

# **The Semantic Uniformity of Traces: Evidence from Ellipsis Parallelism\***

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*Abstract:* This article presents an argument from ellipsis parallelism that traces of all types of movement receive a bound-variable interpretation at LF. MaxElide, a constraint on ellipsis, is used to probe the size of parallelism domains and detect the semantic contribution of a variety of traces. The data examined reveal a detailed interaction between wh-movement from various positions, T-to-C movement, and movement of subjects. I offer an analysis based on the overlapping variable-binder relationships created by these movements. The theoretical conclusion is that A-bar, A-, and head-movement all produce traces that feed interpretation. This conclusion argues directly against several proposals that deprive non-A-bar movements of (certain) semantic effects—e.g., proposals that head-movement occurs at PF, or that A-movement does not leave traces.

*Keywords:* ellipsis, sluicing, VP-ellipsis, interpretation of traces, MaxElide

## **Introduction**

A central question of the syntax-semantics interface concerns the interpretation of movement. While A-bar movement has evident semantic consequences, the interpretive status of head-movement and A-movement has been more controversial. Indeed, it has often been suggested that the semantic component treats different types of movement differently. For instance, several authors (Chomsky 2000, Boeckx and Stepanovic 2001,

Harley 2004) have claimed that head-movement occurs at PF, and hence does not affect interpretation at all. Others (Lasnik 1999, Omaki 2008) have proposed that A-movement and/or head-movement simply do not leave traces.

This paper presents evidence against such proposals, and in favor of the view that all types of movement leave traces that feed interpretation. Using the identity conditions on ellipsis as a diagnostic tool, I show that A-traces, A-bar traces, and traces of head movement are all interpreted as bound variables. In addition to casting empirical doubt on previous proposals, this result has the appealing theoretical consequence that the interpretation of movement is, in an important respect, uniform. All varieties of syntactic movement give rise to variable-binding configurations at LF.<sup>1</sup>

Recent work by Takahashi and Fox (2005) and Merchant (2008) has suggested ellipsis is subject to a constraint “MaxElide”, that prefers a larger elided constituent over a smaller one, in particular environments. The approach I argue for here follows Takahashi and Fox’s proposal. MaxElide chooses the largest deletable constituent within a given domain of semantic parallelism, and its effects are visible whenever a variable inside the elided constituent is bound from outside the elided constituent. By examining the role of traces in various positions and of various movement types, I bring to light an expanded MaxElide paradigm and show that it is explained if all types of traces are interpreted as bound variables.

The paper is organized as follows. Section 1 gives a brief overview of MaxElide, its theoretical background, and the types of data that fall within its purview. Section 2 formulates and confirms a series of predictions regarding the varied location of A-bar

traces. I present new data involving extraction from embedded clauses, as well as higher versus lower positions inside the main clause. Section 3 turns to the role of non-A-bar traces, examining the interaction between wh-adverbials, T-to-C movement, and subject movement. I summarize the data in the paper and then present the analysis. Section 4 concludes by discussing various implications and extensions of the analysis and speculating on directions for further inquiry.

## **1. MaxElide: Background**

### *1.1 Preliminary data and account*

It has been observed (originally by Sag 1976) that VP-ellipsis is often disallowed when sluicing in the same clause is possible. The effect is illustrated in (1):

- (1) a. Mary was kissing someone, but I don't know who (\*she was).
- b. John borrowed a book. Guess which book (\*he did.)
- c. You play a wind instrument? Which one (\*do you)?
- d. *Speaker A*: John has broken something.  
*Speaker B*: What (\*has he)?
- e. Mary was reading. The question is: what (\*was she)?
- f. *Speaker A*: Susan will talk to a professor.  
*Speaker B*: Did you hear which one (\*she will)?
- g. Fred likes chocolates. Does anyone know what kind (\*he does)?
- h. Anna was afraid. But God only knows of what (\*she was.)
- i. You admire a woman in this room. Tell me who (\*you do).

Takahashi and Fox (2005) propose an account of this effect that is based on the theory of ellipsis parallelism developed in Rooth (1992) and Heim (1997). A version of this theory is given in (2)-(3), followed by a brief explication of an important consequence.

(2) For ellipsis of EC to be licensed, there must exist a constituent, which reflexively dominates EC<sup>2</sup>, and satisfies the parallelism condition in (3). Call this constituent the *Parallelism Domain (PD)*.

(3) Parallelism:

PD satisfies the parallelism condition if PD is *semantically identical to another constituent AC, modulo focus-marked constituents*.<sup>3</sup>

(Takahashi and Fox 2005:229)

Note that the definition in (2) leaves the size of parallelism domain unfixed; in principle, the PD may be the elided constituent itself, or larger. The condition in (3), however, entails that there is one particular scenario in which the PD *must* be larger than the elided constituent. This scenario occurs when the elided constituent contains a variable whose binder lies outside the elided constituent. In this configuration, which Takahashi and Fox term “rebinding”, the semantic condition in (3) will require the PD to be large enough to include the binder. If the PD did not include the binder, the PD would contain a free variable, rendering it semantically non-identical to its antecedent.<sup>4</sup>

With these rebinding configurations in mind, Takahashi and Fox propose the following condition on deletion:

(4) MaxElide:

Elide the biggest deletable constituent reflexively dominated by the PD.<sup>5</sup>

(Takahashi and Fox 2005:229)

Assuming, as is standard, that *wh*-traces are interpreted as bound variables, MaxElide explains the effect illustrated in (1) above. As an example, consider the structure in (5).<sup>6</sup>

(5) Mary was kissing someone, but I don't know who [ $\lambda x$ . she was [<sub>VP</sub> kissing  $x$ ]].

This structure instantiates the rebinding scenario described above. VP itself is not a possible choice of PD, since it contains a rebound variable. This variable requires the PD to be at least as large as the constituent immediately dominating the binder,  $\lambda x$ . MaxElide applies to this larger PD, and the biggest deletable constituent it contains is the constituent targeted by sluicing. Deletion of VP, a smaller constituent, will violate MaxElide.

It is important to bear in mind that MaxElide does *not* force selection of the largest PD. It allows selection of *any* PD that satisfies the parallelism condition in (3), and then forces selection of the largest deletable constituent within that PD. The application of MaxElide can thus be represented with the 'two-step' template in (6), which I will employ throughout the paper.

- (6)    1. Select a possible PD  
       2. Apply MaxElide to that PD
- 
- Yields ellipsis possibilities

Note that in the absence of a rebound variable, the possibility of a larger elided constituent does not rule out ellipsis of a smaller constituent, since nothing prevents the smaller elided constituent from being a PD. MaxElide can thus apply to either a larger or

smaller PD, yielding a different elided constituent depending on which PD is selected.

This is the case in (7), where ellipsis of either the higher or lower VP is an option.

- (7) Mary said you would leave, and Sue also [<sub>VP1</sub> said you would [<sub>VP2</sub> leave.]]

- |                                |              |              |
|--------------------------------|--------------|--------------|
| 1. Possible PDs <sup>7</sup> : | VP1          | VP2          |
| 2. MaxElide chooses:           | VP1-ellipsis | VP2-ellipsis |
- 

Mary said you would leave, and Sue also did.

Mary said you would leave, and Sue also said you would.

Again, in the rebinding cases, only a larger PD is possible, so our template looks like this:

- (8) Mary was kissing someone, but I don't know who [ $\lambda x$ . she was [<sub>VP</sub> kissing x]]

- |                      |                  |   |
|----------------------|------------------|---|
| 1. Possible PD:      | ' $\lambda xP$ ' | (i.e., the constituent immediately dominating $\lambda x$ ) |
| 2. MaxElide chooses: | sluicing         |   |
- 

Mary was kissing someone, but I don't know who.

\*Mary was kissing someone, but I don't know who she was.

### 1.2 A note on intervening focus

When focused material intervenes between two potential elided constituents, deletion of the smaller one is possible, as illustrated in (9)-(11). This, too, is predicted by MaxElide, as Takahashi and Fox (2005) note. Since focused material cannot be deleted, the largest *deletable* constituent in these examples will be VP, and MaxElide is satisfied.

- (9) Mary doesn't know who we can invite, but she can tell you who we CANNOT.

- (10) I don't know which puppy you should agree to adopt, but I know which one you should REFUSE to.

(T&F's 9 and 33, respectively)

- (11) I don't know who JOHN will kiss, but I know who SUSAN will.

## 2. The Position of A-bar traces

### 2.1 *Wh-adverbials and MaxElide*

The above examples have dealt exclusively with argument wh-words. In this section, I show that the behavior of wh-adverbials provides a new window onto the workings of MaxElide, confirming the role of trace position in determining the possible PDs, and eventually in Section 3 revealing an important interaction with head-movement and A-movement.

Let us begin with the fact (observed by Schuyler 2001) that wh-adverbials often do not yield MaxElide violations with VP-ellipsis:

- (12) a. Mary was trying to kiss someone, but I have no idea why (she was).  
b. *Speaker A*: John's leaving.  
*Speaker B*: Do you know when (he is)?  
c. John knows the prisoners escaped, but he doesn't know how (they did).  
d. You say you'll pay me back, but you haven't told me when (you will).  
e. Susan practices her violin. I'm just not sure how frequently (she does).  
f. *Speaker A*: Tom baked a cake.  
*Speaker B*: I wonder why he did.

The contrast with the examples in (1) is striking. Recall that with wh-objects, sluicing was available, but VP-ellipsis was unacceptable. With the wh-adverbials in (12), sluicing is still available; the difference is that now VP-ellipsis is available as well. Following an insight of Schuyler (2001), I propose that a smaller parallelism domain is in fact possible in (12), if the wh-adverbials can be merged outside the VP. Much evidence has accumulated in the literature for the availability of VP-external adjunction sites for

adverbial phrases (see Baltin 2007 and references therein).<sup>8</sup> Let us take this VP-external merger to be adjunction to TP, as illustrated in (13b).

(13) I don't know...

- a. [CP who [TP John will [VP leave ~~who~~]]].
- b. [CP when [TP ~~when~~ [TP John will [VP leave]]]].

If the structure in (13b) is available for wh-adverbials but not for wh-objects, then it is clear why wh-adverbials, unlike wh-objects, do not trigger MaxElide violations with VP-ellipsis: they need not leave a trace in the elided VP. This is illustrated in (14).

(14) ...I don't know when  $\lambda Z$ . [TP ~~when~~  $_Z$  [TP John will [VP leave]]]

- |                      |              |             |
|----------------------|--------------|-------------|
| 1. Possible PDs:     | $\lambda ZP$ | VP          |
| 2. MaxElide chooses: | sluicing     | VP-ellipsis |

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John will leave, but I don't know when.  
 John will leave, but I don't know when he will.

Since the VP here contains no rebound variables, it is a possible PD. MaxElide can apply to this PD, and VP will be the largest deletable constituent. Alternatively, it remains an option to select a sufficiently larger PD. This will yield sluicing.

## 2.2 Embedded clauses

The preceding explanation for the lack of MaxElide violations with wh-adverbials relies on the fact that wh-adverbials can originate above the elided VP. This explanation thus makes a straightforward prediction: If we have a structure in which the wh-adverbial originates *below* the elided VP, then VP-ellipsis should once again be ruled out by



MaxElide. One way of testing this prediction is to add an embedded clause and examine the possibility of embedded construal of the wh-adverbial. The two interpretations of sentences like (15) correspond to two different origin sites of the wh-adverbial:

(15) I forget when he said Mary left.

- a. I forget [<sub>CP</sub> when [<sub>TP</sub> ~~when~~ [<sub>TP</sub> he [<sub>VP</sub> said [<sub>CP</sub> [<sub>TP</sub> Mary left?]]]]]  
(MATRIX READING)
- b. I forget [<sub>CP</sub> when [<sub>TP</sub> he [<sub>VP</sub> said [<sub>CP</sub> ~~when~~ [<sub>TP</sub> ~~when~~ [<sub>TP</sub> Mary left?]]]]]  
(EMBEDDED READING)

The embedded reading diagnoses a structure where the wh-adverbial originates below the matrix VP. The prediction, then, is that if we construct examples like (12), except that the elided constituent now includes an embedded clause, we should once again observe MaxElide's signature contrast between sluicing and VP-ellipsis. Specifically, the VP-ellipsis cases should allow a reading where the wh-adverbial modifies the matrix clause, but not a reading where it modifies the embedded clause. The sluicing cases should allow both readings. This prediction is in fact borne out:

- (16) a. John said Mary would leave, but I forget when.  
✓Matrix reading / ✓Embedded reading
- b. John said Mary would leave, but I forget when he did.  
✓Matrix reading / \* Embedded reading
- (17) a. Mary is telling John to object, but I'm not sure how forcefully.  
✓Matrix reading / ✓Embedded reading
- b. Mary is telling John to object, but I'm not sure how forcefully she is.  
✓Matrix reading / \* Embedded reading

- (18) a. Susan asked John to return. Guess when.  
 ✓Matrix reading / ✓Embedded reading
- b. Susan asked John to return. Guess when she did.  
 ✓Matrix reading / \* Embedded reading
- (19) a. Tom learned to play the “Minute Waltz,” though I’m not sure how quickly.  
 ✓Matrix reading / ✓Embedded reading
- b. Tom learned to play the “Minute Waltz,” though I’m not sure how quickly he did.  
 ✓Matrix reading / \* Embedded reading<sup>9</sup>

In the structure corresponding to the matrix readings, the PD can be as small as the matrix VP, or larger. Both sluicing and VP-ellipsis are thus possible, as shown below.

- (20) I forget when  $\lambda z. [\text{TP } \text{when}_z [\text{TP John said Mary } [\text{VP left}]]]$  (MATRIX READING)

- |                      |              |             |
|----------------------|--------------|-------------|
| 1. Possible PDs:     | $\lambda zP$ | VP          |
| 2. MaxElide chooses: | sluicing     | VP-ellipsis |

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John said Mary would leave, but I forget when.  
 John said Mary would leave, but I forget when he did.

In the structure corresponding to the embedded readings, the *wh*-adverbial originates below the matrix VP. Here, the matrix VP *cannot* be a PD, since it contains a rebound variable. Sluicing is possible, but matrix VP-ellipsis violates MaxElide, as shown below:<sup>10</sup>

- (21) I forget when  $\lambda z. [\text{TP he } [\text{VP said } [\text{CP } \text{when}_z \lambda y. [\text{TP } \text{when}_y [\text{TP Mary left}]]]]]$   
 (EMBEDDED READING)

- |                      |              |
|----------------------|--------------|
| 1. Possible PDs:     | $\lambda zP$ |
| 2. MaxElide chooses: | sluicing     |

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John said Mary would leave, but I forget when.  
 \*John said Mary would leave, but I forget when he did.

### 2.3 Subjects extracted from embedded clauses

The same effect can be shown for *wh*-subjects, which have been observed (Lasnik 2001, Merchant 2008) not to trigger MaxElide violations in the simplest cases.<sup>11</sup>

- (22) a. Someone kissed Susan, but I don't know who (did).  
b. One of the professors will give the talk, but I'm not sure which one (will).  
c. *Speaker A*: Someone solved the problem.  
*Speaker B*: Who (did)?  
(Merchant's ex. 37)  
d. *Speaker A*: Someone here has been to Paris.  
*Speaker B*: Really? Who (has)?

In keeping with our prediction, though, subjects *do* in fact trigger MaxElide violations when extracted from an embedded clause:

- (23) a. John wants someone to kiss Susan, but I don't know who (\*he does).  
b. Mary said a certain girl would come, but I forget which girl (\*she did).  
c. *Speaker A*: Mary was hoping one of her friends would win.  
*Speaker B*: Really? Which one (\*was she)?  
d. Tom thinks one of the professors will talk. I forget which one (\*he does)  
e. *Speaker A*: I expect a few of the students to fail the test.  
*Speaker B*: Which students (\*do you)?

As in the *wh*-adverbial cases, the embedded reading indicates a structure where the *wh*-word originates below the matrix VP. In this structure, the matrix VP cannot be a PD, since it contains a rebound variable. When we select a PD large enough to contain a binder for that variable, MaxElide will choose sluicing, ruling out VP-ellipsis.

In this subsection and the previous one, we have examined the behavior of wh-adverbials and wh-subjects, compared to wh-objects. The findings can be summarized with the following generalization:

- (24) With regard to MaxElide, both wh-subjects and wh-adverbials behave differently from wh-objects. The exception is wh-subjects and wh-adverbials extracted from lower clauses, which behave like wh-objects.

In other words, we have confirmed that it is truly *the location of the wh-trace*, rather than the grammatical function of the wh-word, that is relevant for predicting the effects of MaxElide.

#### 2.4 ‘Low’ Adverbial Interpretation

The previous sections examined wh-adverbials and wh-subjects that originate in an embedded clause. In this section, I present a related phenomenon inside a single clause. The data involve two cases of “low” (VP-level) adverbs.<sup>12</sup> In both cases, the basic argument remains the same: the lower interpretation of the adverb corresponds to a trace inside the elided VP, thus producing a MaxElide violation.

##### 2.4.1 Low temporal adverbials and the perfect

Consider the ambiguous sentence in (25):

- (25) John has been in Boston for two months.
- a. John is in Boston now, and has been there for the past two months.  
“U-(niversal) Perfect”: Perfect level-adverb
  - b. There was a two-month period that John spent in Boston (say, back in 1983).  
“E-(xperiential) Perfect”: Eventuality-level adverb

Iatridou et al. (2002) suggest that the first reading is associated with a structure in which the adverbial is adjoined higher in the clause, and the second reading is associated with a structure in which the adverbial adjoins internal to the VP-domain. Let us take the higher location to be TP-adjunction (26a):

- (26) a. [TP [TP John has [VP been in Boston]] for two months]  
 b. [TP John has [VP been in Boston for two months]]

From this proposal it follows that, in wh-movement contexts, the E-perfect reading indicates a structure with a VP-internal trace, and thus provides another testing ground for MaxElide effects. Specifically, the prediction is that the sluicing cases should allow both the U-Perfect and the E-Perfect, while the VP-ellipsis cases should allow only the U-Perfect. The following examples show that this prediction holds:

- (27) a. John's been in Boston, but I don't know for how long.  
 ✓ U-Perfect / ✓ E-Perfect  
 b. John's been in Boston, but I don't know for how long he has.  
 ✓ U-Perfect / ??/\* E-Perfect
- (28) a. Mary's been on a diet, but I'm not sure for how many months.  
 ✓ U-Perfect / ✓ E-Perfect  
 b. Mary's been on a diet, but I'm not sure for how many months she has.  
 ✓ U-Perfect / ??/\* E-Perfect

#### 2.4.2 Low reason adverbials and adverbs of frequency

Consider now the sentence below, which is ambiguous between a 'high' reading (adverbial adjoined above negation, to TP) and a 'low' reading (adverbial adjoined below negation, to VP).

(29) John's not getting married for a certain reason.

- a. John: "I'm never getting married. I'm just too attached to my bachelor lifestyle."  
(*High reading*)
- b. John: "I'm eager to get married. But one thing I'm definitely not doing is getting married for money."  
(*Low reading*)

The prediction is that the sluicing cases should allow both the high and low readings, while the VP-ellipsis cases should allow only the high reading. The following examples show that the prediction holds:

- (30) a. John's not getting married for a certain reason, but I forget why.  
✓ High reading/ ✓ Low reading
- b. John's not getting married for a certain reason, but I forget why he's not  
✓ High reading/ ??/\* Low reading

## 2.5 Conclusion

This section explored the behavior of wh-adverbials and wh-subjects with respect to MaxElide, and demonstrated an important interaction with embedded construal and other types of 'low' interpretation. The next section begins with a revealing contrast that is only observable through the behavior of wh-adverbials. I present an account of the newly expanded MaxElide paradigm and highlight its implications for the semantic representation of non-A-bar traces.

### 3. T-to-C Movement, A-movement, and the Full MaxElide Paradigm

The goal of this section is i) to present a data paradigm that features an interaction between wh-adverbials and T-to-C movement in the context of ellipsis, and ii) to show that this interaction is only accounted for by a combination of A-movement and head movement that demonstrates the ability of both these types of traces to expand parallelism domains.

#### 3.1 Interaction of wh-adverbials and T-to-C movement

Let us begin with a revealing asymmetry. We have seen above in (12) that wh-adverbials do not trigger MaxElide violations in embedded questions. But in main (root) questions, the violations resurface:<sup>13</sup>

- (31) a. *Speaker A:* The guests left already.  
*Speaker B:* Really? When (\*did they)?
- b. *Speaker A:* I'm depressed.  
*Speaker B:* Why (\*are you)?
- c. John and Mary play the drums? How loudly (\*do they)?
- d. *Speaker A:* Susan practices yoga.  
*Speaker B:* Where (\*does she)?
- e. *Speaker A:* Bill met the Queen of England.  
*Speaker B:* How (\*did he)?
- f. The prisoners escaped. But how (\*did they)?
- g. We know Anna is going to resign. The only question is: when (\*is she)?
- h. *Speaker A:* The workers have gone on strike.  
*Speaker B:* For what reason (\*have they)?

This explanation of this asymmetry will be central to the analysis that follows. Before presenting the proposal, let us take stock of our previous generalizations and summarize the data we have seen so far.

VP-ellipsis with an extracted wh-object triggers a MaxElide violation in both main and embedded questions. VP-ellipsis with an extracted wh-subject does not trigger a MaxElide violation in either main or embedded questions. The contrast between main and embedded questions is only visible in the extraction of wh-adverbials, where VP ellipsis triggers a MaxElide violation in main questions but not embedded questions.

The full MaxElide paradigm to be explained, then, is shown in Table 1 below, where “√” stands for the possibility of VP-ellipsis (= no MaxElide violation), and “X” stands for the impossibility of VP-ellipsis (= MaxElide violation).

Table 1: Full MaxElide Paradigm

	<b>Embedded Questions</b>	<b>Main Questions</b>
<b>Wh- Objects</b>	X (1a,b,f-i)	X (1c-e)
<b>Wh- Adverbials</b>	√ (12a-f)	X (31a-h)
<b>Wh- Subjects</b>	√ (22a,b)	√ (22c,d)

Recall also the principled exception to the summary given in (24): subjects and adverbials, when extracted from lower clauses, behave just like objects (16-19; 23).

### *3.2 Analysis*

I suggest that the data set summarized above is evidence for the claim that all traces count towards the calculation of Parallelism Domains. This includes A-bar-traces, A-traces, and traces of head movement. Specifically, this claim entails that the trace of T-to-C



movement is a semantic variable that forces the choice of a Parallelism Domain large enough to include its binder, and the same is true of the trace of A-movement (including, crucially, movement from a VP-internal subject position). Let us see how these claims account for the MaxElide Paradigm in Table 1.

In (32) I show simplified LFs for each of the six cases in our table.<sup>14</sup> The bold, underlined portion of the representation is the (smallest) Parallelism Domain.<sup>15</sup> Recall that although VP-ellipsis relies on a PD small enough that VP is its largest deletable constituent, selection of a larger PD is always possible; this is why sluicing is acceptable in all the cases.

- |      |    |  |              |
|------|----|--|--------------|
| (32) | a. | $[_{CP} \text{ what } \lambda x. [_{TP} \text{ she } \lambda y. \text{ will } [_{VP} y \text{ eat } x]]]$                        | (Obj. Emb.)  |
|      | b. | $[_{CP} \text{ What } \lambda x. \text{ will } \lambda z. [_{TP} \text{ she } \lambda y. z [_{VP} y \text{ eat } x]]]$           | (Obj. Main)  |
|      | c. | $[_{CP} \text{ when } \lambda x. [_{TP} x [_{TP} \text{ she } \lambda y. \text{ will } [_{VP} y \text{ leave}]]]]]$              | (Adv. Emb.)  |
|      | d. | $[_{CP} \text{ When } \lambda x. \text{ will } \lambda z. [_{TP} x [_{TP} \text{ she } \lambda y. z [_{VP} y \text{ leave}]]]]]$ | (Adv. Main)  |
|      | e. | $[_{CP} \text{ who } \lambda x. [_{TP} x \lambda y. \text{ will } [_{VP} y \text{ leave}]]]$                                     | (Subj. Emb.) |
|      | f. | $[_{CP} \text{ Who } \lambda x. [_{TP} x \lambda y. \text{ will } [_{VP} y \text{ leave}]]]$                                     | (Subj. Main) |

Note that in (32f) I adopt the standard assumption (Koopman 1983, Den Besten 1983, Pesetsky and Torrego 2001, a.o.) that extraction of wh-subjects in main clauses does not trigger T-to-C movement; this is evidenced by the lack of *do*-support. I now examine each of these six structures in turn, showing how in each case, the ellipsis possibilities summarized in Table 1 follow from the treatment of all traces as bound variables.

In both (a) and (b), VP cannot be a PD since it contains two rebound variables—the trace of the subject and the trace of the extracted wh-object. The smallest PD that contains binders for both of these variables is the constituent immediately dominating  $\lambda x$  (call it ' $\lambda xP$ '). MaxElide applies to this PD, and chooses the largest deletable constituent, the sluiced constituent. VP-ellipsis violates MaxElide.

[<sub>CP</sub> what  $\lambda x$ . [<sub>TP</sub> she  $\lambda y$ . will [<sub>VP</sub> y eat x]]] (Obj. Emb.)

[<sub>CP</sub> What  $\lambda x$ . will  $\lambda z$ . [<sub>TP</sub> she  $\lambda y$ . z [<sub>VP</sub> y eat x]]] (Obj. Main)

1. Possible PDs:  $\lambda xP$
2. MaxElide chooses: sluicing

- 
- Mary will eat something, but I don't know what (\*she will).
  - *Speaker A*: Mary will eat something.
  - *Speaker B*: What (\*will she)?

In (c), VP cannot be a PD since it contains one rebound variable—the trace of the subject. The smallest PD that contains a binder for this trace is the constituent immediately dominating  $\lambda y$ . This PD *does not* dominate the potentially sluiced constituent, so when MaxElide applies, the largest deletable constituent will be VP, and VP-ellipsis is grammatical.

[<sub>CP</sub> when  $\lambda x$ . [<sub>TP</sub> x [<sub>TP</sub> she  $\lambda y$ . will [<sub>VP</sub> y leave]]]]] (Adv. Emb.)

1. Possible PDs:  $\lambda xP$   $\lambda yP$
2. MaxElide chooses: sluicing VP-ellipsis

- 
- Mary will leave, but I don't know when (she will).

In (d), VP cannot be a PD, since it contains one rebound variable, the trace of the subject.

[<sub>CP</sub> When  $\lambda x$ . will  $\lambda z$ . [<sub>TP</sub> x [<sub>TP</sub> she  $\lambda y$ . z [<sub>VP</sub> y leave]]]] **Not possible**

The smallest constituent that contains a binder for this trace is the constituent immediately dominating  $\lambda y$ .

[<sub>CP</sub> When  $\lambda x$ . will  $\lambda z$ . [<sub>TP</sub> x [<sub>TP</sub> she  $\lambda y$ . z [<sub>VP</sub> y leave]]]]] **Not possible**

But crucially, this constituent is not a possible PD either, since it now contains a new rebound variable. By expanding the PD, we “catch” the trace of T-to-C movement. The smallest constituent containing a binder for *this* trace is the constituent immediately dominating  $\lambda z$ .

[<sub>CP</sub> When  $\lambda x$ . will  $\lambda z$ . [<sub>TP</sub> x [<sub>TP</sub> she  $\lambda y$ . z [<sub>VP</sub> y leave]]]]] **Not possible**

Crucially again, this constituent is not a possible PD since it “catches” yet another rebound variable, the trace of the wh- adverbial. Thus it is necessary to expand once more, to include a binder for this variable:

[<sub>CP</sub> When  $\lambda x$ . will  $\lambda z$ . [<sub>TP</sub> x [<sub>TP</sub> she  $\lambda y$ . z [<sub>VP</sub> y leave]]]]] **Possible!**

The resultant PD will be the constituent immediately dominating  $\lambda x$ . MaxElide applies to this PD, and chooses the largest deletable constituent, which is the sluiced constituent. VP-ellipsis will violate MaxElide:

[<sub>CP</sub> When  $\lambda x$ . will  $\lambda z$ . [<sub>TP</sub>  $x$  [<sub>TP</sub> she  $\lambda y$ .  $z$  [<sub>VP</sub>  $y$  leave]]]]] (Adv. Main)

1. Possible PDs:  $\lambda xP$
2. MaxElide chooses: sluicing

---

- *Speaker A*: Mary will leave  
*Speaker B*: When (\*will she)?

In (e) and (f), VP cannot be a PD since it contains the rebound trace of the subject. The smallest PD that includes the binder for this trace is the constituent immediately dominating  $\lambda y$ . MaxElide applies to this PD, and the largest deletable constituent will be VP, so VP-ellipsis is grammatical.

[<sub>CP</sub> who  $\lambda x$ . [<sub>TP</sub>  $x$   $\lambda y$ . will [<sub>VP</sub>  $y$  leave]]]] (Subj. Emb.)

[<sub>CP</sub> Who  $\lambda x$ . [<sub>TP</sub>  $x$   $\lambda y$ . will [<sub>VP</sub>  $y$  leave]]]] (Subj. Main)

1. Possible PDs:  $\lambda xP$   $\lambda yP$
2. MaxElide chooses: sluicing VP-ellipsis

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- Someone will leave, but I don't know who (will).  
- *Speaker A*: Someone will leave.  
*Speaker B*: Who (will)?

Now that we have worked through the account of the full MaxElide paradigm in Table 1, note that the interpreted traces of both T-to-C movement (head-movement) and subject movement (A-movement) are essential to the analysis—if we ignored either one, we'd lose the contrast between (32c) and (32d). In the latter example, if we did not count the trace of T-to-C movement, we would not be forced to expand the parallelism domain beyond  $\lambda yP$ . If we did not count the trace of subject movement, we would not be forced to expand the parallelism domain beyond VP. Either way, we would wrongly predict VP-

ellipsis to be available in (32d) as well as (32c). Further corroboration and discussion of the role of head-movement and A-movement traces is provided below in sections 3.3 and 4.2, respectively.

At this point, the full range of data presented so far—the distinct behaviors of *wh*-objects, *wh*-subjects, and *wh*-adverbials; the exceptions regarding the last two when extracted from lower positions; the existence of a MaxElide asymmetry between main vs. embedded questions; the fact that this asymmetry surfaces only with *wh*-adverbials—is all accounted for by the existing theory of parallelism, along with the new claim that all types of traces are interpreted as bound variables.

### *3.3 Head movement is implicated: evidence from two non-standard Englishes*

In the immediately preceding subsection, we saw that the semantic contribution of head-movement traces offers a successful account for the main/embedded asymmetry with *wh*-adverbials. It is of course possible that this asymmetry is actually due to some independent property of main versus embedded questions, and that the correlation with T-to-C movement is an epiphenomenon, not an explanation. In this subsection I present data from two non-standard varieties of English that strongly implicate T-to-C movement as the cause of the main/embedded asymmetry discussed above.

Indian Vernacular English (IVE, Bhatt 2000) is the mirror image of Standard English with regard to subject-auxiliary inversion. Bhatt (2000) shows that IVE has T-to-C movement in embedded questions but lacks it in main questions. The following examples illustrate:

- (33) a. What he has eaten?  
 b. What you want?  
 c. How much interest they charged you?  
 d. How long ago that was?  
 e. Why you look worried?
- (34) a. They know who has Vijay invited tonight.  
 b. I wonder where does he work.  
 c. I asked Ramesh what did he eat for breakfast.  
 d. Do you know where is he going?

(Bhatt 2000:74-75)

The predictions made by the present account are as follows. If the contrast between *wh*-adverbials in embedded questions (12; 32c) versus main questions (31; 32d) is due to the (non-)occurrence of T-to-C movement, IVE should show the *opposite* contrast. That is, VP-ellipsis with *wh*-adverbials should be acceptable in main questions, but not in embedded questions. If the Standard English contrast were instead due to some independent property of main versus embedded questions, then IVE should show the same contrast, all else being equal. In fact, my informants indeed report the opposite contrast, as shown below.

- (35) a. \*Mary will leave, but I don't know when will she. (IVE)  
 b. \*John's baking a cake, but I'm not sure why was he.  
 c. \*I fixed the car, but I can't remember how did I.
- (36) a. *Speaker A:* Mary will leave. (IVE)  
       *Speaker B:* When she will?

- b. *Speaker A:* John was baking a cake.  
*Speaker B:* Why he was?
- c. *Speaker A:* I fixed the car.  
*Speaker B:* Really? How you did?

Furthermore, varieties of Irish English (Henry 1995; McCloskey 1992, 2006) allow subject-auxiliary inversion in embedded questions (though, unlike IVE, they do not lack inversion in main questions.) These dialects thus provide *half* a testing ground. The prediction for embedded questions with subject-auxiliary inversion is that VP-ellipsis with *wh*-adverbials should be unacceptable. This is indeed the case, as shown below.

- (37) a. \*Mary will leave, but I don't know when will she. (*Irish E*)  
 b. \*John's baking a cake, but I'm not sure why was he.  
 c. \*I fixed the car, but I can't remember how did I.

The facts from IVE and Irish English provide strong evidence that the matrix/embedded asymmetry with regard to *wh*-adverbials and VP-ellipsis is truly an effect of T-to-C movement, rather than an independent property of matrix versus embedded questions.

#### 4. Implications of the analysis

The previous sections have used the effects of MaxElide to detect the effects of various types of traces on the calculation of semantic identity. Successful analysis of the full MaxElide paradigm revealed that A-bar movement, A-movement, and head-movement all leave traces that behave like bound variables at LF. In this section I discuss several consequences and extensions of this analysis, starting with the direct architectural implications for non-A-bar movements.

#### *4.1 Architectural implications*

The semantic contribution of head-movement traces provides direct evidence against proposals that have assigned head-movement to the PF wing of the grammar (Chomsky 2000, Boeckx and Stjepanovic 2001, Harley 2004). If head-movement were a PF operation, it would be impossible for its traces to feed interpretation and affect semantic identity. This result of the present study can be seen as part of a larger research program that aims to uncover the interpretive effects of head movement (see, e.g., Lechner 2006, Shimada 2007).

Second, the demonstrated role of A-movement and head-movement traces is evidence against proposals that these movements do not leave traces (Lasnik 1999 for A-movement, Omaki 2008 for head movement). If these did not leave a trace, the presence of a bound variable at the origin site would be unexpected, and the account of the full MaxElide paradigm would be lost. (See also the following subsection for a further point about the role of A-traces.)

Finally, I note that the uniform contribution of all types of movement in this respect provides an obstacle for accounts that have sought to maintain the existence of wh-movement, but call the existence of A-movements into question (e.g., Bresnan 1978).

#### *4.2 An argument for successive-cyclic A-movement*

The interpretation of A-traces as bound variables brings to light an argument for successive-cyclic A-movement, first alluded to by Takahashi and Fox (2005:235). Consider the following pair of sentences in (38), which show that either higher VP-ellipsis or lower VP-ellipsis is possible.



- (38) a. John is likely to attend the party, and Mary is as well.  
 b. John is likely to attend the party, and Mary is likely to as well.

Assuming that subject-to-subject raising proceeds successive-cyclically, the intermediate landing site will create a lower lambda-abstractor, as in (39). Thus, a smaller PD will be possible. MaxElide can apply to this smaller PD, and choose the lower VP-ellipsis.

- (39) a. ... Mary  $\lambda y$  is likely [<sub>TP</sub> y  $\lambda x$  to [<sub>VP</sub> x attend the party] as well.  
 b. ... Mary  $\lambda y$  is likely [<sub>TP</sub> y  $\lambda x$  to [<sub>VP</sub> x attend the party] as well.

- |                      |              |              |
|----------------------|--------------|--------------|
| 1. Possible PDs:     | $\lambda yP$ | $\lambda xP$ |
| 2. MaxElide chooses: | High VPE     | LowVPE       |

---

John is likely to attend the party, and Mary is as well.  
 John is likely to attend the party, and Mary is likely to as well.

If, on the other hand, A-movement did not stop in lower Spec,TP, then there would be no lower lambda-abstractor, as in (40). Thus, only the larger PD would be possible, and one would expect the lower VP-ellipsis to be ruled out by MaxElide, contrary to fact.

- (40) ... Mary  $\lambda y$  is likely [<sub>TP</sub> to [<sub>VP</sub> y attend the party]] as well.

- |                      |              |
|----------------------|--------------|
| 1. Possible PDs:     | $\lambda yP$ |
| 2. MaxElide chooses: | High VPE     |

---

John is likely to attend the party, and Mary is as well.

### 4.3 Empirical support for an assumption about the binding of traces

Let me now highlight a crucial assumption that has underlain much of the argumentation in this paper. The assumption—adopted in Heim and Kratzer (1998) and much

subsequent work—is that traces are not bound directly by the moved element itself, but rather by a lambda-abstractor associated with the moved element. One consequence is that, since each movement step creates its own binder-trace relation, the first link in a movement chain is sufficient to establish a Parallelism Domain with an internal-binding structure.

The assumption becomes relevant in cases of successive-cyclic movement. To appreciate this point more concretely, consider (32e)/(32f), repeated below in (41). In these examples, a *wh*-extracted subject undergoes successive cyclic movement from its V/vP-internal base position to Spec,TP, and then to Spec,CP. If traces were bound directly by moved elements, we would instead expect a structure like (42):

(41)  $[_{CP} \text{ who } \lambda x. [_{TP} x \text{ } \underline{\lambda y. \text{ will } [_{VP} y \text{ leave}]}]]$

(42)  $[_{CP} \text{ } \underline{\text{who}_x [_{TP} x_y \text{ will } [_{VP} y \text{ leave}]}]}]$

Heim and Kratzer (1998:188) consider these two structures for successive-cyclic movement and observe that “These surely *look* different, but it is harder than one might think to come up with empirical evidence that would bear on the choice. To our knowledge the issue has not been investigated.”<sup>16</sup> The effects of MaxElide provide us with precisely such empirical evidence. In the first structure, the lower lambda abstractor “closes off” a possible parallelism domain that excludes the intermediate trace. This is what allows VP-ellipsis. In the second structure, a smaller PD is impossible, since there is no constituent that includes the lower binder but excludes the intermediate trace. The PD in (42) must be as large as CP, in order to include the moved element itself, in its final

landing site. With a PD this large, we would predict VP-ellipsis in these cases to be ruled out by MaxElide, contrary to fact.

Insofar as it succeeds, then, the analysis in this paper offers new empirical support for variable-binding structures in which the binder forms a constituent with the scope of the moved element, to the exclusion of the moved element itself. Exactly how the creation of such structures should be integrated into the syntactic theory of movement remains an issue of considerable importance, but it is ultimately beyond the scope of this paper.<sup>17</sup>

#### 4.4 A remaining puzzle

This final section describes a puzzle that I will not solve here. It concerns a further asymmetry between wh-objects and wh-adverbials in main questions. That is, I am “zooming in” on the circled portion of the table below.

Table 2: Locus of the remaining puzzle

	<b>Embedded Questions</b>	<b>Main Questions</b>
<b>Wh- Objects</b>	X (1a,b,f-i)	X (1c-e)
<b>Wh- Adverbials</b>	√ (12a-f)	X (27a-h)
<b>Wh- Subjects</b>	√ (22a,b)	√ (22c,d)

With wh-adverbials in main questions, intervening focus (see section 1.2.) renders VP-ellipsis acceptable, even in rebinding contexts, as expected:

- (43) a. *Speaker A*: I didn’t want to come to the party.  
       *Speaker B*: Then why DID you?
- b. If the prisoners can’t escape by breaking the lock, then how CAN they?
- c. Mary woke up at 7:00. When did JOHN?

The puzzle is why intervening focus does *not* save these examples with wh-objects, as shown below:

- (44) a. *Speaker A:* I didn't kiss Mary.  
           *Speaker B:* Then which girl DID you \*(kiss)?  
       b. If you aren't drinking water, then what ARE you \*(drinking)?  
       c. Mary will kiss Bill. Who will JOHN \*(kiss)?

A striking clue that MaxElide seems to be involved comes from our principled exception in (24), restated below in (45). Indeed, when we embed them, the wh-adverbials become like wh-objects with respect to this puzzle, as shown in (46):

- (45) With regard to MaxElide, wh-subjects and wh-adjuncts behave differently from wh-objects. But we can get them to behave like wh-objects by embedding them.

- (46) a. \*If you don't think Mary's leaving because she's sick, then why DO you?  
       b. *Speaker A:* I don't want Mary dance quickly.  
           *Speaker B:* \*How DO you, then?  
       c. *Speakier A:* John will ask Mary to leave at 5.  
           *Speaker B:* When will TOM?                      ✓Matrix      \*Embedded

I have no solution to this puzzle to offer yet. I leave it for further study.

#### 4.5 Conclusion

This paper has offered an argument that A-bar-movement, A-movement, and head-movement share at least one semantic effect. Their traces all enter into the calculation of

semantic parallelism. MaxElide, a constraint on deletion that makes reference to domains of parallelism, was pressed into service to diagnose the size of these domains. The main results of the diagnosis were threefold.

First, we confirmed a detailed set of predictions regarding the location of A-bar traces. Different ellipsis possibilities were observed for *wh*- extracted objects, adverbials, subjects, embedded adverbials and subjects, and two kinds of ‘low’ adverbials. The full range of contrasts was shown to follow from the location of the trace, the identity requirement on parallelism, and the application of MaxElide.

Second, we found that a rebound trace of *any movement type* was enough to spoil the semantic identity relation between constituents and force a larger domain of parallelism. This latter result constitutes evidence that traces of A-movement and head-movement affect semantic representations—and provides an argument against models of grammar in which these movements do not feed interpretation, or in which they do not leave traces that can be interpreted as bound variables.

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<sup>1</sup> I leave open the possibility that these configurations can be altered or nullified by later LF operations—see the extensive literature on ‘reconstruction’ for debate about the existence, nature, and extent of such operations (May 1977, Lebeaux 1995, Fox 1999, Lasnik 1999, Romero 1999, Sauerland and Elbourne 2002).

<sup>2</sup> XP reflexively dominates YP if XP dominates YP or  $XP = YP$ .

<sup>3</sup> PD is semantically identical to AC modulo focus-marked constituents, if there is a focus alternative to PD,  $PD_{Alt}$ , such that for every assignment function  $g$ ,  $[[PD_{Alt}]]^g = [[AC]]^g$ .  $PD_{Alt}$  is an alternative to PD if  $PD_{Alt}$  can be derived from PD by replacing focus-marked constituents with their alternatives.

<sup>4</sup> As Takahashi and Fox note, we must also assume Heim’s (1997) ban on “meaningless coindexation” to ensure that the variable that is free within the elided constituent and the variable that is free within the antecedent constituent are not ‘accidentally’ assigned the same index:

If an LF contains an occurrence of a variable  $v$  that is bound by a node  $\alpha$ , then all occurrences of  $v$  in the LF must be bound by the same node  $\alpha$ .

(Heim 1997:202)

<sup>5</sup> An alternative formulation is given by Merchant (2008):

Let XP be an elided constituent containing an A’-trace

Let YP be a possible target for deletion

YP must not properly contain XP

(Merchant 2008:141)

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As we will see, there is good reason to disprefer a formulation that explicitly restricts MaxElide to A-bar traces. See also Takahashi and Fox (2005:225) who take examples from Sag (1976) and Williams (1977) to show that the effects of MaxElide extend to bound-variable *pronouns*, which are not traces at all.

<sup>6</sup>I take the variable-binder to be a lambda-abstractor adjoined to the scope of the moved element. See section 4.3 for discussion of the importance of this assumption.

<sup>7</sup>Technically, there are many more possible PDs than indicated. Here and elsewhere I show only the minimal PD that licenses each syntactically deletable constituent. E.g., the constituent “would leave” is a possible PD but, for syntactic reasons, is not itself a deletable constituent (see Lobeck 1995, among others).

<sup>8</sup>Further evidence for the availability of the VP-external adjunction structure comes from the fact that wh-adverbials, unlike wh-objects, can escape deletion in VP-ellipsis constructions:

- (i) a. John called on Monday, but he didn’t on Tuesday.  
b. \*John called Mary, but he didn’t Susan.
- (ii) a. We can’t succeed today. But we have to someday.  
b. \*We can’t hire John. But we have to someone.

(For speakers who liberally accept imperfect instances of pseudogapping, the (b) sentences may be marginally acceptable due to this independent derivation.)

<sup>9</sup>It is at least worth considering another, less intuitive possibility: perhaps in the (a) examples, what appears to be an embedded reading is in fact produced by omitting the

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higher clause entirely. E.g., (16a) could be derived from “I forget when  $<_{EC}$  Mary will leave  $\triangleright$ ”. This idea must be rejected. The distinct embedded reading can easily be made salient in examples like (i):

- i. That crazy cult wants Moses to return to earth, but I don’t know when.

In this case, the second clause clearly means “I don’t know when they want him to return to earth” and not “I don’t know when he will return to earth.”

<sup>10</sup>I am ignoring here the uninteresting possibility of eliding the lower VP, which is fine, as expected, on both the matrix and embedded structures (*John said Mary would leave, but I forget when he said she would.*)

<sup>11</sup>The acceptability of VP-ellipsis here is part of Merchant’s motivation for restricting his version of MaxElide to A-bar traces; he notes that in cases of wh-movement from subject position, VP-ellipsis is allowed “since the elided VP does not contain a wh-trace”.

<sup>12</sup>I owe the suggestion of these two arguments to Sabine Iatridou (p.c.) and Jeroen van Craenenbroeck, (p.c.) respectively.

<sup>13</sup>As expected, focusing the auxiliary renders these examples acceptable – but see the puzzle at the end of Section 4.

<sup>14</sup>I use the variable names  $x,y,z$  merely for convenience. I make no claim about the semantic type of head-movement traces and traces of wh-adverbials, or about the denotations of the elements that bind them. These are important questions, but they do not bear directly on the present argument. All that matters for the purposes of this analysis is that the traces are variables of *some* type at LF.

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<sup>15</sup>I abstract away from the possibility of an intermediate Spec,vP landing site for a wh-extracted object. As the reader can verify, this does not affect the predictions.

<sup>16</sup>Subsequently, the issue *has* been investigated. For defenses of the binding structure in (41), see Nissenbaum (1998), Sauerland (1998), and Nissenbaum and Schwarz (2009).

<sup>17</sup>The traditional implementation, following Heim and Kratzer (1998) is to have movement introduce an index, adjoined to the scope of the moved element. The trace of the moved element is then interpreted as variable of the appropriate type, and the inserted index is interpreted as a lambda abstractor over this variable. Some version of this system is assumed, tacitly or explicitly, by many authors (e.g., Barker 2007, Bhatt and Takahashi 2007, Meier 2003), and it seems compatible with the arguments presented here.