THE PROCESSING COST OF REFERENCE-SET COMPUTATION: GUESS PATTERNS IN ACQUISITION

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An idea which got much attention in linguistic theory in the nineties is that the well-formedness of sentences is not always determined by absolute conditions, but it may be determined by a selection of the optimal competitor out of a relevant reference-set. A restricted version of this was assumed (and gradually abandoned) at the early stages of the minimalist program, and simultaneously, it has been the central notion developed in Optimality Theory.

The type of computation required by reference-set economy is inconsistent with what is known about the processing ability of the human parser. If it is indeed vastly at work in the computational system, then processing must be guided by independent algorithms that enable skipping the actual computation, that is, special devices are needed to enable the computational system to be actually used, given the limitations on human working memory.

Chomsky (1998) offers a new perspective on the relations between the computational system and the processing systems (what he calls 'the empirical conditions'-processing and acquisition). The basic idea is that an optimally designed computational system (a system which optimally connects sound and meaning, namely satisfies the interface conditions) would turn out also optimal for the processing systems. If true, we would expect the parser to be as 'transparent' as possible. If massive devices are needed to mediate between the CS and the processing systems this means that there are serious imperfections in the CS. Alternatively put, if the parser is transparent, as it should be in an optimal design, then any imperfection in the CS will be observable in processing cost. It is this last entailment that I want to pursue here.

Reference-set computation is, as I will argue, an imperfection of the system. If the whole CS consists of such computations, as in Optimality theory, then, obviously, there can be no transparent parser, and the whole idea of optimal design is empirically wrong. However, restricted 'last resort' imperfections still enables a transparent parser, with the cost being local processing difficulties where the imperfections are.

I argue that restricted instances of reference-set computation are operative at the interface, precisely at these areas where the outputs of the computational system do not meet the (contextual) interface needs, and adjustments are needed, i.e. areas where there are, indeed, imperfections in the CS. As such, we may expect that there should be also some observable processing cost associated with these imperfections.

Reference-set computation requires greater load on working memory than local computation. Adults, apparently, can cope with this load (given also that it is only required in very restricted areas of language use), but there is growing evidence that this load is too big for children, whose working memory is not yet as developed. Grodzinsky and Reinhart (1993) argue that the (relatively rare) chance-pattern found in the acquisition of coreference indicates guess performance. The reason is that the relevant coreference strategy involves reference-set computation, and children are unable to execute the computation which, as they know innately,

[1] I wish to thank Eddy Ruys for extensive comments and discussion of this paper.

is required for this task. Here I will argue that once the guess pattern is distinguished from the default pattern in acquisition, we discover this pattern in other areas of reference-set computation as well.

To establish the type of computation involved, I begin with a survey of the development of concept of reference-set economy in the minimalist program, and the reasons it was abandoned.

1. Some history of reference-set economy in syntax.

At the transit stage from the P&P framework to the minimalist program, (following Rizzi's relativised minimality), it was noted that certain, apparently distinct, constraints on syntactic movement have something in common, that could be characterized as "least effort". It was felt that what the bad derivations in (1), have in common is that the (italicized) moved element skips a potential landing site, which is closer, so, in some sense, the movement is 'longer' than necessary.

Relativised minimality.

1 a) Head movement (HMC): *Where *find* Max will t the book.
  b) A-movement (super-raising): **Max* seems [that it is certain [t to arrive]]
  c) A'-movement(wh-islands): *I wonder *what* you forgot from whom you got t.

In the superiority cases of (2b) -(3b), there is no intervening landing site[2]. Still, the derivations seems longer than necessary, since to check the wh-features of C, the wh-element closer to it could move, as in the (a) derivations.

Superiority.

2 a) Who e discussed what with you?
  b) */?What did who discuss e with you?

3 a) Whom did Lucie persuade e [PRO to visit whom]?
  b) */? Whom did Lucie persuade whom [PRO to visit e]?
  c) Whom did Lucie persuade Max [PRO to visit e]?

A striking property of the superiority restriction is that there is no way to state it as an absolute constraint on (overt) movement, like number of barriers crossed. The distance between whom and its trace is precisely identical in the bad (3b) and the good (3c). So well formedness appears here to be a relative matter: For (3c), there is no shorter movement that could check the C features, while for (3b) there is.

[2] In the spirit of Rizzi's relativized minimality (1990), an element of the same syntactic type and properties intervenes between the moved element and its trace (underlined in (1)). This is also how this was formulated in Chomsky and Lasnik, chapter 1 of Chomsky (1995) (p. 81 -on). But then one may ask why should an intervening element of the same type matter.

In the first implementation of the minimalist framework (Chomsky, 1993, reprinted as chapter 3 of Chomsky, 1995), movement was motivated by the need of the moved element to check its features ("greed"). Under this implementation, it was not possible to state the 'shorter link' intuition locally. E.g. in (1b), once we select and merge it in the second cycle, there is no shorter way for Max to check its case or DP features. Similarly, from the perspective of the wh that moved in (3b) (or (2b)) the route it took is the only (hence the shortest) way to check its own features. Capturing this intuition required, therefore, comparing a set of competing derivations, which was later labeled 'the reference-set'. (A modified version of) this first formulation is given in (4).

4) Minimal Link Condition (the version of Chomsky 1993)
Given two convergent derivations D1 and D2 [out of the same numeration[3]] D1 blocks D2 if its links are shorter.

For the super-raising case in (1b), the relevant reference set is (5), which contains two possible derivations from the same numeration (the same 'deep structure', in the previous model).

5 a) [(F) It seems that [(F) Max_i is certain [t_i to arrive]]]
b) *[(F) Max_i seems that [(F) it is certain [t_i to arrive]]]

In (5a) Max moves in the second cycle (of certain), to check the feature F, and in the higher cycle it is merged. (5b) is (1b). Since the link between Max and its trace is shorter in (5a) than in (5b), (5a) block (5b). Similarly, the reference-set for (3b) is the pair (3a, 3b). (3a), with the shorter link blocks (3a). For (3c), there is no alternative derivation that will satisfy the wh feature (-no alternative convergent derivation), so it is the single member in its reference-set, hence the shortest possible derivation in this set. From this perspective, the previously unrelated prohibitions on super-raising and superiority are just different realization of one and the same principle.

The characteristic properties of reference-set economy are that it assumes a relative concept of well-formedness (as we saw), and, next that it requires global computation. In (5) e.g. it is useless to construct a reference-set locally, at the second (certain) cycle, since the effects of either inserting it or moving Max are only noticeable at the next cycle. So the whole derivation must be kept open and available at that top cycle. As pointed out by Collins (1997), the problem is more general. Since (4) requires comparing only convergent derivations, the construction of the reference set is only possible at the very end, where non-convergent derivations can be filtered out.

Optimality-Theory (OT), which developed around the same period, is based on the same notion of reference-set economy, with these two properties, though the technical details of the implementation are different. But the OT system is much richer, assuming, first, that what needs to be checked against a reference-set is not just which derivation is shorter, but a currently open

[3]The concept of numeration was introduced later. (In the original formulation, the specification was "with the same LF output", which is obviously not what was intended. See Reinhart (1993) for further discussion.)

list of constraints, and next, that these constraints are ranked, with possible variations of the ranking across languages.

The global nature of reference-set economy disables a transparent parser. If we translate it to terms of actual processing, it requires, first, holding all nodes in the derivation accessible in working memory, until the full derivation can be completed, and at the same time constructing (or attempting to construct) alternative derivations, to compare the held material with. The type of load on working memory assumed here far exceeds what is known to be realistic for human parsers. The assumption shared by all processing studies (since, at least Fodor Bever and Garett (1970) is that given the limitations of working memory, the human processor attempts to close constituents as soon as possible. Chunks of the derivation which are closed, are assigned some abstract representation and the nodes they dominate are no longer available for subsequent processing. Opening a closed constituent to access its subparts is possible, but highly costly, leading to a garden-path effect. If the parser requires global reference-set computation, then either nothing gets closed and eventually the overload is too big for processing, or constituents constantly close and reopen (garden-path). Neither is consistent with the fact that in actual use of language, sentences usually get processed smoothly. The least we can infer is that the human parser does not operate, in processing, by computation of this kind.

A line developed to address this problem, particularly in the OT framework (though it is still found also in the earlier parts of Chomsky (1995), is that one should not attempt to deduce the properties of the computational system (competence) from properties of the parser (performance): The actual processing of derivations need not literally compute optimality, but rather some heuristic strategies, or algorithms, are developed by speakers for a quick assessment. (For some algorithms proposed for acquisition, see Pulleyblank and Turkel (1998), and Tesar (1998).) Presently, this line is hardly falsifiable, given that the algorithms guiding the parser still need to be specified. But rather than dwelling on this point, we may note that if this turns out true then language is not 'optimally designed' in the sense of Chomsky (1998).

The hypothesis of optimal design (proposed at least, but not only, as a guideline for linguistic research) is that an optimal language - system, namely a system that meets the elementary interface conditions for being useable (connecting sound and meaning) also turns out to satisfy other empirical conditions, such as processing and acquisition. Suppose we found a computational system which is an optimal solution to the elementary interface conditions, and it still fails the other conditions (e.g. it is not fit to processing with limited working memory), then we have to add special devices such as processing algorithms. (This would mean either that the strong hypothesis above is false, and human language is not a perfect solution, or that our theory - the computational system we found - is not, in fact, the optimal one). Stated this way, the question is whether the problem at hand justifies this departure from the hypothesis of optimal design.

In fact, it turned out that there was no real motivation to assume the complex computation in (4), since whatever is correct about the intuition of 'least effort' or 'shortest move' can also be captured by a local computation: In chapter 4 of Chomsky (1995), both the views of what triggers movement and of the MLC, are revised. 'Greed' is replaced with 'attract': Movement is not triggered by the needs of the moving element, but by the higher (functional) category, that needs this element in order to be interpreted or deleted. This enabled building the MLC into the definition of 'attract':

6) 'Attract' (combines Last resort and MLC): K attracts F if F is the closest feature that can enter into a checking relation with a sublabel of K. (p. 297)

From the perspective of the attracting target, there is nothing complex about finding its nearest candidate. Suppose we reached a stage in the derivation where a functional category (a feature) has been merged. At this point we search in the chunk of the derivation we have just built, for the necessary element to check it, and the search stops as soon as the first such element (going from up to bottom) is found. E.g. in the superiority cases of (3), repeated, the relevant state of the derivation is (7), where the wh feature has just been merged at the matrix.

7) Q+wh [Lucie persuade whom [PRO to visit whom]]

3 a) Whom did Lucie persuade e [PRO to visit whom]?
b) */? Whom did Lucie persuade whom [PRO to visit e]?
c) Whom did Lucie persuade Max [PRO to visit e]?

This feature attracts now the nearest wh-element that it can find, which is in the complement of persuade. Hence (3a) is derived, and there are no further options of continuing the search that could derive (3b). (In (3c), the first wh that can be found is the complement of visit, hence it is this one which is attracted.) I return directly to the cases of relativized minimality in (1).

The MLC on this view is not a relative condition, but an absolute one. The first relevant element must be selected, regardless of whatever other considerations may have tempted us to do otherwise. On this formulation, no reference set is constructed at all - (3b) is not ruled out by comparison to alternative options, but it is underivable. The MLC is also local, in the sense that it applies as soon as the attracting node has merged, with no need to know about any potential future steps in the derivation.

On the other hand, under this formulation it is possible to observe that this absolute condition is indeed a 'least effort' condition in terms of actual processing: It minimizes the search, thus enforcing the quickest possible conclusion of the given step in the derivation, and freeing working memory for the next task.

Conceptual issues aside, the reasons why the global reference-set approach was discarded in the minimalist framework are also empirical. Even for the small corpus examined here, we can see that the version of the reference-set MLC, as stated in (4), yields the wrong results in the case of wh-islands. (This was pointed out in Reinhart (1993).)

The reference set for (1c), repeated in (8c), is (8b,c). (In terms of 'deep structure', both (8b,c) are derived from (8a).) Recall how this was determined: with the numeration used in (8c), we could obtain all three derivations in (8), as well as several others. However, only the derivations in (8b,c) converge: In (8a), as well as in the other conceivable options, the wh feature is not checked.

8 a) I wonder [Q+wh [you forgot [Q+wh [you got what$_j$ from whom$_i$]]]]

b) *I wonder [from $whom_i$ [you forgot [$what_j$ [you got t_j t_i]]]]
c) *I wonder [$what_j$ [you forgot [from $whom_i$ [you got t_j t_i]]]]

Given (4), there are now two possible conclusions: either we decide that the two derivations have equally short links, or one of them is shorter than the other. (Computing here is not simple, but nothing hinges on deciding this.) In the first case, both derivations should be allowed. In the second - one of them (the shorter one). Both these conclusions are wrong[4].

The account suggested in Chapter 4 for these cases rests on another option of satisfying 'attract' in (8), which we overlooked so far: Suppose what moved to check the wh-feature of its clause as in the first step of (8b). When the next Q+wh is merged and looks for a feature to attract, the nearest one it can find is this same what. Hence the MLC in (6) determines that this is the only option, and what must move again. Thus the only derivation permitted from this numeration (-from the 'deep structure' in (8a)), is (9).

9) I wonder [$what_j$ Q [you forgot [t_j Q [you got t_j from $whom_i$]]]]

The assumption is that (9) indeed converges, in the sense that all relevant features are checked, but it is semantically defective[5]. Similar reasoning applies in the case of super-raising in (1b), though it entails some further complications.[6]

We should note that this specific account of wh--islands and super-raising is a matter of implementation, which is being continuously revised in the MP framework. Another possibility

[4]This in itself does not prove that the idea of reference-set economy is wrong for syntax, as one may argue, very reasonably, that wh islands are governed by an independent absolute constraint. Nevertheless, the problem illustrates the danger in using such strategy freely.

[5]This account rests on a distinction between interpretable and uninterpretable features. Interpretable features are not deleted after checking, since they play a role in the interpretation. They include Category features, Phi features (gender, number) and wh-features. Given that they are not deleted, they remain, technically, available for further feature checking.

[6]Once it was merged in (ia), the only possible continuation, given (6) is to move it further, as in (ib), which is why (ic) cannot be derived. The problem is why the convergent (ib) is in fact bad, and it cannot be any semantic defectiveness in this case. (Earlier considerations regarding the case of Max, which were available at the P&P model are not usable in the same way in the MP.)

i a) e seems that [it is certain [Max to arrive]]
b) It seems that [t is certain [Max to arrive]]
c) *Max seems [that it is certain [t to arrive]]

For extensive discussion of this, and related problems in Chapter 4, see Ruys (1996), and Chomsky (1998).

(suggested in Reinhart 1993) is that these are not, in fact, direct instances of the MLC[7]. An issue still open in the MP is the precise account of syntactic islands (which originally included also wh-islands). The decision regarding the division of labor between the MLC and other conditions must await such an account.

In any case, the properties of the computational system which emerge out of this view of "least effort" provide no evidence for a need to impose "imperfections", such an altogether separate parser, or processing algorithms. So far, it seems that this system happens to also match the processing limitation of human users, namely the limitation of working memory: The computation is local, which means that only chunks of the derivation which are actively at work need to be retained in working memory; the MLC imposes further acknowledgment of this limitation, forcing the quickest conclusion of operations required in a given step in the derivation, and syntactic islands define the absolute limit for search operations.[8]

2. **Interface reference-set economy**

Though it was found irrelevant for syntax, the concept of reference-set computation, in the early minimalist program, inspired a line of research of its role at the interface of the computational and the conceptual systems. (The development of this line can be tracked, in chronological order in Golan (1993), Reinhart (1993), Fox (1995), Reinhart (1995), Fox (1998), among others, some of whom will be mentioned below.) The basic idea has been that in those (restricted) areas where reference-set economy is active, the reference-set consists of pairs <d,i> of derivation and interpretation, and it is motivated by interface needs: A given <d,i> pair is blocked if the same interface effect could be obtained more economically (i.e. there is a more economical <d,i> competitor in the reference-set). Reinhart (1995) suggests that this computation is involved when an uneconomical procedure is needed in order to adjust a derivation for use at the interface.

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[7]Note that super-raising cases violate the chain-condition, which Reinhart and Reuland (1993) argue is still indispensable, for various cases of anaphora: The trace of Max form a singleton Chain, which is -R, which violates the requirement that argument chains are (headed by) +R.

[8]E.g. Once the Q feature is merged in (ia), it starts the search for a wh it can attract. However, the search cannot reach into the syntactic island (which is why (ib) is out. Hence no wh feature can be attracted, and a derivation starting with this numeration, has no way to converge. The same is true for the CED island in (ii).

i a) Q+wh [you resign [after Max behaved (in) what way]
b) *In what way did you resign after Max behaved t.

ii) * Which shelve did you borrow the books on t.

In terms of processing, islands correspond to units which have been closed and stored at the stage of the derivation where the attractor is introduced. Their unavailability, again, decreases the load on working memory.

So, reference-set computation is triggered **only** by the application of such uneconomical procedures. Obviously, this still raises the same questions of optimal design discussed above, and my main goal here is to address these questions. But let me first review briefly the areas where this type of complex computation is argued to be operative in Reinhart (1995, forthcoming).

The first question is what is the sense of 'economy' involved here, specifically, what counts as a non-economical way to satisfy an interface need (-what is the metric, in OT terms). I know of two instances: One is applying a superfluous CS operation (not needed for convergence) - this is the case with QR and stress-shift for focus. The other is applying a superfluous interpretative procedure, witnessed in coreference (conditions B, C) and in scalar implicatures. Though the later has had a longer history and accumulated substantial evidence, the first is theoretically clearer, so let us view some of the motivation for assuming that economy considerations are involved here.

There is a certain resemblance in the history of the view of quantifier scope, and of focus, in theoretical linguistics. (Note that we are talking here about the question how scope and focus are computed, or identified, and not about their semantics.) At the earlier stages, e.g. Chomsky (1971), focus was viewed, essentially, as a property defined on PF structures. The basic idea was that sentence stress is assigned independently, by the phonological rules (nuclear stress rule), and the interface systems make use of this available stress in relating a sentence to its context, namely, signaling the focus and presupposition structure. The focus was defined as any constituent containing the intonation center of the sentence. This view rests on the notion of 'normal, or neutral, intonation' and assumes a distinction between neutral stress, and marked stress which is at times forced by discourse needs[9]. In Keenan and Faltz (1978) and Reinhart (1983), the same was assumed for the scope of quantifiers: Scope is determined by the syntactic configuration of the overt structure. A rule like QR is used only when it is necessary to derive scope construal wider than the overt c-command domain, and it is viewed there as a marked operation,

However, the concept of markedness was problematic. It appears easy to find examples of covertly determined wide scope which sound perfectly natural. (E.g. Hirschbuller's An American flag was hanging in front of every building). If it can at times be as easy to get the marked derivation as the unmarked one, it is not clear what empirical content the concept could have. Similarly, The distinction between marked and neutral stress has been challenged. It was repeatedly argued against the nuclear stress rule, or Chomsky's (1971) focus analysis, that in the appropriate context, main stress can fall anywhere, with effects hardly distinguishable from that of the neutral stress. (For an overview, see Selkirk (1984).) The crucial problem here as well is whether any content can be given to the concept of markedness. If there is no obvious way to distinguish neutral and marked stress, then we run into the danger of vacuity - having a theory which excludes nothing regarding stress: The facts that follow from its rules are labelled 'neutral', and everything else -'marked'. (This type of theory is always true, regardless of what its rules are.) A more realistic conclusion appeared to be that there is no sentence-level generalization

[9] "Special.. processes of a poorly understood sort may apply in the generation of sentences, marking certain items as bearing specific expressive or contrastive features that will shift the intonation center." (Chomsky, 1971 p. 199)

governing the selection of possible foci, and any expression can be a focus, subject only to discourse appropriateness. Hence, main stress cannot be assigned at PF independently of the semantics of the sentence, and it must be the other way around: sentence intonation reflects its independently determined focus structure.

The prevailing solution (since Chomsky (1976, where LF movement was introduced) has been that both scope and focus are identified at the covert structure (LF), requiring QR and 'focus-movement'. But this solution is problematic as well. First, while focus movement eliminates indeed the problem of markedness, the relations between stress and structure get to be a complex issue, raising questions of visibility of the covert structure to PF rules (stress). Next, a broader problem came to light at the stage of the minimalist program. The basic assumption is that syntactic movement is triggered only by needs of convergence (technically implemented as feature-checking), and it is blind to any interface considerations. In an optimally designed language, the bare minimum needed for convergence should enable also meeting the interface conditions. This is not the case with QR and focus movement: the derivation would converge without them, so this is superfluous movement. Though technically we can always introduce focus and quantification features, feature-checking is only the implementation, and the problem remains the same. Any way we go about it, this is a case of imperfection - we must depart from optimal design to enable the computational system to meet the interface conditions.

Admitting an imperfection, we may still wonder whether it must be as sweeping as entailed by this analysis, e.g. that the derivation's main stress is uniformly determined at the covert structure. Furthermore, we may note that this massive imperfection still does not take us very far towards capturing the actual interface conditions. Though no satisfactory content could be given to the notion of markedness, in practice it is not the case that covert quantifier scope is always as free and easy to get as overt scope, and certainly not that the so-called 'marked' stress is just free. Introducing the machinery of superfluous covert movement is, thus, just the very first step in stating the question when it can actually be used. Answering this question will require introducing more conditions and rules (more imperfections). One may wonder whether it is not possible to start directly with that second question, skipping the massive imperfection we already introduced just to state it.

In an influential work, Cinque (1993) offered a new perspective on the nuclear stress rule, and argued that the earlier view can be maintained. If so, then focus identification is a PF matter. Independent considerations of the computational system determine that stress must be assigned to a derivation, as part of its phonetic spell-out. At the interface, this property of sentences is used to facilitate communication, using stress to identify the focus, as in the view of focus in Chomsky (1971). This line was extensively developed by Zubizarreta 1995 (though she still assumed that focus is marked also at LF) and others.

We should note however, that the analysis is based on a revival of the distinction between neutral and marked stress: When the stress assigned by the nuclear stress-rule is not appropriate to the context, special stress shift operations apply, yielding marked stress. So the question 'how do we know it is marked?' is relevant again.

In Reinhart (1995), I argued that it is a mistake to search the evidence for markedness in the realm of direct intuitions. A marked derivation is a derivation which involves a superfluous -

hence uneconomical - operation. When this is done with no reason, the result is visibly awkward. But if using the uneconomical derivation is, decisively, the only way to satisfy a certain interface need, the result sounds perfectly fine, and it is only indirectly that we can see that it is nevertheless marked, or uneconomical. (In the case of QR, Fox' (1995) provides ellipsis evidence consistent with the claim that QR does not take place when not needed for interpretation.) The details of how this works with stress-shift will be clarified shortly.

In more precise terms, what is claimed in the last paragraph is that computing QR and stress-shift involves constructing a reference-set, and checking whether it does not contain a more economical <d,i> pair, namely a pair derived without the superfluous operation. If it does, the derivation is blocked (namely, if we nevertheless produce it, it has a visibly marked air). This brings us back to the question of optimal design.

If correct, this analysis still means that we have an instance of imperfection in the language system: That superfluous operations can apply at all is, as we saw, an imperfection of the core system. However, it is substantially less massive than we had to assume before. First, PF procedures, like stress, operate, as they should, on the overt structure. Next, the superfluous QR and stress-shift cannot apply all over the place, but are restricted by reference-set economy. On the other hand, as we saw, reference-set computation has a serious processing cost, which is an imperfection on the secondary requirement of meeting the empirical conditions of use. Here too, the problem is far less massive than that demonstrated by the Minimal Link condition, since reference-set computation is triggered only if a superfluous operation applies. Nevertheless, in these restricted cases, we do have an imperfection.

The strongest interpretation of the concept of imperfection, is that if we have to admit it into our theory, there should also be some way to observe the imperfection in the (use of) language itself. What I want to show is that computing reference sets, as needed here, is indeed an imperfect way to meet interface needs - it exists, but it has a heavy observable processing cost. To argue this, I have first to be more specific on the details of how this computation works, and I will do this here for stress-shift.

3. Focus and stress shift operations.

3.1. Neutral stress (Cinque 1993)

The basic framework of Cinque's analysis is the metrical grid theory of Halle and Vergnaud (1987). Previous analyses in this framework had to assume that the nuclear stress rule is parametrized in order to account for the varying stress patterns across languages. In the VP cycle, for example, stress falls on the right node in the English (10), but on the left node in the Dutch (11) (throughout I will use **bold** to indicate the main sentence-stress):

10) I read the **book**

11) dat ik het **boek** las
that I the book read

Cinque's insight is that, in fact, no parametrization of the stress rule is needed. Such parametrization, in fact, only duplicates the mechanism which independently governs word order variation in syntax. Abstracting away from technical details, the procedure Cinque proposes starts the assignment of stress with the most deeply embedded constituent, which then moves up to the next metrical line. The outcome will be, then, that the most prominent stress falls on this constituent.

This is not yet sufficient for the analysis of (10-11), since the object and the verb are sisters, and hence equally deeply embedded. The gist of Cinque's analysis is that the depth of embedding (in the case of sisters) is determined by the direction of selection (or recursion, as he phrases it). Given two sisters, the one which is selected by the other is the most deeply embedded one (and hence it occurs on the recursive side of the tree). At first sight, this may seem like begging the question, but Cinque's point is that the order of recursion (i.e the distinction between OV and VO languages) is a problem independent of stress. Whatever determines this parametrization will also determine the stress pattern. So, both in a VO language like English and in an OV language like Dutch, the most deeply embedded constituent is the object. Hence, in both, the object receives main stress:

(12) a. [$_{V'}$ V **DP**]
b. [$_{V'}$ **DP** V]

Many problems left open by this analysis, particularly with respect to adjunct stress, are addressed and further developed in Zubizarreta 1995.

3.2. The focus-set

Cinque's theory of sentence stress enables reformulation of the idea that focus is marked overtly, at PF, rather than covertly. In Reinhart's (1995) execution, each derivation is associated not with an actual focus, but with a set of possible foci, that is, a set of constituents that can serve as the focus of the derivation in a given context. This set is determined by the computational system at the stage where both the syntactic tree and stress are visible. In other words, focus selection applies to a pair <PF, LF> of sound and configurational structure. The focus set is defined, then, in (13). If stress falls on the object, either in English SVO structures, or in Dutch SOV structures, the focus set defined by (13) is the one in (14c).

13) The focus set of IP consists of the constituents containing the main stress of IP.

14 a) [$_{IP}$ Subject [$_{VP}$ V **Object**]]
b) [$_{IP}$ Subject [$_{VP}$ **Object** V]]

c) *Focus set*: {IP, VP, Object}

This means that in actual use, any of the members of the set in (14b) can serve as focus. At the interface, one member of the focus set is selected, as the actual focus of the sentence. For illustration, let us look at a concrete example (of a familiar type). (15a), which is generated with stress on the object, can be used as an answer in any of the contexts in (15b-d), with the F-bracketed constituent as focus.

15 a) My neighbor is building a **desk**

b) Speaker A: What's this noise?
Speaker B: [F My neighbor is building a **desk**]
c) Speaker A: What's your neighbor doing these days?
Speaker B: My neighbor [F is building a **desk**]
d) Speaker A: What's your neighbor building?
Speaker B: My neighbor is building [F a **desk**]

At this stage, it is up to the discourse conditions, rather than syntax, to determine whether a derivation with a particular stress is appropriate in a given context. The derivation is inappropriate if no member of its focus set can be used as an actual focus in that context. (15a), for example, cannot be used as answer in either of the contexts of (16). (# indicates, throughout, inappropriateness to context.)

(16) a. Speaker A: Has your neighbor bought a desk already?
Speaker B: #No, my neighbor is [F building] a **desk**
b. Speaker A: Who is building a desk?
Speaker B: #[F My neighbor] is building a **desk**

This is so because in the contexts of (16), the F-bracketed constituents should be the foci, but these constituents are not in the focus set generated by (13) for a sentence in which the object bears stress (cf. 14).

3.3. Stress shift operations.

For cases like (16), where the focus set defined by the neutral stress does not contain the desired focus, a special stress-shifting operation apply. For the present discussion it suffices to state it schematically, as in (17).

(17) Relocate the main stress.

In the context of (16a), repeated in (18a), extra stress is assigned to the verb, yielding (18aB). As a result, the verb is in the focus set defined by (13), and the derivation is appropriate in this context. In (18b), the same operation applies to the subject.

(18) a. Speaker A: Has your neighbor bought a desk already?
Speaker B: No, my neighbor is [F **building**] a desk
b. Speaker A: Who is building a desk?
Speaker B: [F My **neighbor**] is building a desk

The output of (17) is what I called marked stress. Although they sound perfectly natural in their context, the foci in (18) are marked, since they are obtained by a superfluous operation that undoes the results of the nuclear stress rule. I return directly to the symptoms of markedness.

The effects of (17) are often confused, in discussions of marked stress, with the effects of a different process of anaphoric destressing. This distinction is discussed in Reinhart (1997) and Neeleman and Reinhart (1998), who argue that the later is completely independent of considerations of the focus-set. Possibly, it applies before the nuclear stress rule, at word level. In any case, for reasons discussed there, it does not generate the same markedness effects. (In terms of the next sub-sections, it allows focus-projection, and it does not require reference-set computation).[10]

4. Reference-set computation.

The widely acknowledged characteristics of the focus obtained by shifted (marked) stress is that it 'does not project' (-it can only be 'narrow focus'). As we saw, stress obtained by the nuclear stress rule allows any projection containing it to serve as focus, e.g. the whole IP in (15b), repeated. The shifted cases of (18), by contrast, cannot be used in the same context, as we see in (19), which means that they do not project IP as focus. Similarly, stress shifted inside the VP does not project VP as focus, as seen in the comparison of (15c) and (20).

15 b) Speaker A: What's this noise?
Speaker B: [$_F$ My neighbor is building a **desk**]

19 Speaker A: What's this noise?
Speaker B: #[$_F$ **My neighbor** is building a desk]
#[$_F$ My neighbor is **building** a desk]

15 c) Speaker A: What's your neighbor doing these days?
Speaker B: My neighbor [$_F$ is building a **desk**]
20) #My neighbor [$_F$ is **building** a desk]

The same difference can be witnessed with the scope of only (which is always the focus). In (21), stress is assigned by the nuclear stress rule to builders. In this case, the scope of only can be either (the narrow focus) builders, or the whole VP that contains it[11]. Suppose our store sells equipment only to builders, but at the same time we also buy used equipment from builders and others. In this situation, (21a), with the narrow focus is true, but (21b) with the VP focus is false.

21 a) We only sell equipment [$_F$ to **builders**] (- not to the general public).
b) We only [$_F$ sell equipment to **builders**] (- We do not buy anything from anybody).

[10]In the present discussion I do my best to abstract away from anaphoric effects, which should be helped by the use of a verb of creation, like build.

[11]The standard assumption is that the potential scope of only is just its c-command domain, where it selects the focus as its scope.

22 a) We only sell [$_F$ **equipment**] to builders - not health-insurance.
b #We only [$_F$ sell **equipment** to builders] - We do not buy anything from anybody.

In (22), stress-shift applied. The sentence can only be used to exclude the option that we sell anything but equipment to builders, but not to exclude anything else, as witnessed by the inappropriateness of (22b). This means that the only element in the scope of <u>only</u> is the narrow focus -the argument bearing the new stress, as in (22a), but not the whole VP.

Though widely discussed, such facts did not receive a satisfactory account. Standard approaches postulate a special focus-projection rule for 'contrastive' focus. But it is far from obvious how we can distinguish (in a non circular way) the 'contrastive' (22a) from the 'standard' (21a), given that in both the focus is narrow. Such lines also disable a unified notion of focus projection (the focus-set). Given the reference-set approach to superfluous operations, outlined in section 2, these facts is exactly what we should expect. Such operation is allowed just in case this is the only derivation (in the reference-set) which meets interface-requirements.

I assume, first, just the one definition of the focus-set in (13), repeated, which is blind to how stress is assigned. Hence, for the derivations at hand the focus-sets defined are those in (b).

13) The focus set of IP consists of the constituents containing the main stress of IP.

23 a) My neighbor is building a **desk**
b) *Focus set*: {IP, VP, Object}

24 a) My neighbor is **building** a desk
b) *Focus set*: {IP, VP, V}

25 a) My **neighbor** is building a desk
b) *Focus set*: {IP, subject}

The focus sets of (23) and (24) intersect in the case of IP and VP. Suppose that in a given context we want VP (or IP) to be the focus. We could obtain this result by using (23a), without applying the superfluous stress shift. Hence, (24a) is ruled out for that context. The only focus of (24a) not already in the focus set of (23a) is the verb. Hence, it is only the need to use this focus that can motivate the stress shift. Similarly, (25b) intersects with (23b) on IP. Hence (25b) can only be used with the subject as focus.

As mentioned, computing this type of reasoning, requires a construction of a reference set, which consists of <d,i> pairs of a derivation and interpretation. In this case, the relevant interpretation is a selection of a focus out of the focus set. So, suppose our task is to decide whether (24a) can be used in the context of (19), namely, with the selection of IP as focus. The reference-set is (26).

26 a) d: My neighbor is building a **desk** --->
My neighbor is **building** a desk
i: Focus: IP

b) d: My neighbor is building a **desk**
i: Focus: IP

Since the pair in (26b) does not involve the extra-operation, it blocks (26a).

Suppose now we want to use (24a) with the verb as the focus, as in the context of (18a). Since stress-shift is involved, we have to construct a reference-set here as well. However, the reference-set is (27), which contains only this one member, since no other derivation (of the same numeration) has the verb as focus. Hence this derivation is allowed.

27) d: My neighbor is building a **desk** --->
My neighbor is **building** a desk
i: Focus: V

In conclusion, whenever stress-shift applies, a reference-set must be constructed to check its appropriateness. This means that this operation entails a computational complexity, whether the final outcome is 'in' or 'out'. On the other hand, there is no reason to assume any reference-set computation in derivations involving no stress-shift (as would be assumed in some optimality approaches). So, the difference between neutral and 'marked' stress is that the latter requires computational complexity not involved in the first.

4. The processing cost of reference-set computation: Acquisition evidence.

The theoretical prediction of this framework is that whenever reference-set computation is involved, there should be some evidence of processing complexity. Apparently, the processing load posed here is not beyond the processing ability of adults (given, e.g. that stress-shift can be used). But we may expect that appropriate processing experiments should show a greater load in processing, say, sentences with shifted-stress than sentences with neutral stress. Though, to my knowledge, this has not been studied, unexpected evidence starts accumulating in acquisition studies that this processing load exceeds children's processing ability. (Unexpected, because the studies finding it were not set up with this purpose in mind, which is often the strongest evidence there is in acquisition.)

The most commonly reported pattern of children performance has been uniformity of response (at a given age group, or in individual children). They can either produce close to a 100% adult-like responses (80%-100%), or close to a 100% wrong -responses, e.g. in areas where they have set a parameter to the wrong value. A (so far) much rarer pattern is around 50% of correct (adult-like) response, namely results at chance level. When such a pattern is established (e.g. it is consistently found in different experimental settings of the same age group, and also in individual children), it indicates that the relevant children perform by guessing.

The most studied and established guess pattern was found in acquisition of the coreference aspects of condition B. In sentences like (28a), children allow coreference in around 50% of their responses (a figure which can vary in individual experiments between 30% and 70%). This contrasts with their performance on variable binding, as in (28b), where they follow the more standard pattern - ruling anaphora out at close to 100% (reported, e.g. in Wexler and Chien 1991) .

28 a) Teddy bear touches him.
b) Every bear touches him.

Grodzinsky and Reinhart (1993) argue that a (genuine) guess pattern is inconsistent with the assumption that children do not know the relevant rule (either because they have set the wrong parameter, or the rule has not matured), since in this case they should perform at the 100% correct, or 100% incorrect pattern, depending on the rule and the experimental setting. Another account, which has been neglected before, is that the computation required by this rule exceeds the processing ability of children, specifically - their working memory, which is known to develop with age.

The coreference aspects of condition B (and C), require indeed much more complex computation than variable binding. In the present terminology, the coreference procedure proposed in Reinhart (1983), or Grodzinsky and Reinhart's rule I, require that in configurations which, in principle, also allow variable binding, (namely, when one of the arguments c-commands the other) a reference-set of <d,i> pairs must be constructed to determine whether coreference is also allowed. If the coreference interpretation is semantically indistinguishable than what could have been obtained by variable-binding, coreference is blocked. The underlying assumption is that variable-binding is a more efficient way to obtain anaphora than coreference. So whenever possible (in configurational terms), it is the only anaphora option, unless this interpretation is inappropriate to the given interface needs, i.e. unless the intended reading cannot be expressed with variable binding[12].

Grodzinsky and Reinhart argue that this is what explains the guess-pattern in coreference tasks: Assuming that all linguistic knowledge is innate, children know that they have to construct a reference-set, keep two representations in working memory, and check whether the interpretation

[12]A relevant question is why variable-binding is more efficient than coreference. Reinhart (1983) attempted an answer in terms of the Gricean maxim of manner ('be as explicit as the conditions permit'). Levinson (1987) shows that it cannot be the manner maxim, and develops a more plausible line in terms of the Gricean maxim of quantity (active in scalar implicatures). A more recent approach is in terms of semantic processing: variable-binding is less costly, since it enables immediate closure of open properties, while coreference requires that the property is stored open until we find an antecedent for the variable. This approach underlies Fox' (1998) analysis of rule I as reference-set computation of the shortest link. Reinhart (1998) explores the possibility that the reason why coreference is inefficient in rule I environments is that it enables bypassing a CS restriction: Variable-binding is excluded in these environments, so if coreference just sneaks in precisely the same excluded interpretation in the discourse door, this is not the optimal way to communicate, in a more global sense of optimality. (Communication optimality requires reducing, rather than increasing the competing interpretative options of a given derivation.)

In any case, under all these accounts, the computation requires a reference-set.

needed in the given context justifies selection of coreference. So, they start execution. But their working memory is not big enough to hold the materials needed to complete the execution of this task. Hence they give up and resort to a guess.

If reference-set computation exceeds children's processing ability, we expect to find the guess pattern in every area where we assume such computation is involved, regardless of the nature of the specific task and rule. Although this hypothesis has not been studied experimentally for stress-shift computation, it happens to be confirmed in studies that used sentences with stress-shift for other purposes.

Halbert, Crain, Shankweiler and Woodmans (1995) checked the interaction of only with what they call 'emphatic stress', as in their (29). Under the analysis in section 3, the nuclear stress rule assigns stress to the dative object Miss Piggy, and in (29), stress shift has applied.

29) Daisy only gave a **cherry** to Miss Piggy.

33 children aged 3;6 to 6;6 were tested. The experiment was a truth value judgment task. One experimenter told a story. Another experimenter, playing a puppet, then played a tape with a sentence about the story (prerecorded to guarantee the correct stress, with the pretext that the puppet has a soar throat), and the child would tell if the puppet was right or wrong. For (29) the story was about Daisy Duck who had a famous restaurant, with hot dogs and cherries. Miss Piggy, who spent her day in the gym, came in very hungry. But Daisy explained that it is not good to eat much after the gym, and therefore offered her a cherry, which she accepted. Then a spacemen arrived, who was not familiar with earth food, and Daisy gave him a hot dog.

In this context, (29) is true under the narrow construal of focus (-The only thing Daisy gave Miss Piggy was a cherry). But it is false on the wide construal, with the VP/IP as focus, namely that the only thing that happened was that Daisy gave a cherry to miss Piggy. Uttered in this context, no adult will have a problem judging (29) as true (as witnessed also by the judgments of the adult control group in the experiment.): This judgment requires first identifying the focus of the sentence (in order to compute only). Since Stress shift is involved, a reference needs to be consulted, to check whether this is the only way to obtain cherries as focus, and this is indeed the case. (The example is precisely analogous to (21)-(22), where the computation was discussed.)

The results of the experiments were that only 46% of the children judged it true, namely the results were in the guess pattern. Ken Drozd (pc) reports that in his experiments with only the same pattern was found in the stress-shift cases.

The few experiments conducted on this are not yet sufficient to establish a guess pattern. Still, these are precisely the results expected for the reference-set analysis. As noted in section 3.4, in this approach it should not matter whether we test sentences ruled in or ruled out by the reference-set computation, since both involve the same computation. In the coreference case, the tested sentences were those ruled out by the coreference rule, which invited various kinds of speculations regarding children's performance on illicit sentences (See e.g. Grimshaw and Rosen (1990)). However, the prediction of the analysis is that we should get the same guess pattern in cases ruled in. For the coreference rule, this was not tested[13]. But in the stress-shift experiment, children indeed showed the guess pattern with sentences ruled in. The prediction is, of course, that we should find the same pattern also in contexts where stress shift is ruled out (which were exemplified in section 3.4). The whole point is that children know what they should do to judge whether the sentence is ruled in or out, in the given context, but since they can't perform the computation, they offer a guess.

Nevertheless, to complete the argument, experiments need to be conducted also on cases ruled out by the stress-shift computation. Namely to test sentences with a stress shift when the context is consistent only with a VP reading. (This is particularly interesting, since, as will be mentioned soon, children have a default favoring wide focus interpretation with neutral stress.) The prediction is the same 50% (though interaction with the default should be carefully examined.)

Another instance of the stress-shift operation, which does not involve only, is illustrated in (30).

30 a) Lucie **touched** him.
   b) Lucie touched **him.**

With pronouns, the neutral stress pattern is (30a), rather than (30b). This is so, since pronouns do not carry stress at word level. (As mentioned, anaphoric destressing takes place at word-level before the nuclear stress rule). The nuclear stress rule operates by pa/ssing the most embedded word-stress up to the next metrical line. If the object is a pronoun, the first word-stress it finds is the verb's, which becomes, then, the main stress. This means that (30b) is derived by applying the superfluous stress-shift operation to stress the pronoun, which is consistent with the common description of this stress as 'emphatic' or 'contrastive' (i.e. marked). So the reference-set analysis predicts a guess pattern whenever a child has to process or judge such sentences. Indeed, this is the pattern found in all experiments on such sentences (designed, again, to find other things). The

[13]E.g. coreference in the sentences in (i) is ruled in by Reinhart's (1983) coreference strategy, or Grodzinsky and Reinhart's rule I ((ic) is an example of Higginbotham, discussed also by Wexler).

i a) Only he (himself) praised him.
  b) Only he thinks that Max is clever.
  c) This must be John: He put John's coat on.

ii a) He praised him.
   b) He thinks that Max is clever
   c) John decided to take a walk. He put John's coat on.

These are hard to test for independent reasons: In Condition B contexts like (ia) coreference is difficult also for adults, for reasons discussed briefly in Reinhart (1983). In condition C contexts, the linear order of pronoun and antecedent interferes with children's (and adults') performance. This is discussed in Grodzinsky and Reinhart, where studies neutralizing this effect are surveyed. In any case, the theoretical prediction is that for children, these should show precisely the same performance pattern as their counterparts in (ii), which are ruled out.

experiments tested sentences like (31).

31) First Max touched Felix and then Lucie touched **him**.

For adults, this stress pattern forces coreference of the pronoun and Max. (The account for this fact is irrelevant for our purpose). Children performed at chance level (identifying either Max or Felix as the antecedent). Reported in ///.[14]

For proving the hypothesis that reference-set computation is indeed the source of trouble in cases like (31) and (29), it is of course necessary, first, to show that children have no problems with just the standard nuclear stress-rule, and next, to exclude other possible accounts. One such account which has been floating around (for (31)) is that children cannot use stress as a key to disambiguation. The pair in (32) (from the same paper by Halbert et al (1995)) can check both.

32 a) Big Bird threw [the fish] **food**
b) Big Bird threw the [**fish**-food]

Without stress, the word-string in (32) is ambiguous between the syntactic construal (a) and (b). When pronounced, (i.e. once the nuclear stress applied) there is no ambiguity: In (32a), where food is the theme-argument, its stress is projected as the sentence-stress. In (32a), the most deeply embedded argument is fish-food, which gets the standard compound stress. This stress then projects as the main sentence stress. No stress-shift applies in these structures. If children have problems either with the nuclear stress rule, or with disambiguating via stress, they should perform badly on distinguishing these sentences. Under our hypotheses that the nuclear stress rule is both innate and computationally simple, and that it is only stress-shift that requires reference-sets computation, they should do well here.

In Halbert et al's study, the same methodology was used as in (29): The children were again given a story for each sentence. This time, the sentence would be false for adults, given the story told with it. 89% of the children subjects (16 out of 18, aged 3 to 5;3) gave indeed the correct answer (i.e. judged the sentence as false). This is a normal variation of what I called the 100% correct pattern, So, they did well.

In conclusion, the results reported here are not sufficient to prove the reference-set hypothesis for stress-shift[15], but they seem a good enough reason to test it further. What we saw is that although no experiment was set so far to check directly this hypothesis, every experiment which happened, for whatever reason, to involve the operation of stress-shift, found chance results consistent with the guess pattern.

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[14] I thank Sergey Avrutin for providing these findings. Avrutin found similar results with aphasics.

[15] E.g. Halbert et al found different results when they checked a verb with two obligatory internal arguments like give, and the findings were not further tested and clarified.

5. Guess and default patterns in acquisition.

It would be recalled that in the view presented here, all instances of reference-set computation, are (marked) interface strategies, applying only when the need arises to adjust a derivation to the context of use. (Thus, these are departures from optimal design). For this reason, their application is always also relative to context: The computation checks whether the derivation could not meet the context requirements also without the offensive operation. It may be argued, therefore, that the difficulties children are facing here (the guess pattern) are not caused by reference-set computation as such, but by the need to check derivations against contexts. (If this turns out true, then we have no processing evidence that reference-set computation is too complex to be assumed everywhere in syntax, as in Optimality Theory.)

In fact, this was brought up against the account given by Grodzinsky and Reinhart (1993) for the acquisition of coreference - their rule I (or Conditions B, C). Avrutin (1994) and Thornton and Wexler (in press) argue, from varying perspectives, that children have a broader deficiency in contextual computation. Avrutin argues that they face difficulties in all areas of anaphora resolution in discourse. At the present, it is premature to enter this issue in detail, because the precise nature of the deficiency is still at work in his framework. To establish this argument, it would be necessary, first, to define the discourse rules that children are presumed to have difficulties with, show that these rules are involved in the experimental settings of rule I, and then produce experimental evidence that, indeed, the guess pattern occurs in environments of these rules, also when isolated from effects of rule I (or stress-shift).

The most explicit and successful account I know of the rules governing anaphora resolution in discourse is Ariel's (1990) accessibility theory. (Her accessibility rules apply whenever anaphora resolution takes place, hence also in experiments on rule I.) Under this theory, the standard task of identifying antecedents in discourse is incomparably easier than what is involved in the reference-set computation of rule I and it does not require storing and comparing representations in working memory. Though it is possible that children perform less good on accessibility than adults, in the absence of evidence to the contrary, I keep expecting that experiments will not find a guess pattern here, in tasks which do not involve also rule I or stress-shift. The few experiments available on this issue, (again, conducted for other purposes) support this expectation. Thus, recall that on (31), repeated, a guess pattern was found with a stress-shift on the pronoun.

31) First Max touched Felix and then Lucie touched **him**.
33) First Max touched Felix and then **Lucie** touched him.

The same studies found that on (33), where the pronoun is not stressed, children had the correct (adult) anaphora resolution (namely, they identified him with Felix)[16]. If children have a general accessibility problem, they should perform the same on both. (On other possible anaphora-resolution rules that await formulation, I cannot judge.)

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[16]Note that the stress on Lucie in (33) is not obtained by stress-shift, but by anaphoric destressing of touched him, which, as mentioned, does not involve reference-set computation. Neeleman and Reinhart (1998) argue that the different effects of these two operations are also audible, in the appropriate setting.

Thornton and Wexler (forthcoming) propose a more specific deficiency which explains children's problems with rule I. (Based on the report of their argument in Thornton (1998)), they assume, as in Grodzinsky and Reinhart, that rule I involves reference-set computation: Children have to construct both a bound-variable and a coreference representation. If they are indistinguishable semantically, the coreference representation is blocked. However, this computation is not too complex for them. Their difficulty is in deciding when two representations are distinguishable, since this rests on the notion of guises, and children have not yet acquired the understanding "which circumstances lend themselves to an individual being presented in two guises". However, to establish this hypothesis, one has first to define the notion of guises (much discussed but still undefined)[17]. Next, one has to show that there are other areas of guises, apart from rule I, on which children also guess.

Nevertheless, the general spirit of these objections is valid. For the present analysis to be correct, it is necessary to exclude the option that it is the computation in context which is the source of children's difficulties, rather than reference-set computation. This is particularly clear in the case of stress-shift and focus. The actual identification of the focus in context is a matter of disambiguation. As we saw, the CS associates with each derivation only the set of its possible foci, one of which will be selected in context. This means that derivations are always ambiguous regarding what is their actual focus. The task of (semantic) disambiguation in context requires indeed a certain amount of computation complexity. It is also known that in disambiguation tasks children do not perform as adults. It may be argued, then, that the processing complexity we found with stress-shift is just an instance of the focus-disambiguation problem.

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[17]E.g. Thornton argues that (i) with a stressed pronoun is always acceptable since "Two guises of John are being presented: (i) the 'John' in the here-and-now, who is a voter and the 'John' as the person who people voted for".

(i) John voted for **him**

As far as I can see, the sentence will have precisely the same status if John is the only one who voted for John. So I guess the second clause should read "the person who someone voted for". In other words, the two guises of John are John the voter (agent), and John the 'votee' (theme), just like in John shaved himself we have John the shaver, and John the shaved. It appears, then, that what it means for the the same entity to occur in two distinct guises is that it realizes two distinct theta roles.

But this is not the whole story. For example (ii) (quoted from Heim, 1998), the account is that the first occurrence she is a visual guise, while her is a memory guise.

ii) Speaker A: Is this speaker Zelda?
Speaker B: How can you doubt it? She **praises** her to the sky.

So, the impression one gets is that the content of the term is just established afresh for each example. The only real generalization I can see is that when rule I allows a pronoun to corefer in condition B environments, then this pronoun can be called a guise.

The fact is, however, that what is found in children's performance on semantic disambiguation is not the guess pattern, but the default pattern. If they use a different default than adults, then their performance may be dramatically different than adults, but still the two patterns are clearly distinguishable. Let us follow on this the analysis of focus disambiguation in Crain Ni and Conway (1994):

34 The dinosaur is only painting a **house**

a. The only thing the dinosaur is doing is painting a house.
b. The only thing the dinosaur is painting is a house.

In their (34), the scope of only is just the VP. (The example is analogous to (21) in section 3.4). The two possible foci in the focus set (for the neutrally stressed VP) are the object house and the VP painting a house. If house is selected (and its set of alternatives constructed), we obtain the reading (34b), and if we select the VP, we get (34a). There are subset relations between the readings: (34a) entails (34b), which means that the situations in which (a) is true are a subset of the situations in which (b) is true. (E.g. while (b) will be true if at the same time the dinosaur is also playing a guitar, (a) will be false in that case.) Both foci can be selected in the appropriate context. However, in the absence of context, or in a context consistent with both, adults tend to take reading (b) as default, a choice reflecting 'minimum commitment' (- Select a reading which excludes least situations). The majority of children follow, in the experiments they conducted, the opposite default of 'maximum commitment' and select the wider VP focus (a). The account Crain et al give for this default is that it is the most efficient strategy to acquire semantic interpretation - The more children exclude, the more they will get the chance to add, based on positive evidence, while subtracting from the initial hypothesis may require negative evidence.

The crucial point for the present discussion is that the default pattern does not involve any guess behavior: Children operating by this default consistently reject pictures inconsistent with this default, which would be admissible to adults. Once a default is identified, it is thus possible, in principle, to control the experiments so that an adult-like, or non-adult-like performance is obtained, (a 100% type result), depending on choice of the tested pictures. This is impossible with the guess pattern, where whichever way the experiment goes, one gets chance results.

The results obtained in focus disambiguation with neutral stress are, thus, clearly distinguishable from the results obtained (so far) when focus is marked with a stress-shift (as in (29). More generally the disambiguation default pattern is clearly distinguishable from the guess pattern, which, I argue is characteristic of reference-set computation.

This enables us to form a strong, and strictly falsifiable hypothesis that if it is independently established that reference-set computation is involved, then there should be a guess pattern in its acquisition. (For the time being it is premature to propose an even stronger iff condition, since there may be other considerations leading to chance results in experiments.) If true, an entailment of this hypothesis is that if no guess pattern is found, it is incorrect to explain a given linguistic problem as determined by reference-set computation.

Grodzinsky and Reinhart (1993) suggested that lexical disambiguation (e.g. selecting the relevant entry of bug in context) is a task similar to the coreference rule I, based on its acquisition findings. Given the present hypothesis, this was a mistake. In fact (as also acknowledged there), the findings indicate a default pattern, which is not sufficient to establish reference-set computation. It is an interesting theoretical question to define precisely the properties distinguishing semantic disambiguation from reference-set computation, despite their superficial similarity. But I leave this question open here.

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