

VP Ellipsis and Constraints on Interpretation

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1 Introduction

Beginning with early work such as (Ross, 1967) and (Sag, 1976), the interpretation of ellipsis has been an enduring preoccupation of linguistics research. Many researchers have attempted to use ellipsis as a tool to gain insight into otherwise hidden structures and mechanisms underlying interpretation. According to Sag's account of VP Ellipsis (VPE), the facts of ellipsis reflect logical aspects of the representation of pronouns, which are ambiguous between a lambda-bound and referential reading. On this influential view, ellipsis reveals an intricate machinery of lambda binding, pronoun indexing, and scope relations.

Subsequent research has shed doubt on this pleasing picture – it has been shown that ellipsis interpretation is more flexible than Sag's theory permits, and this has led to the proposal of numerous alternative theories. In (Hardt, 1993), I proposed that VPE resolution be completely free, at least with respect to pronoun interpretation. This makes it possible to represent pronouns in a uniform way, without indexing or ambiguity. If VPE resolution is indeed free in this sense, then any constraints that appear to arise in ellipsis must instead be imposed by more general mechanisms.

Perhaps ellipsis is revealing in a rather different sense than suggested by Sag: instead of providing insight into the intricacies of the logical form of sentences, ellipsis emerges as a window onto the general mechanisms governing the interpretation of multi-sentence discourse. In this paper I will use ellipsis to investigate two potential mechanisms for general, inter-sentential constraints on interpretation: Background Matching, based on (Rooth, 1992; Dalrymple *et al.*, 1991), and Parallel Dependencies, based on (Fiengo and May, 1994). The Background Matching approach attempts to determine a common semantic background to the ellipsis and antecedent clause, while the Parallel Dependencies approach places rather involved constraints on the structural material connecting dependent expressions with antecedents.

Background Matching was originally formulated by (Rooth, 1985) as an account of focus, and it thus has clear motivation independent of its application to ellipsis. Parallel Dependencies, on the other hand, appears to be tailor-made to account for complex cases of ellipsis, and it is not clear whether it can be given independent, general motivation. Furthermore, Background Matching is conceptually clearer and simpler than the Parallel Dependencies approach.

Unfortunately, it appears that the complex Parallel Dependencies approach is necessary to account for certain complex ellipsis examples, involving multiple occurrences of pronouns, as has been argued by (Fiengo and May, 1994; Fox, 2000). No convincing account of these cases has been given using Background Matching. I will argue however, that a simple version of Background Matching can indeed account for such cases, with proper attention to aspects of their logical structure that have previously been ignored.

In section 2, I will present a free approach to VPE resolution, and show how this fits together with a somewhat modified version of the Background

Matching and Parallel Dependencies approaches. In section 3, I consider the complex cases that have proved problematic for previous version of Background Matching, including the so-called two-pronoun puzzle. I review two accounts (Fiengo and May, 1994; Fox, 2000) in which versions of the Parallel Dependencies approach are used to analyze the two-pronoun puzzle. I show that the Background Matching approach as presented here can also correctly analyze these examples. I show that this modified Background Matching approach can also correctly analyze a complex example involving embedded ellipsis occurrences. Finally, I suggest that the Background Matching operation is best viewed as the reflex of a particular discourse structure. As evidence for this, I show that Background Matching does not necessarily apply when the discourse structure involves a relation other than parallelism.

2 Two General Constraints: Background Matching and Parallel Dependencies

2.1 Free VPE Resolution

As in (Hardt, 1993), I assume that the VPE resolution operation itself imposes no constraints on the interpretation of pronouns within the antecedent. Pronouns are represented in a simple uniform way, as instructions to retrieve an appropriate semantic object from the current context. In (Hardt, 1993), this idea was implemented using a processing model of Store and Retrieve instructions. Here I will implement the same idea using LF representations. Pronouns will have no index at LF, and VPE can be resolved by a VP-copy

operation.¹ Since pronoun-antecedent relations are not determined prior to VPE resolution, the only constraints on interpretation must arise from external mechanisms. In what follows, we consider Background Matching and Parallel Dependencies. These mechanisms will apply to structures after VP-copy has applied and after pronoun-antecedent relations have been determined.

2.2 Background Matching

Several authors (Rooth, 1992; Tancredi, 1992; Dalrymple *et al.*, 1991; Prust *et al.*, 1994; Asher, 1993; Hobbs and Kehler, 1997; Asher *et al.*, 2001) have argued that interpretation is constrained by an operation that attempts to match background material between parallel clauses in a discourse. Essential to this view is Background Construction, which can be thought of as follows: given two related clauses C1 and C2, construct a Background from these clauses by substituting variables for any material that differs between C1 and C2.

Here we focus on the case where C2 contains a VPE occurrence, while C1 contains the antecedent VP, which is copied by the VP-copy operation described above. Consider the following example:

- (1) John saw his mother. Bill did too. (saw his mother)

Following (Dalrymple *et al.*, 1991), we produce a Background from the antecedent clause (ANT) by means of lambda abstraction, and the Back-

¹A similar approach to VPE resolution is taken in many works, such as (Kitagawa, 1991; Asher *et al.*, 1997). In this paper I will not address the question of the level of representation at which a copy is performed. It may be thought of as a syntactic level of LF or a semantic DRS structure or dynamic semantics representation.

ground is then applied to the parallel element(s) in the ellipsis clause. A given reading for an ellipsis occurrence is only permitted if it can be derived in this way. The following is a simplified version of the Background Construction algorithm from (Dalrymple *et al.*, 1991) (henceforth the DSP algorithm):²

- (STEP 1) prefix ANT with lambda x
- (STEP 2) replace primary occurrence *s* with x
- (STEP 3) for each pronoun *p* in ANT, optionally replace *p* with x if *p* is coindexed with *s*

For the above example, we have

- (STEP 1) $\lambda x.$ John₁ saw his₁ mother
- (STEP 2) $\lambda x.x$ saw his₁ mother
- (STEP 3 – optional) $\lambda x.x$ saw x’s mother

If the optional STEP 3 is performed the sloppy reading is derived. Otherwise, we derive the strict reading.

This is very similar to the approach in Rooth (92), where Rooth suggests that general constraints on focus might also be applied as a constraint on ellipsis interpretation. The *alternative semantics* theory of focus is that a focused element is permitted if it is contained in a clause that matches an antecedent clause.

²We restrict attention to cases with a single primary occurrence, which is normally the subject of the antecedent VP. Also, we assume that *x* is a variable that does not occur in ANT.

Rooth defines the focus value of an expression as the set of alternative expressions, where each alternative expression is constructed by replacing the focused element with some alternative (i.e., an element of the same semantic type.) Applied to ellipsis we have the following definition (Rooth 92):

- Ellipsis (E) requires that there be some phrase P containing E and some antecedent phrase ANT in the discourse, such that $\llbracket ANT \rrbracket \in F(P)$.
- $F(P) = \{P' | \exists x. P' = P[e/x]\}$, e focused in P .

The set of all P' where occurrences of the focused element e is replaced by some element of the appropriate type.

According to Rooth’s approach, we assume there is focus on *Bill*. For the strict reading (where Bill and John both see John’s mother), the focus value of VPE is then the set of propositions of the form: *x saw John’s mother*. The ANT meaning *John saw John’s mother* is clearly an element of this set, so the reading is permitted. For the sloppy reading, the VPE focus value is the set of propositions of this form: *x saw x’s mother*. Again, the ANT meaning *John saw John’s mother* is clearly an element of this set, so the reading is permitted.

The empirical content of the (Dalrymple *et al.*, 1991) and Rooth approaches appears quite similar. I will ignore several differences in presentation which may or may not have empirical content – for example, Rooth uses focus to determine the element(s) which are to be replaced by variables, while (Dalrymple *et al.*, 1991) leave this to a general processing of determining parallel elements, which would presumably take into account focus as well as general contextual reasoning. For presentational purposes, I will

define the Background with respect to LF structures, although Rooth explicitly defines his approach with respect to semantic denotations. Although this difference undoubtedly has empirical significance, it is not relevant to my purposes in this paper. Another difference is that Rooth constructs the Background from the ellipsis clause, while (Dalrymple *et al.*, 1991) constructs it from the antecedent clause. Again, the empirical significance of this is unclear. However, I would like to propose a constrained version of Background Construction, which is more conveniently described using Background Construction from the antecedent clause, as is done by (Dalrymple *et al.*, 1991).

Recall that the DSP algorithm permits a choice with respect to each coreferential pronoun. In example (1), this leads to two possible readings, since there is one coreferential pronoun. In general, the algorithm will generate 2^n distinct Backgrounds, where n is the number of coreferential pronouns. I will propose a more restrictive variant, where either all or none of the coreferential pronouns are replaced with the lambda-bound variable.

Background Construction (constrained version):

- (STEP 1) prefix ANT with lambda x
- (STEP 2) replace primary occurrence s with x
- (STEP 3 – optional) Replace *all* pronouns p in ANT with x (for p coindexed with s)

To illustrate the constrained version of Background Construction, consider the following example:

- (2) John said he saw his mother. Bill did too.

The original DSP algorithm produces the following four Backgrounds:

- $\lambda x.x$ said x saw x 's mother
- $\lambda x.x$ said John saw John's mother
- $\lambda x.x$ said x saw John's mother
- $\lambda x.x$ said John saw x 's mother

According to the more restrictive variant, we produce only two Backgrounds:

- $\lambda x.x$ said x saw x 's mother
- $\lambda x.x$ said John saw John's mother

We will return to this issue in section 3, when we consider examples with multiple pronoun occurrences.

2.3 Parallel Dependencies

The intuition behind Parallel Dependencies can be stated like this: ellipsis resolution always permits *strict* identity of pronouns, while *sloppy* identity is only permitted if the sloppy pronouns are resolved in a parallel way to each other. While this intuition can be found with many authors, I will focus on the Parallel Dependencies approach due to (Fiengo and May, 1994). In this theory, elided material must be a syntactic copy of the antecedent, apart from index change.³ Index change, or sloppy identity, is only permitted if there is a parallel dependency, defined as follows (Fiengo and May, 1994, page 51):

³Here we ignore other changes, which Fiengo and May describe as “vehicle change”.

1. A dependency is a sequence of syntactic categories connecting a dependent category with its antecedent. It is represented as follows: $\langle S, I, SD \rangle$, where S is a sequence of category labels bearing the index I , and SD is a sequence of category labels of the material connecting the indexed elements.

- **Completeness Requirement:**⁴ The sequence S must include *all* elements of the SD which bear the index I .

2. Two dependencies are identical if “they vary at most in the value of I ” (the index) (Fiengo and May, 1994, page 95). In other words, they must have the same sequence of elements and the same structural description. Note that the relevant notion of identity here is identity of category labels, not of lexical items; although the sequence is typically written as a sequence of lexical items, it is their category labels which are significant.

To demonstrate the analysis, let us consider again example (1), repeated here.⁵

- (3) John₁ saw his₁ mother. Bill₂ did too. (saw his₂ mother)

The strict reading is always permitted. The sloppy reading is portrayed by the above indexing. To permit this reading, we must show that the two

⁴This is my term for this requirement, from (Fiengo and May, 1994, page 151).

⁵This presentation differs in certain ways from that of Fiengo and May. One difference is that I ignore the distinction, introduced by Fiengo and May, between *alpha* and *beta* occurrences. In my view, this distinction lacks independent motivation and plays no role in the empirical results of interest here. On the other hand, the **Completeness Requirement** is crucial to the results concerning the two pronoun puzzles, although this does not emerge clearly from Fiengo and May’s presentation.

occurrences of *his* are in parallel dependencies. The two dependencies are the following:

$\langle ([John]_{NP}, [his]_{NP}), 1, \langle [John]_{NP}[saw]_V[his]_{NP} \rangle \rangle$
 $\langle ([Bill]_{NP}, [his]_{NP}), 2, \langle [Bill]_{NP}[saw]_V[his]_{NP} \rangle \rangle$

Recall the conditions on i-copy: both the sequence and the structural description must be identical in terms of category labels. (I include the lexical items only for the sake of readability.) Clearly this is the case above: the two sequences are $NP - NP$, and the two SD's are $NP - V - NP$. Thus sloppy identity is correctly permitted.

3 Complex Examples

In this section, we consider complex examples which have previously been accounted for by Parallel Dependencies, but not by Background Matching. I will show that Background Matching can in fact successfully account for these well-known cases.

3.1 The Two Pronoun Puzzle

We turn now to the two-pronoun puzzle, where the antecedent VP contains two pronouns (Dahl, 1974).

(4) John said he saw his mother and Bill did too.

One might expect there to be four possible readings, since each of the two pronouns could be either strict or sloppy. In fact, only three of these four readings are possible, as shown by the following list.

- **Readings:**

1. JJ
2. BB
3. BJ
4. *JB

Note that Sag's theory incorrectly permits the fourth reading, since it permits a representation where the first pronoun is referential and the second is lambda bound.

- (5) [John₁, λ x.x said he₁ saw x's mother]
- (6) [Bill₂, λ x.x said he₁ saw x's mother]

For similar reasons, both DSP and Rooth's theory also incorrectly permit the fourth reading.

3.1.1 The Parallel Dependencies Account

As shown by (Fiengo and May, 1994), the Parallel Dependency approach correctly rules out the fourth reading, while permitting readings 1-3. To see this, let us examine readings 3 and 4.

- Reading 3:

John₁ said he₁ saw his₁ mother, Bill₂ [said he₂ saw his₁ mother] too.

Consider the two pronoun occurrences at the ellipsis site. The first pronoun, he₂, has changed its index, and thus we must determine whether it participates in a parallel dependency. The following two dependencies are

i-copies, differing only in the value of the index – both the sequences and the structural descriptions are identical categories.

$\langle ([John]_{NP}, [he]_{NP}), 1, \langle [John]_{NP}[said]_V[he]_{NP} \rangle \rangle$

$\langle ([Bill]_{NP}, [he]_{NP}), 2, \langle [Bill]_{NP}[said]_V[he]_{NP} \rangle \rangle$

Consider now Reading 4:

(7) John₁ said he₁ saw his₁ mother, Bill₂ [said he₁ saw his₂ mother] too.

Here it is the second pronoun, his₂, which has changed index, and therefore must participate in a parallel dependency. Thus we must find in the first clause a dependency that is parallel to

$\langle ([Bill]_{NP}, [his]_{NP}), 2, \langle [Bill]_{NP}[said]_V[he]_{NP}[saw]_V[his]_{NP} \rangle \rangle$

There is no such dependency. It might appear that we have the following dependency:

$\langle ([John]_{NP}, [his]_{NP}), 1, \langle [John]_{NP}[said]_V[he]_{NP}[saw]_V[his]_{NP} \rangle \rangle$

But the structural description contains an element indexed with *I* that is not included in the sequence – namely, he₁. This is not permitted, as it violates the *Completeness* constraint. If we include the omitted element, we get

$\langle ([John]_{NP}, [he]_{NP}, [his]_{NP}), 1, \langle [John]_{NP}[said]_V[he]_{NP}[saw]_V[his]_{NP} \rangle \rangle$

But this dependency doesn't match – it has a sequence of three elements, while the “Bill-his” dependency has a two- element sequence.

3.1.2 Fox's Account

(Fox, 2000) adopts Fiengo and May's claim that index change requires Parallel Dependencies, but combines this with an economy-based preference for local links. Interestingly, Fox's *Locality* constraint plays exactly the same role as *Completeness* does in Fiengo and May's account. Recall that, for Reading 4, the dependency in the ellipsis clause is the following:

$$\langle ([Bill]_{NP}, [his]_{NP}), 2, \langle [Bill]_{NP}[said]_V[he]_{NP}[saw]_V[his]_{NP} \rangle \rangle$$

To satisfy parallelism, we need the following dependency from the antecedent clause:

$$\langle ([John]_{NP}, [his]_{NP}), 1, \langle [John]_{NP}[said]_V[he]_{NP}[saw]_V[his]_{NP} \rangle \rangle$$

This dependency is not permitted for Fox, because the link between *his* and *John* is not local, and the following dependency is therefore preferred:

$$\langle ([John]_{NP}, [he]_{NP}, [his]_{NP}), 1, \langle [John]_{NP}[said]_V[he]_{NP}[saw]_V[his]_{NP} \rangle \rangle$$

But with this dependency, parallelism fails, and thus Reading 4 is not permitted. Thus, for Fox Reading 4 would either violate parallelism or would have a non-local link. Note that the non-local link ruled out by Fox would be ruled out by Fiengo and May's *Completeness* constraint, for essentially the same reason: the existence of a coindexed pronoun "he" intervening between "John" and "him".

3.1.3 Solving the Two-Pronoun Puzzle with Background Matching

Here I will show that Background Matching can indeed account for the two-pronoun puzzle. The key to this result is that I will permit any non-atomic indexed expression $[...]_i$ to be *Collapsed*, ie, to be replaced with an atomic expression e_i . (I assume that maximal projections NP, VP, and S can receive indices.) This makes it possible to ignore the internal content of indexed expressions in ellipsis resolution. It seems to me that this is an entirely natural option to permit prior to ellipsis resolution. Indeed there are a variety of ways that this effect can be achieved⁶. For simplicity, I will simply allow *Collapsing* as an option in the construction of the Background. Recall also that we have modified the Background Matching approach so that it only generates two readings in the two-pronoun example; either both pronouns are replaced with bound variables, or neither are. Consider now Reading 3:

- (8) John₁ said he₁ saw [his₁ mother]₂, and Bill₃ did (said he₃ saw [his₁ mother]₂) too.

We make use of Collapsing to derive the following representation for the antecedent clause: John₁ said he₁ saw [e]₂. We can then derive the following Background:

⁶One alternative would be that Collapsing is a result of Quantifier Raising (QR) – the non-atomic indexed expression is moved by QR, and replaced by an atomic indexed expression. Another alternative relates to Merchant’s view (Merchant, 1999) that ellipsis simply must satisfy Background Matching, permitting any syntactically well-formed expression to appear at the ellipsis site. Here, this would mean for the relevant cases that a pronoun appears at the ellipsis site in the position corresponding to the non-atomic indexed expression in the antecedent.

$\lambda x. x \text{ said } x \text{ saw } e_2.$

Applying P to *Bill*, we derive the following representation, showing that Reading 3 is permitted:

- (9) John₁ said he₁ saw [his₁ mother]₂, and Bill₃ said he₃ saw [e]₂)
too.

Consider now Reading 4:

- (10) John₁ said he₁ saw [his₁ mother]₂, and Bill₃ did (said he₁ saw
[his₃ mother]₄) too.

It is easy to see that Reading 4 cannot be produced. First, note that the Collapsing option is not relevant here; if we collapse [his₁ mother]₂ to [₂], we would only be able to produce readings referring to *John's* mother. Thus we must produce a Background in which the pronoun *his* from the antecedent clause is lambda-bound. However, because of our restriction on Background Matching, this means that *he* must also be lambda-bound, meaning we will produce Reading 2. Thus, Reading 4 is correctly ruled out on our version of Background Matching.

As several authors have noted (Fiengo and May, 1994), the two-pronoun puzzle is sensitive to the particular positions of the two pronouns; embedding of the first pronoun causes the fourth reading to re-emerge, as in the following variant of (4):

- (11) John₁ said [his₁ mother]₂ [saw him₁]₃, and Bill₄ did too.

To derive Reading 3 (“Bill said Bill’s mother saw John”), we produce the Background as follows:

- (ANT Clause) John₁ said [his₁ mother]₂ [saw him₁]₃

- (Collapse VP 3) John₁ said [his₁ mother]₂ (did) [e]₃
- (Lambda Prefix) λ x.x said [his₁ mother]₂ (did) [e]₃
- (Replace pronoun) λ x.x said [x's mother] (did) [e]₃

When applied to “Bill”, the Background produces the following representation:

Bill₄ said [Bill₄'s mother] (did) [e]₃

Since e₃ represents the VP [saw him₁], this captures Reading 3. This examples illustrates that our collapsing option can apply to VP's as well as NP's. Consider now Reading 4 (“Bill said John's mother saw Bill”). The derivation involves the collapsing of [*his₁ mother*]₂, as follows:

- (ANT Clause) John₁ said [his₁ mother]₂ [saw him₁]
- (Collapse NP 2) John₁ said [e]₂ [saw him₁]
- (Lambda Prefix) λ x.x said [e]₂ [saw him₁]
- (Replace pronoun) λ x.x said [e]₂ [saw x]

When applied to “Bill”, the Background produces the following representation:

Bill₄ said [e]₂ [saw Bill₄]

Since e₂ represents the NP [his₁ mother]₂, this captures Reading 4.

3.2 A Symmetry Effect

There are additional examples, due to (Fox, 2000, page 119), where Fox argues that a similar constraint is at work.

- (12) Every boy₁ said that Mary₂ liked her₂ dog. Well Mary₂ did too.
(said that she₂ liked her₂ dog)
- (13) Every boy₁ said that he₁ liked his₁ dog. Well Mary₂ did too.
(said that she₂ liked her₂ dog)
- (14) Every boy₁ said that he₁ liked Mary₂'s dog. Well Mary₂ did too.
(said that she₂ liked her₂ dog)
- (15) *Every boy₁ said that Mary₂ liked his₁ dog. Well Mary₂ did too.
(said that she₂ liked her₂ dog)

Fox points out that reading (15) is ruled out by *Locality* in his Parallel Dependencies account. To see this, note that *her* in the ellipsis clause must participate in a parallel dependency. There are two choices:

1. $\langle ([she]_{NP}, [her]_{NP}), 2, \langle [she]_{NP}[liked]_V[her]_{NP} \rangle \rangle$
2. $\langle ([Mary]_{NP}, [her]_{NP}), 2, \langle [Mary]_{NP}[said]_V[she]_{NP}[liked]_V[her]_{NP} \rangle \rangle$

It is clear that choice 1 is not permitted; the structurally parallel material in the antecedent clause is $\langle \text{Mary}_2 \text{ liked his}_1 \rangle$, but *his* is not dependent on *Mary*. For choice 2, we can find the following parallel dependency in the antecedent clause:

$\langle ([Everyboy]_{NP}, [his]_{NP}), 1, \langle [Everyboy]_{NP}[said]_V[Mary]_{NP}[liked]_V[his]_{NP} \rangle \rangle$

However, note that choice 2 contains an element in its SD ($[she]_{NP}$) that bears index 2. Thus it is ruled out for familiar reasons: *Completeness* in Fiengo and May's version, and *Locality* in Fox's account.

On the proposed Background Matching account, it appears that (15) would incorrectly be permitted. The following Background can be produced from the antecedent:

(16) $\lambda x.x$ said that $Mary_2$ liked x 's dog

Applied to *Mary*, this gives the reading in question. These examples point up the fact that the Parallel Dependencies account is completely symmetrical between antecedent and ellipsis clause. On the other hand, Background Matching (as formulated here) is not symmetrical. This can be demonstrated by applying Background Matching in the opposite direction. That is, we can extract the Background from the ellipsis clause instead of from the antecedent clause. We consider the case where the ellipsis clause is resolved as follows:

(17) $Mary_2$ said that she_2 liked her_2 dog

There are the following two possible Backgrounds:

1. $\lambda x.x$ said that x liked x dog
2. $\lambda x.x$ said that $Mary_2$ liked $[her_2$ dog]₃

These readings, applied to *every boy*, give the readings in (12) and (13). The reading in (14) is derived using the outer index, so that the background property is

$\lambda x.x$ said that x liked e_3

There is no way to derive Reading 4, given that we are constructing Backgrounds from the ellipsis clause. Thus, a symmetrical version of Background Matching would correctly capture the above judgments. In other

words, we would require that a given reading must be derivable both using a Background extracted from the ellipsis clause, and from the antecedent clause. We will leave for future research the question of whether this symmetrical version should be used in all cases, or perhaps a subset of cases.

3.3 A Six-Reading Example

The following example, studied by many researchers (Gawron and Peters, 1990; Dalrymple *et al.*, 1991; Asher *et al.*, 2001), motivates an additional application of the collapsing option. I show here that our proposed version of Background Matching successfully accounts for constraints that are not captured by previous versions of Background Matching or Parallel Dependencies.

- (18) John revised his paper before the teacher did (revise his paper), and Bill did (revised his paper before the teacher did revise his paper) too.

As pointed out by (Dalrymple *et al.*, 1991), there are six conceivable readings, which can be represented as follows:

Readings:

1. JJJJ
2. JTBT
3. JJBB
4. ?JTJT
5. ?JJBJ

6. *JJJB

Note that there are three copies of the pronoun *his* produced by ellipsis resolution. Thus *JJJJ* represents the reading where all copies are interpreted as *John*, and so on. While there is disagreement in the literature about the acceptability of these six readings, it is generally agreed that 1-3 are completely acceptable, while 6 is not acceptable. I will give 4 and 5 an intermediate status.

We will set aside Readings 1 and 2, which receive straightforward derivations in all the approaches we are considering. Consider Reading 3:

- (19) [[John₁ revised his₁ paper]_{S1a} before [the teacher₂ did revise his₁ paper]_{S1b}]_{S1}, and [[Bill₃ did revise his₃ paper]_{S2a} before [the teacher₂ revise his₃ paper]_{S2b}]_{S2} too.

We assume that the following constraints are imposed by Background Matching: *S1a* must match *S1b*, *S2a* must match *S2b*, and *S1* must match *S2*.

- *S1a*, *S1b*: Background = λ x.x revised his₁ paper
- *S2a*, *S2b*: Background = λ x.x revised his₃ paper
- *S1*, *S2*: Background = λ x.x revised x's paper before the teacher₂ revised x's paper

We can see that a common Background can be identified for each of the required clause pairs. We turn now to Reading 4:

- (20) [[John₁ revised his₁ paper]_{S1a} before [the teacher₂ did revise his₂ paper]_{S1b}]_{S1}, and [[Bill₃ did revise his₁ paper]_{S2a} before [the teacher₂ revise his₂ paper]_{S2b}]_{S2} too.

Again we attempt to match three pairs of clauses:

- $S1a, S1b$: Background = $\lambda x.x$ revised x 's paper
- $S2a, S2b$: Background = ??
- $S1, S2$: Background = $\lambda x.x$ revised his_1 paper before the $teacher_2$ revised his_2 paper

Here, matching of $S2a$ and $S2b$ fails. To see this, consider the options in producing the Background. First we prefix $S2a$ with the lambda binder, resulting in:

$P = \lambda x.x$ revised his_1 paper.

We cannot replace his_1 with x , since his_1 is not coreferential with the subject *Bill*. Thus P applied to *the teacher* will produce the reading

the teacher revised his_1 paper

However, there is one way to produce the desired reading, if we include time variables in the logical representation, and allow the Collapsing option to apply here as well.

- (21) $[[John_1$ revised his_1 paper] $_{S1a}$ before $[t_5$ [the $teacher_2$ did revise his_2 paper] $_{S1b}$] $_{S1}$], and $[[Bill_3$ did revise his_1 paper] $_{S2a}$ before t_5 too.

This representation is meant to be analogous to the following variant:

- (22) $[[John_1$ revised his_1 paper] $_{S1a}$ before *the time t_5 that* [the $teacher_2$ did revise his_2 paper] $_{S1b}$] $_{S1}$], and $[[Bill_3$ did revise his_1 paper] $_{S2a}$ before (then) $_{t_5}$ too.

If this option is taken, there is no longer an issue of matching *S2a* and *S2b*, so the reading is now permitted. Reading 5 can be similarly derived:

- (23) [[John₁ revised his₁ paper]_{S1a} before [t₅ [the teacher₂ did revise his₁ paper]_{S1b}]_{S1}], and [[Bill₃ did revise his₃ paper]_{S2a} before (then)_{t5} too.

Note that Reading 6 can still not be derived. This is because the temporal index associated with *S1b* cannot be identified with that associated with *S2b*. Thus, all three pairs of clauses must Match, and there is no Background that can be constructed for *S1b* and *S2b*.

The Parallel Dependencies approach will accept Readings 1-3, and rule out 4-6. To see this, consider again Reading 3:

- (24) [[John₁ revised his₁ paper]_{S1a} before [the teacher₂ did revise his₁ paper]_{S1b}]_{S1}, and [[Bill₃ did revise his₃ paper]_{S2a} before [the teacher₂ revise his₃ paper]_{S2b}]_{S2} too.

We assume Parallel Dependencies must be determined for the same three pairs of clauses as with Background Matching. For the pairs $\langle S1a, S1b \rangle$ and $\langle S2a, S2b \rangle$ there are only strict pronouns, so there are no dependencies to compare. For the pair $\langle S1, S2 \rangle$, there are two sloppy occurrences of *his* in *S2* that must be licensed by Parallel Dependencies. Both occurrences can be included in a single dependency, that has a corresponding identical dependency in *S1*:

- $\langle ([John]_{NP}, [his]_{NP}, [his]_{NP}), 1,$
 $\langle [John]_{NP}[revised]_V[his]_{NP}[paper]_{NP}[before]_{ADV}[the]_{DET}[teacher]_N[revised]_V[his]_{NP} \rangle \rangle$

< (*Bill*_{NP}, [*his*]_{NP}, [*his*]_{NP}), 3,
 < [*Bill*]_{NP}[*revised*]_V[*his*]_{NP}[*paper*]_{NP}[*before*]_{ADV}[*the*]_{DET}[*teacher*]_N[*revised*]_V[*his*]_{NP} >>

Readings 4-6 are ruled out. Consider Reading 4:

(25) [[*John*₁ revised *his*₁ paper]_{S1a} before [*the teacher*₂ did revise *his*₂ paper]_{S1b}]_{S1}, and [[*Bill*₃ did revise *his*₁ paper]_{S2a} before [*the teacher*₂ revise *his*₂ paper]_{S2b}]_{S2} too.

Consider the pair < *S2a*, *S2b* >. Here, we have to match the dependencies involving *his*₁ and *his*₂. But this clearly cannot be done. These are the corresponding dependencies:

< (*John*]_{NP}, [*his*]_{NP}, [*his*]_{NP}), 1,
 < [*John*]_{NP}[*revised*]_V[*his*]_{NP}[*paper*]_{NP}[*before*]_{ADV}[*the*]_{DET}[*teacher*]_N
 [*revised*]_V[*his*]_{NP}[*paper*]_{NP}[*and*]_{CC}[*Bill*]_{NP}[*revised*]_V[*his*]_{NP} >>
 < (*teacher*]_{NP}, [*his*]_{NP}), 2,
 < [*teacher*]_{NP}[*revised*]_V[*his*]_{NP} >>

The reader can verify that Readings 5 and 6 are similarly ruled out.

4 Motivation for General Constraints: Discourse Structure

I have shown that a free approach to VPE resolution, together with a general constraint on interpretation, can account for important puzzles in interpretation. We examined two candidates for General Constraints: Parallel Dependencies and Background Matching. While it has been previously been argued that Parallel Dependencies is superior to Background Matching in

accounting for constraints on complex cases of ellipsis, I have presented a simple form of Background Matching that successfully accounts for these well-known cases.

The question arises: what is the ultimate source of the Background Matching operation? The account of (Dalrymple *et al.*, 1991) suggests that Background Matching is tied specifically to the process of ellipsis resolution.⁷ Rooth’s account would suggest that it applies more generally to the interpretation of focus and background, with ellipsis being a special case of this. An alternative view, put forward by many authors (Asher, 1993; Prust *et al.*, 1994; Hobbs and Kehler, 1997; Asher *et al.*, 1997; Asher *et al.*, 2001) is that the constraints on ellipsis and focus in fact arise from discourse relations such as Contrast and Parallel. It has often been suggested that particles like *too* signal a Parallel relation, while negation signals Contrast.

This would suggest that other discourse relations might show rather different requirements on interpretation than we have seen up to this point, where all the examples involved parallel or contrastive relations. The following example (Hardt, 1992) shows that this is indeed the case:

- (26) Every student₁ expected Professor Jones₂ to like his₁ work. In John₃’s case, I’m sure she will. (like his₃ work)

Here, there is a felicitous sloppy reading, although Background Matching fails (note that Parallel Dependencies also fails). The proposed clause *In John’s case* places a requirement on the matrix clause, that it be in some sense “about” John. It also seems clear that the relation between the VPE and antecedent clause is not Parallel or Contrast, as has been the case in the other examples we have examined.

⁷But see (Kehler and Shieber, 1997) for a different perspective on this.

This suggests that the relevant constraints on interpretation in VPE do not arise from the occurrence of VPE, but rather, they are tied to the existence of particular discourse relations.

The nature of these relations is a topic of ongoing research. I have suggested here that ellipsis might be used as a tool to bring the structure of discourse into sharper focus. As a preliminary step in that direction, I have shown that ellipsis facts can be used to show that there is a general discourse process better described as Background Matching than as Parallel Dependencies.

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