cann et al 2005).

[35]Throughout this paper, we have had nothing to say about how individual interpretations are selected, focussing merely on the types of construal available as the means of pinpointing the nature of interpretation and context; and in all cases, we have rather simplistically assumed that interpretation is recovered from some minimal context. See Bezuidenhout 2006 for evidence to the contrary:
(i) A: Mary's father was at the concert, because she was playing a cello solo.
B: Was her mother too?

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