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	Suffix	
	Division	Department of Linguistics
	Organization	New York University
	Address	New York, NY, USA
	Email	chris.barker@nyu.edu

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Abstract	This paper analyzes sluicing as anaphora to an ANTI-CONSTITUENT (a continuation), that is, to the semantic remnant of a clause from which a subconstituent has been removed. For instance, in *Mary said that* [*John saw someone yesterday*], *but she didn't say who*, the antecedent clause is *John saw someone yesterday*, the subconstituent targeted for removal is *someone*, and the ellipsis site following *who* is anaphoric to the scope remnant *John saw __yesterday*. I provide a compositional syntax and semantics on which the relationship between the targeted subconstituent and the rest of the antecedent clause is one of scopability, not movement or binding. This correctly predicts that sluicing should be sensitive to scope islands, but not to syntactic islands. Unlike the currently dominant approaches to sluicing, there is no need to posit syntactic structure internal to the ellipsis site, nor is there any need for a semantic mutual-entailment requirement. Nevertheless, the fragment handles phenomena usually taken to suggest a close syntactic correspondence between the antecedent and the sluice, including case matching, voice matching, and verbal argument structure matching. In addition, the analysis handles phenomena exhibiting antecedent/sluice mismatches, including examples such as *John remembers meeting someone, but he doesn't remember who* , and especially so-called sprouting examples such as *John left, but I don't know when*, in which there is no overt subconstituent to target for removal. In Sect. 5, I show how the analysis accounts for Andrews Amalgams such as *Sally ate* [*I don't know what*] *today*, in which the antecedent surrounds the sluiced clause. Finally, in Sect. 6, I propose a new semantic constraint on sluicing: the Answer Ban, which says that the antecedent clause must not resolve, or even partially resolve, the issue raised by the sluiced interrogative.

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RESEARCH ARTICLE

Scopability and sluicing

Chris Barker

Abstract This paper analyzes sluicing as anaphora to an ANTI-CONSTITUENT (a continuation), that is, to the semantic remnant of a clause from which a subconstituent has been removed. For instance, in *Mary said that* [*John saw someone yesterday*], *but she didn't say who*, the antecedent clause is *John saw someone yesterday*, the subconstituent targeted for removal is *someone*, and the ellipsis site following *who* is anaphoric to the scope remnant *John saw __ yesterday*. I provide a compositional syntax and semantics on which the relationship between the targeted subconstituent and the rest of the antecedent clause is one of scopability, not movement or binding. This correctly predicts that sluicing should be sensitive to scope islands, but not to syntactic islands. Unlike the currently dominant approaches to sluicing, there is no need to posit syntactic structure internal to the ellipsis site, nor is there any need for a semantic mutual-entailment requirement. Nevertheless, the fragment handles phenomena usually taken to suggest a close syntactic correspondence between the antecedent and the sluice, including case matching, voice matching, and verbal argument structure matching. In addition, the analysis handles phenomena exhibiting antecedent/sluice mismatches, including examples such as *John remembers meeting someone, but he doesn't remember who ~~he met~~*, and especially so-called sprouting examples such as *John left, but I don't know when*, in which there is no overt subconstituent to target for removal. In Sect. 5, I show how the analysis accounts for Andrews Amalgams such as *Sally ate* [*I don't know what*] *today*, in which the antecedent surrounds the sluiced clause. Finally, in Sect. 6, I propose a new semantic constraint on sluicing: the Answer Ban, which says that the antecedent clause must not resolve, or even partially resolve, the issue raised by the sluiced interrogative.

C. Barker (✉)
Department of Linguistics, New York University, New York, NY, USA
e-mail: chris.barker@nyu.edu

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1 Sluicing as anaphora to an anti-constituent

Sluicing is a form of ellipsis in which the complement of a wh-phrase is missing, with its interpretation depending on material elsewhere in the discourse:

(1) Someone left, but I don't know who __.

In this sluicing example, the sluiced interrogative embedded under *know* can be interpreted as if the expression *left* had been pronounced in the place of the gap ('__'). The antecedent clause (here, *someone left*) typically contains within it an indefinite (*someone*) whose role in the antecedent clause is parallel to the role of the wh-phrase in the sluiced interrogative. Following Chung et al. (1995) (CLM), I will call the wh-phrase correlate the INNER ANTECEDENT. Then the interpretation of the sluiced clause is given by the following recipe:

$$\text{sluice} = \text{wh-phrase} + (\text{antecedent-clause} - \text{inner-antecedent})$$

In this informal arithmetic, the sluiced clause [*who* __] in (1) can be interpreted as *who* + ([*someone left*] − *someone*) = *who* + [__ *left*]. The formal system below will make this informal analysis precise.

This paper will discuss three strategies for accounting for the syntactic and semantic properties of sluicing: LF copying, PF deletion, and anaphora. The key empirical phenomena that I will discuss that will distinguish among the strategies are case matching, syntactic island insensitivity, and sprouting (all to be explained shortly). One of the main goals of this paper will be to argue that the anaphoric strategy remains viable.

There is a fourth general strategy for ellipsis on which the content of the ellipsis is filled in via pragmatic reasoning. Although this strategy is well-represented in the literature (the higher-order unification theory of Dalrymple et al. (1991) is a prominent example), I will not discuss it here. Chung et al. (2011) evaluate the pragmatic approach as applied specifically to sluicing. I take it that case matching and voice matching establish that a purely pragmatic approach to sluicing is inadequate, and that there is an irreducible, essentially grammatical component to sluicing.

The view that emerges here is one on which there are silent syntactic elements (gaps and silent proforms), but those silent elements do not contain any internal syntactic structure. Instead, sluicing exhibits what Chung (2013) calls "limited syntactic identity", where the required syntactic identity is limited to the syntactic environment local to the inner antecedent. I will argue that as long as we have theory of anaphora flexible enough to allow an anaphor to specify the syntactic category of the inner antecedent, we will have exactly the limited syntactic identity required.

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1.1 Sluicing strategy 1: LF copying

The first strategy, LF copying, will be represented here by the analysis of Chung et al. (1995) (CLM), as further discussed and developed in Chung (2006, 2013) and Chung et al. (2011). On their analysis, material from the Logical Form (LF) of the antecedent clause is copied into the ellipsis gap site. The copy of the inner antecedent must contribute an unbound variable that will be bound by the wh-phrase in the sluice. Since the relationship between the wh-phrase and the variable inside the copied LF is one of binding, the LF copying account correctly predicts (as we will see shortly) that sluicing is insensitive to syntactic islands, since islands do not impede binding.

However, the LF copying analysis does not account so automatically for the fact that the wh-phrase must match the inner antecedent in morphological case, as shown by these German examples:

(2) Er will jemandem schmeicheln, aber sie wissen nicht, {*wen / wem}.
he wants someone.DAT flatter but they know not {who.ACC / who.DAT}
'He wants to flatter someone, but they don't know who.'

(3) Er will jemanden loben, aber sie wissen nicht, {wen / *wem}.
he wants someone.ACC praise but they know not {who.ACC / who.DAT}
'He wants to praise someone, but they don't know who.'

These examples are from Ross (1969). Merchant (2001) shows that this pattern is robust across a number of languages. If the LF copying approach is to be maintained, clearly the binding mechanism must be able to transmit information about morphological case. This is not unreasonable, since binding certainly must be able to guarantee matching between an anaphor and its antecedent in phi features such as gender and number (Sect. 2.3); but case matching is not expected, let alone inevitable, on an LF copying view.

1.2 Sluicing strategy 2: PF deletion

The second strategy, PF deletion, will be represented here by the analyses of Romero (1998) and of Merchant (2001). On this strategy, the sluiced clause is derived just like any interrogative clause, but the complement of the wh-phrase can be deleted (remain unpronounced) at Phonetic Form (PF) if certain requirements are met. For Romero (1998), the antecedent clause and the sluiced clause must satisfy general constraints on ellipsis and focus; for Merchant (2001), the antecedent clause and the sluiced clause must entail each other (after making certain adjustments; see Sect. 6 for details).

The PF deletion strategy gives a satisfying account of case matching: because the wh-phrase arrives in its position within the sluiced clause in exactly the same way that a wh-phrase moves to the front of any interrogative clause, the wh-phrase in the sluiced clause will show exactly the same pattern of case marking it would if there were no sluice.

However, precisely because the wh-phrase moves into its position via ordinary syntactic movement, it would be natural to expect that a sluice should be impossible when

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the inner antecedent is embedded inside of a syntactic island. But in general (Ross 1969; Merchant 2001, p. 86), sluicing is insensitive to syntactic islands surrounding the inner antecedent:

(4) a. He wants a detailed list, but I don't know how detailed (*he wants a __ list).
b. Bo talked to the people who discovered something, but we don't know what (*Bo talked to the people who discovered __).
c. They want to hire someone who speaks a Balkan language, but I don't remember which one (*they want to hire someone who speaks __).

In each of these examples, wh-movement from the gap position to the front of the embedded interrogative violates a syntactic island, so the examples are grammatical only if they are sluiced. Merchant (2001, p. 162) adopts a wide range of strategies for dealing with different kinds of islands, but for some at least, including, e.g., left-branch island violations such as (4a), he proposes that it is the fact that the elided material is not pronounced that amnesties the island violations.

1.3 Sluicing strategy 3: anaphora

A third approach to sluicing, the anaphoric strategy, relies on finding a suitable expression whose denotation can serve as the meaning of the sluice gap. Jäger (2001, 2005) provides an anaphoric analysis on which indefinites in general contribute an unbound variable to the semantics. The formal system requires that the presence of unbound indefinite variables must be recorded by adjusting the syntactic category of each containing clause. Then wh-phrases are ambiguous between a normal version and a sluicing version that is anaphoric to clauses that contain an unbound variable.

Just as in the LF copying approach, it is necessary to assume that this type of anaphora can be sensitive to morphological case. And also like the LF copying approach, the relationship between the wh-phrase and the position of the inner antecedent does not involve syntactic movement, so once again there is the correct expectation that sluicing will be insensitive to syntactic islands.

However, the analysis in Jäger (2001, 2005) suffers from the limitation that the antecedent clause must contain an indefinite. But sluicing is often possible even when there is no overt inner antecedent:

(5) John left, but I don't know when __.

In (5), there is no inner antecedent, let alone an indefinite inner antecedent. I will follow CLM (pp. 240 ff.) in calling this phenomenon "sprouting": as they put it, in some cases, "the recycled IP does not come supplied with a syntactic position for the displaced [wh] constituent to bind. When such a position does not already exist, it must be created, by an additional part of the recycling process we call **sprouting**." That is, as the pieces of the antecedent LF are copied and reassembled inside the gap site, CLM propose that it is possible to create fresh structure that contributes variables that can be bound by the wh-phrase, in which case the reconstituted LF has 'sprouted' new structure not present in the antecedent clause.

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The PF deletion strategy provides a satisfying account of sprouting examples. Since the only constraints on the sluiced clause are semantic, we are free to construct a clause that includes a temporal adjunct or other structure for the wh-phrase to originate from. Because the algorithm for testing for semantic equivalence involves existentially quantifying over the trace bound by the wh-phrase, the mismatch between the antecedent and the syntax inside the gap site will not disturb the recognition of an appropriate semantic equivalence. Thus on the PF deletion account, sprouting examples are not special in any way, but rather are automatically predicted to be possible by the basic sluicing mechanism.

1.4 Anaphora to a continuation

The analysis proposed here will use the anaphoric strategy. One advantage over (Jäger 2001, 2005) analysis is that it will provide an account of sprouting.

The key technique in the formal fragment is to build a system that explicitly recognizes continuations. The continuation of an expression relative to some larger containing expression is the larger expression with the smaller one removed—precisely the notion required here.

I have argued in other work (e.g., Barker 2002; Shan and Barker 2006; Barker and Shan 2008) that a grammar that recognizes continuations is independently desirable in order to give an account of scope-taking. If the same mechanism (continuations) governs scope-taking and sluicing, we might expect that there will be grammatical similarities between scope-taking and sluicing. I will argue that this is correct. More specifically, I will argue that in order to serve as a sluicing antecedent, the inner antecedent must take scope over the outer antecedent. It follows that the relationship between the outer antecedent and the inner antecedent is one of scopability, not movability.

1.5 Scopability

The scopability hypothesis immediately makes the good prediction that a sluice is only possible if the inner antecedent takes scope over the rest of the antecedent clause, as noted by CLM (1995, p. 255):

(6) Everyone selected a book, but I don't know which book.

They note that the sluice in (6) is only possible if the indefinite *a book* is interpreted as taking wide scope over the rest of the antecedent clause, including the universal quantifier *everyone*. The scopability requirement and how it follows from the analysis here is discussed below in Sect. 3.2. (See also Sect. 7.3 for a brief discussion of pair-list readings.)

To a large extent, scopability is compatible with LF copying and with PF deletion. For instance, on the PF deletion strategy, a sluice will only be grammatical if the sluice means the same thing as the antecedent (modulo existential focus closure, see Sect. 5). Since wh-movement generally guarantees that the wh-phrase will take semantic scope

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over everything in its syntactic scope, a sluice will only be good under a construal on which the inner antecedent also takes wide scope over the rest of the antecedent clause, since otherwise the mutual entailment requirement will fail. Similarly, on the LF copying account, the only way to arrive at an LF to copy that will deliver a suitable free variable for the wh-phrase to bind is if the inner antecedent has taken scope wider than the rest of the antecedent clause.

This means that the predictions of scopability may not provide strong evidence distinguishing among the three main sluicing strategies. Nevertheless, scopability follows in a particularly natural way on the anaphoric account.

A prediction of the scopability hypothesis is that if allowing an inner antecedent to take scope over the rest of the antecedent clause is difficult or impossible, the corresponding sluice will be at least as problematic. Given that indefinites can almost always take effortless wide scope, this is not easy to test.

(7) [John photographed a woman or the Empire State Building yesterday],
but I don't know {which one/*who}.

The bracketed antecedent clause in (7), taken on its own, strongly favors an interpretation on which the disjunction takes wider scope than the indefinite: either John photographed a woman, or else John photographed the ESB. It is difficult, perhaps even impossible, for (7) to express the proposition that there exists a woman such that John either photographed her or the ESB. As predicted, the sluice can target the entire disjunction as the inner antecedent, in which case the appropriate wh-phrase is *which one*, and the sluice will be grammatical. But if the wh-phrase is *who*, with an intended interpretation for the sluiced clause of *who John photographed __ or the Empire State Building yesterday*, the sluice is severely degraded or ungrammatical. The explanation is that on the analysis here, the indefinite would have to take scope over the entire remainder of the antecedent clause, including the disjunction, but that is not possible.

Of course, coordinate structures are syntactic islands. Could (7) be a case of sensitivity to syntactic islands? No:

(8) John photographed a woman and the Empire State Building yesterday.
Do you know who?

Replacing *or* with *and* leads to a grammatical sluice. Since conjunction is just as much of a coordinate structure as disjunction, syntactic islandhood can't explain (7).

As a second example of a construction in which scope restrictions are independent of syntactic islands, consider the fact that a quantifier can only bind a pronoun if it takes scope over that pronoun. That means that if an indefinite contains a pronoun that is bound by some other quantifier, the indefinite must take narrow scope with respect to that quantifier:

(9) *No one spoke to a neighbor of his, but I don't know who.

Consequently, an attempt to take the pronoun-containing indefinite as the inner antecedent fails. Romero (1998, p. 59) observes that weak island violations sometimes appear to determine the grammaticality of a sluice, though she immediately goes on to show that weak islands can't be the full explanation. In any case, a weak-island effect

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can't be the explanation here, since *Who did no one speak to?* is not a weak island violation, and in fact is perfectly well-formed.

For a third example, direct object modified numerals resist taking scope over universal subjects (Szabolcsi 2010, p. 178):

(10) Every teacher called more than two students. #more than two > every

This fact predicts that a sluice that targets *more than two students* will be degraded or impossible:

(11) a. More than two people called, but I don't know who.
b. #Every teacher called more than two students, but I don't know who.

Despite the fact that modified numerals can serve as inner antecedents (as shown by (11a)), when modified numerals are placed in a position where they cannot take sufficiently wide scope, the resulting sluice is infelicitous.

1.6 Summary

To summarize, both the LF copying approach and the PF deletion approach crucially postulate grammatical structure internal to the gap site. In the LF copying approach, the internal structure is copied from salient material in the discourse, perhaps with new structure added to account for sprouting. Case matching is manageable, and insensitivity to syntactic islands follows in a satisfying way. In the PF deletion approach, the internal structure is generated in the normal way, but (under the right conditions) not pronounced. There is a satisfying explanation of case matching and sprouting, and insensitivity to syntactic islands is manageable.

On the anaphoric approach, there is no structure internal to the ellipsis site: there is simply a silent proform that is anaphoric to some salient discourse object.[1] Case matching is manageable, and there is a satisfying explanation for insensitivity to syntactic islands. But on the analysis of Jäger (2001, 2005), the antecedent object must be a clause containing an indefinite. On that account, then, sprouting remains mysterious, since (by the definition of sprouting) there is no suitable indefinite in the antecedent clause. The anaphoric account proposed here, as we will see, generalizes smoothly to sprouting examples.

The next section provides a relatively simple continuation-based fragment that will illustrate the key ideas of anaphora to a continuation, and that will provide concrete explicit analyses of the empirical data discussed above and in later sections.

[1] In fact, positing a silent proform in the elided position is not essential. In Jäger (2001, 2005), the anaphoric dependence of the ellipsis is encoded as a variant form of the wh-word itself. There is no reason this strategy couldn't be adopted here, if desired; however, I will continue treat the ellipsis as a silent proform that is independent of the wh-word, in part in order to emphasize the similarity in structure between the silent ellipsis elements and overt pronouns.

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2 A formal fragment for reasoning about constituents and anti-constituents

Implementing the idea that sluicing is anaphora to a continuation is challenging technically. It is easy for a human linguist to contemplate a configuration such as [*John saw* [*someone*] *yesterday*] and perceive that what remains after the inner constituent has been removed can function as a unit. Likewise, it is relatively easy for a formal grammar to recognize a gapped clause as a constituent when the inner component has been overtly moved through some syntactic process, as in the bracketed relative clause in *someone that* [*John saw* __ *yesterday*]. It is quite another thing for a formal grammar to recognize the presence of a remnant when the inner element has not been displaced. This is like looking at a lump of dough, and asking how many donuts it might contain: wherever there might have been a hole, the surrounding material might have been a donut.

In order to demonstrate that it is possible to build a suitable formal grammar, I will present the analysis in type logical grammar. We shall see that type logical grammar allows explicit reasoning about constituents and anti-constituents (i.e., continuations). However, I will not dwell on technical matters in this paper, so this section provides only enough detail to follow the derivations in later sections. The fragment here is closely similar to the one given in Barker (2007); for a more leisurely introduction to type logical grammar, see Jäger (2005).

Of course, if the relationship between the inner antecedent and the rest of the antecedent clause is indeed one of scope-taking, we could characterize that relationship using the familiar process of Quantifier Raising (QR): if we QR *someone* in *John saw someone*, the nuclear scope created by QR will provide exactly the right semantic value to serve as the antecedent of the sluice in *John saw someone, but I don't know who* __. Why not, then, develop a QR-based account?

This is undoubtedly feasible. However, in order to develop a QR implementation, there are a number of elements that would need to be added to the standard framework. For instance, we would need to provide a LIFT type-shifter to deal with inner antecedents that are not normally assumed to be scope-takers (such as proper names, see Sect. 6.1). We would also need to devise a way for the syntactic category of the nuclear scope constituent at LF to make available details about the case and other syntactic properties of the inner antecedent, which would require a fairly extensive re-thinking of QR. In addition, we would have to explain how a nuclear scope can come to bind a proform that it does not c-command. Once we make these mechanisms fully explicit, we will end up with a system with at least the same degree of complexity as the one given here. But even if all this is feasible, what remains unclear to me is how to reconstruct in the standard QR framework a way to handle sprouting and implicit arguments.

In fact, one way to understand the type-logical system is that it allows us to reason about what a complete QR account would have to be like. On this view, the logic here would provide proofs that make guarantees about possible LF derivations: if an inner antecedent has such-and-such syntactic properties, and takes scope via QR over some particular antecedent clause, then the resulting nuclear scope will be able to license sluicing in such-and-such circumstances.

So—let us reason about syntactic and semantic composition:

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Categories: The set of syntactic categories contains at least the basic (atomic) categories DP, S, and Q (for embedded interrogatives). In addition, if A and B are any categories, then $A\backslash B$, A/B, $A\diagdown\!\!\backslash B$, and $A/\!\!\diagdown B$ are also (complex) categories. For instance, determiner phrases, DP; clauses, S; verb phrases, DP$\backslash$S; gapped clauses, DP$\diagdown\!\!\backslash$S; transitive verbs, (DP$\backslash$S)/DP; generalized quantifiers, S$/\!\!\diagdown$(DP$\backslash$S); and fronted wh-phrases, Q/(DP$\diagdown\!\!\backslash$S), are examples of syntactic categories.

Structures: Structures play the role of syntactic trees, as well as of LFs. A single category counts as a structure (i.e., the set of structures includes the set of syntactic categories). In addition, if Γ and Δ are structures, then $\Gamma \cdot \Delta$ ('Γ syntactically merged with Δ') and $\Gamma \circ \Delta$ ('Γ taking scope over Δ') are also structures. For instance, determiner phrases, DP; verb phrases, DP$\backslash$S; clauses consisting of a subject merged with a verb phrase, DP $\cdot$ DP$\backslash$S; clauses consisting of a transitive verb merged with two arguments, DP $\cdot$ ((DP$\backslash$S)/DP $\cdot$ DP); and a clause consisting of a determiner phrase taking scope over the rest of the clause it is embedded in, DP $\circ$ DP$\diagdown\!\!\backslash$S, are structures. (We will need to enlarge the set of structures below in order to represent gapped expressions, i.e., constituents with pieces removed.)

Logical rules: These rules are identical to the rules given in Moortgat (1997, p. 129).

$$\frac{\Gamma \vdash A \quad \Sigma[B] \vdash C}{\Sigma[\Gamma \cdot A\backslash B] \vdash C}\backslash L \qquad \frac{A \cdot \Gamma \vdash B}{\Gamma \vdash A\backslash B}\backslash R \qquad \frac{\Gamma \vdash A \quad \Sigma[B] \vdash C}{\Sigma[B/A \cdot \Gamma] \vdash C}/L \qquad \frac{\Gamma \cdot A \vdash B}{\Gamma \vdash B/A}/R$$

$$\frac{\Gamma \vdash A \quad \Sigma[B] \vdash C}{\Sigma[\Gamma \circ A\diagdown\!\!\backslash B] \vdash C}\diagdown\!\!\backslash L \qquad \frac{A \circ \Gamma \vdash B}{\Gamma \vdash A\diagdown\!\!\backslash B}\diagdown\!\!\backslash R \qquad \frac{\Gamma \vdash A \quad \Sigma[B] \vdash C}{\Sigma[B/\!\!\diagdown A \circ \Gamma] \vdash C}/\!\!\diagdown L \qquad \frac{\Gamma \circ A \vdash B}{\Gamma \vdash B/\!\!\diagdown A}/\!\!\diagdown R$$

The solid slashes '$\backslash$' and '$/$' are the familiar slashes of categorial grammar, and have the same meaning they do there. The hollow slashes, '$\diagdown\!\!\backslash$' and '$/\!\!\diagdown$' are for reasoning about scope-taking, and their nature will emerge in the discussion below. In the terminology of type-logical grammar, solid slashes characterize one *mode* of syntactic combination, which I will call the MERGE mode, as in the syntactic merge operation, and the hollow slashes characterize a second mode, which I will call the CONTINUATION mode.

Bracket notation for substitution into structures: In these rules, '$\Sigma[\Delta]$' is a structure Σ with a particular occurrence of the structure Δ highlighted somewhere within it. Then $\Sigma[\Gamma]$ is a structure just like Σ except with Δ replaced by Γ (assuming that Γ is also a legitimate structure, of course). For instance, if $\Sigma = \text{John} \cdot \text{left}$, and Δ is the occurrence of the structure *left* inside of Σ, then $\Sigma[\text{saw} \cdot \text{Mary}] = \text{John} \cdot (\text{saw} \cdot \text{Mary})$, with the complex verb phrase *saw* $\cdot$ *Mary* in place of *left*. Thus the bracket notation is a way to manipulate structures and their subparts, and in particular to replace one substructure with another.

As the labels attached to the logical rules indicate, there are two types of inference patterns, R inferences and L inferences. Here is an example of an R-type inference:

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$$\frac{\text{DP} \cdot \text{VP} \vdash \text{S}}{\text{VP} \vdash \text{DP}\backslash\text{S}}\backslash R$$

In words, reading from top to bottom: if the syntactic merge of a DP with a VP forms ('$\vdash$') an expression in category S, then it follows that any expression in the category VP must also be a member of the category DP\S. This rule captures the sense in which an expression in category DP\S is the kind of expression that can be merged with a DP to its left to form an S.

And here is an example of a L-type inference:

$$\frac{\text{John} \vdash \text{DP} \qquad \text{S} \vdash \text{S}}{\text{John} \cdot \text{DP}\backslash\text{S} \vdash \text{S}}\backslash L$$

This rule has two premises. The first premise says that *John* is in category DP. The second premise is trivial in this instance, and merely says that everything in the category S is in the category S (as surely it must be). If both these premises hold, the conclusion on the bottom line says that *John* must be the kind of thing that can be syntactically merged with an expression in the category DP\S in order to form a complete S.

As for the other six logical rules, they differ only in whether the expression in question appears on the left or the right, and whether we are reasoning about merging (solid slashes) or scope-taking (hollow slashes).

By chaining inferences together, we can analyze complex sentences:

$$\dfrac{\dfrac{\text{Mary} \vdash \text{DP} \qquad \dfrac{\text{John} \vdash \text{DP} \qquad \text{S} \vdash \text{S}}{\text{John} \cdot \text{DP}\backslash\text{S} \vdash \text{S}}\backslash L}{\text{John} \cdot ((\text{DP}\backslash\text{S})/\text{DP} \cdot \text{Mary}) \vdash \text{S}}/L}{\text{John} \cdot (\text{saw} \cdot \text{Mary}) \vdash \text{S}}\text{LEX}$$

The first inference (beginning at the top) is the very same $\backslash L$ inference discussed immediately above. The last inference, labelled LEX, simply substitutes the lexical item *saw* in the place of its syntactic category, (DP\S)/DP.

A derivation is complete if the premises at the top of the proof consist entirely of lexical correspondences (such as 'Mary $\vdash$ DP') and tautologies (such as 'S $\vdash$ S').

The inferences and the derivation discussed so far involve only the merge mode. In order to make use of the categories and logical rules governing the continuation mode, we need to add a structural rule. In order to state this structural rule, we will need to enlarge the set of structures (as promised) to include **gapped structures**: if $\Sigma[\Delta]$ is a structure, then so is $\lambda\alpha\Sigma[\alpha]$, where α is a variable taken from the set $x, y, z, x_1, x_2, \ldots$. For instance, $\lambda x x$, $\lambda y y$, $\lambda x(x \cdot \text{left})$, $\lambda x(\text{John} \cdot (\text{saw} \cdot x))$, and $\lambda x \lambda y(y \cdot (\text{saw} \cdot x))$ are gapped structures. Then we have the following structural inference rule:

$$\Sigma[\Delta] \equiv \Delta \circ \lambda\alpha\Sigma[\alpha]$$

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In words: if a structure Σ contains within it a structure Δ, then Δ can take scope over the rest of Σ, where 'the rest of Σ' is represented as a gapped structure of the form $\lambda\alpha\,\Sigma[\alpha]$.[2]

This structural rule handles scope-taking of in-situ quantifiers, and so is motivated entirely independently of sluicing. It plays a role in the grammar analogous to the role of Quantifier Raising. If we assume that *everyone* is in the syntactic category $\mathrm{S}/\!\!/(\mathrm{DP}\backslash\!\!\backslash\mathrm{S})$, then we can give the following derivation to the sentence *John saw everyone*:

$$\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\mathrm{John}\cdot(\mathrm{saw}\cdot\mathrm{DP})\vdash\mathrm{S}}{\mathrm{DP}\circ\lambda x(\mathrm{John}\cdot(\mathrm{saw}\cdot x))\vdash\mathrm{S}}\equiv}{\lambda x(\mathrm{John}\cdot(\mathrm{saw}\cdot x))\vdash\mathrm{DP}\backslash\!\!\backslash\mathrm{S}}\backslash\!\!\backslash R \qquad \mathrm{S}\vdash\mathrm{S}}{\mathrm{S}/\!\!/(\mathrm{DP}\backslash\!\!\backslash\mathrm{S})\circ\lambda x(\mathrm{John}\cdot(\mathrm{saw}\cdot x))\vdash\mathrm{S}}/\!\!/L}{\mathrm{everyone}\circ\lambda x(\mathrm{John}\cdot(\mathrm{saw}\cdot x))\vdash\mathrm{S}}\mathrm{LEX}}{\mathrm{John}\cdot(\mathrm{saw}\cdot\mathrm{everyone})\vdash\mathrm{S}}\equiv$$

Reading from the bottom to the top, the first step is to suppose that *everyone* might take scope over the rest of the clause (second line from the bottom). In order to complete the derivation, it is necessary to prove that "the rest of the clause", corresponding here to the gapped structure $\lambda x(\mathrm{John}\cdot(\mathrm{saw}\cdot x))$, has category $\mathrm{DP}\backslash\!\!\backslash\mathrm{S}$. (The derivation is not complete, since the initial premise is neither a lexical correspondence or a tautology, but the remaining steps are similar to the derivation of *John saw Mary* given above.)

2.1 Continuations are scope remnants

Categories of the form "$A\backslash\!\!\backslash B$" are exactly what I have been calling CONTINUATIONS: the remnant formed by subtracting an A from a containing B. For instance:

(12) Mary claimed [John saw someone yesterday] repeatedly, but she never said who __.

In a sluice like (12), then, the sluice gap will be anaphoric to the remnant of the antecedent clause (*John saw someone yesterday*) after the inner antecedent has been removed. That is, the sluice gap will be anaphoric to the continuation $\lambda x(\mathrm{John}\cdot((\mathrm{saw}\cdot x)\cdot\mathrm{yesterday}))$. This continuation has category $\mathrm{DP}\backslash\!\!\backslash\mathrm{S}$: a clause with a DP abstracted (scoped out).

[2] The equivalence should be restricted to cases in which the variable instantiating α is distinct from all other variables in Σ. This restriction is not essential; there is a variable-free implementation of the fragment in Barker (2007).

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2.2 Semantics: automatic Curry–Howard labeling

One pleasant property of type-logical grammar is that the compositional semantics follows automatically from the structure of the logical rules according to the Curry–Howard correspondence. In brief (see Jäger 2005 or Moortgat 1997 for full details), L inference rules have the semantics of function application, R rules have the semantics of functional abstraction, and the scope-taking structural rule has no effect on the semantic labeling. Variables that remain unbound in the conclusion correspond to the denotations of the lexical items.

For instance, here is the same proof given immediately above, but with semantic labels prefixed to each syntactic category:

$$\dfrac{\dfrac{\dfrac{\dfrac{\mathbf{j}\text{:John} \cdot (\mathbf{saw}\text{:saw} \cdot x\text{:DP}) \vdash (\mathbf{saw}\ x\ \mathbf{j})\text{:S}}{x\text{:DP} \circ \lambda x(\mathbf{j}\text{:John} \cdot (\mathbf{saw}\text{:saw} \cdot x)) \vdash (\mathbf{saw}\ x\ \mathbf{j})\text{:S}}\equiv}{\lambda x(\mathbf{j}\text{:John} \cdot (\mathbf{saw}\text{:saw} \cdot x)) \vdash (\lambda x.\mathbf{saw}\ x\ \mathbf{j})\text{:DP}\backslash\text{S}}\backslash R \qquad p\text{:S} \vdash p\text{:S}}{Q\text{:S}/\!/(\text{DP}\backslash\text{S}) \circ \lambda x(\mathbf{j}\text{:John} \cdot (\mathbf{saw}\text{:saw} \cdot x)) \vdash Q(\lambda x.\mathbf{saw}\ x\ \mathbf{j})\text{:S}}/\!/L}\text{LEX}$$

$$\dfrac{\mathbf{everyone}\text{:everyone} \circ \lambda x(\mathbf{j}\text{:John} \cdot (\mathbf{saw}\text{:saw} \cdot x)) \vdash \mathbf{everyone}(\lambda x.\mathbf{saw}\ x\ \mathbf{j})\text{:S}}{\mathbf{j}\text{:John} \cdot (\mathbf{saw}\text{:saw} \cdot \mathbf{everyone}\text{:everyone}) \vdash \mathbf{everyone}(\lambda x.\mathbf{saw}\ x\ \mathbf{j})\text{:S}}\equiv$$

The way in which the inferences adjust the semantic labeling automatically derives the compositional semantics. In particular, the conclusion (the bottom line) states that if the semantic values of *John*, *saw*, and *everyone* are **j**, **saw**, and **everyone**, then the semantic value of the sentence is **everyone**(λx.**saw** x **j**). Although simple and straightforward conceptually, the semantic labeling is somewhat cumbersome visually, and the derivations below will include only the syntactic categories followed, where relevant, by the final semantic value determined by the derivation.

2.3 Anaphora as parasitic scope

It would be enough for present purposes to provide a grammar that recognized the presence of scope remnants that could serve as sluice antecedents. Then the anaphoric link between the sluice gap an its antecedent could be regulated via some independent mechanism governing anaphoric binding. Some candidates for such a mechanism are informal coindexation, Büring's (2004) beta-binding, some variation of one of the many kinds of dynamic semantics, etc.

But in fact the fragment above, which was motivated purely on the basis of providing an account of in-situ scope taking, already provides the ingredients of a grammatically-mediated binding mechanism. In order to be fully explicit about case matching and sprouting without introducing additional formal mechanisms to the grammar, I will implement anaphora as a particular kind of scope-taking. Although this mechanism will serve the purposes of this paper well, it is nevertheless important to appreciate that the hypothesis that sluicing is anaphora to a continuation is independent of any particular way of implementing anaphoric binding relationships.

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The approach to anaphora here makes use of a technique called 'parasitic scope' in Barker (2007). In parasitic scope, some operator intervenes between a separate scope-taking operator and its nuclear scope. The main application for parasitic scope in Barker (2007) involves so-called sentence-internal readings of *same* and *different*, as in the most salient reading of *everyone read the same book*.

$$\dfrac{\dfrac{\text{everyone} \circ (\text{same} \circ \lambda f \lambda x (x \cdot (\text{read} \cdot (\text{the} \cdot (f \cdot \text{book}))))) \vdash \text{S}}{\text{everyone} \circ \lambda x (x \cdot (\text{read} \cdot (\text{the} \cdot (\text{same} \cdot \text{book})))) \vdash \text{S}} \equiv}{\text{everyone} \cdot (\text{read} \cdot (\text{the} \cdot (\text{same} \cdot \text{book}))) \vdash \text{S}} \equiv$$

The parasitic scope derivation begins (reading from the bottom up) with the quantifier *everyone* taking scope over the rest of the sentence (middle line). Then *same* takes scope in a way that allows it to intervene between *everyone* and the nuclear scope of *everyone*—thus the scope-taking of *same* is parasitic on the scope-taking of *everyone*. See Barker (2007) for full details of the completion of this derivation, along with a proposal for the semantics of *same*.

Parasitic scope has been used to characterize a number of different phenomena. Kennedy and Stanley (2009) propose a parasitic scope analysis for sentences like *The average American has 2.3 kids*, resolving the puzzle posed by the fact that no individual person can have a fractional number of kids. Parasitic scope analyses are also useful for understanding comparatives (see, e.g., Szabolcsi 2012), and for various types of coordination (Kubota and Levine 2013).

The application of parasitic scope to anaphora is based on an idea due to Morrill et al. (2007, p. 52). On their account, anaphors take scope that is parasitic on that of their antecedents. Assuming the pronoun *he* has category $(\text{DP}\backslash\text{S})/\!\!/(\text{DP}\backslash(\text{DP}\backslash\text{S}))$, we have:

(13) Everyone$_i$ said he$_i$ left.

$$\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\text{DP} \cdot (\text{said} \cdot (\text{DP} \cdot \text{left})) \vdash \text{S}}{\text{DP} \circ \lambda x (x \cdot (\text{said} \cdot (\text{DP} \cdot \text{left}))) \vdash \text{S}} \equiv}{\lambda x (x \cdot (\text{said} \cdot (\text{DP} \cdot \text{left}))) \vdash \text{DP}\backslash\text{S}} \backslash R}{\text{DP} \circ \lambda y \lambda x (x \cdot (\text{said} \cdot (y \cdot \text{left}))) \vdash \text{DP}\backslash\text{S}} \equiv \qquad \dfrac{\dfrac{\text{DP}\backslash\text{S} \vdash \text{DP}\backslash\text{S} \qquad \text{S} \vdash \text{S}}{\text{S}/\!\!/(\text{DP}\backslash\text{S}) \circ \text{DP}\backslash\text{S} \vdash \text{S}} /\!\!/ L}{\text{everyone} \circ \text{DP}\backslash\text{S} \vdash \text{S}} \text{LEX}}{\lambda y \lambda x (x \cdot (\text{said} \cdot (y \cdot \text{left}))) \vdash \text{DP}\backslash(\text{DP}\backslash\text{S})} \backslash R}{\text{everyone} \circ ((\text{DP}\backslash\text{S})/\!\!/(\text{DP}\backslash(\text{DP}\backslash\text{S})) \circ \lambda y \lambda x (x \cdot (\text{said} \cdot (y \cdot \text{left})))) \vdash \text{S}} /\!\!/ L}{\text{everyone} \circ (\text{he} \circ \lambda y \lambda x (x \cdot (\text{said} \cdot (y \cdot \text{left})))) \vdash \text{S}} \text{LEX}}{\text{everyone} \circ \lambda x (x \cdot (\text{said} \cdot (\text{he} \cdot \text{left}))) \vdash \text{S}} \equiv}{\text{everyone} \cdot (\text{said} \cdot (\text{he} \cdot \text{left})) \vdash \text{S}} \equiv$$

Providing *he* with the duplicator combinator $\mathbf{W} = \lambda\kappa\lambda x.\kappa x x$ as a denotation, and assuming that the generalized quantifier $\mathbf{everyone} = \lambda P \forall x.Px$, the semantics for the derivation is as follows:

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$$\textbf{everyone}((\lambda\kappa\lambda x.\kappa x x)(\lambda y\lambda x.\textbf{said}(\textbf{left}\ x)\ y))$$
$$= \textbf{everyone}(\lambda x.\textbf{said}(\textbf{left}\ x)\ x) = (\lambda P\forall x.Px)(\lambda x.\textbf{said}(\textbf{left}\ x)\ x)$$
$$= \forall x.\textbf{said}(\textbf{left}\ x)\ x$$

This derivation gives the bound reading, on which the pronoun varies with the choice of the universal quantifier.

In this derivation, the bound pronoun is a DP taking another DP as its antecedent. It will be convenient to adopt a convention for abbreviating the syntactic category that delivers the parasitic scope derivation:

$$A^B \equiv (B\backslash\!\backslash \text{S})/\!/(A\backslash\!\backslash(B\backslash\!\backslash \text{S}))$$

This is the category of an anaphor of category A taking an antecedent of category B. Usually, though not always, A and B will match exactly (e.g., in the derivation above, $A = B = \text{DP}$). We shall see in Sect. 5.2 that allowing A and B to differ may account for certain examples in which the syntax of the antecedent does not match the sluice gap.

2.4 A sketch of verb phrase ellipsis as parasitic scope

It will be instructive to show how the parasitic scope analysis of bound anaphora can provide an account of a construction that more closely resembles sluicing. In verb phrase ellipsis (VPE), a verb phrase takes a nearby verb phrase as antecedent. We can model this by providing a silent proform VPEGAP with category VP^{VP} (where 'VP' abbreviates DP\S):

(14) a. John left or Bill did.

b.
$$\dfrac{\dfrac{\text{left} \circ (\text{VPEGAP} \circ \lambda y\lambda x((\text{John} \cdot x) \cdot (\text{or} \cdot (\text{Bill} \cdot y)))) \vdash \text{S}}{\text{left} \circ \lambda x((\text{John} \cdot x) \cdot (\text{or} \cdot (\text{Bill} \cdot \text{VPEGAP}))) \vdash \text{S}} \equiv}{(\text{John} \cdot \text{left}) \cdot (\text{or} \cdot (\text{Bill} \cdot \text{VPEGAP})) \vdash \text{S}} \equiv$$

This is basic VPE: the VP proform takes the verb phrase *left* as its antecedent. The interpretation is that John left or Bill left.

The VPE analysis and the analysis of bound pronouns given above interact to provide analyses of the traditional strict versus sloppy ambiguity. To illustrate a sloppy interpretation, simply replace the verb phrase *left* in the derivation above with the following derivation of *said he left* in which the pronoun takes scope over the rest of the verb phrase (i.e., covaries with the subject of the verb phrase):

(15) a. John said he left or Bill did.

b.
$$\dfrac{\dfrac{\dfrac{\text{DP} \circ (\textit{he} \circ \lambda y\lambda x(x \cdot (\text{said} \cdot (y \cdot \text{left})))) \vdash \text{S}}{\text{DP} \circ \lambda x(x \cdot (\text{said} \cdot (\text{he} \cdot \text{left}))) \vdash \text{S}} \equiv}{\text{DP} \cdot (\text{said} \cdot (\text{he} \cdot \text{left})) \vdash \text{S}} \equiv}{\text{said} \cdot (\text{he} \cdot \text{left}) \vdash \text{DP}\backslash\text{S}}\ \backslash R$$

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Assuming that the VPEGAP proform has the same duplicator semantics as the bound pronoun (though with arguments of a different semantic type: $\lambda\kappa\, P.\kappa\, P\, P$), the Curry–Howard labeling of this verb phrase will be $\lambda x.\mathbf{said}(\mathbf{left}\, x)\, x$. The interpretation in this case is that John said John left or Bill said Bill left.

In order to arrive at the strict interpretation, working from the bottom up, it is necessary for the strict antecedent (in this case, *John*) to take scope over the entire sentence, and in particular, to take wider scope than the verb phrase ellipsis:

(16) a. John said he left or Bill did.

b.
$$\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{(\text{DP}\cdot(\text{said}\cdot(\text{DP}\cdot\text{left})))\cdot(\text{or}\cdot(\text{Bill}\cdot\text{VPEGAP}))\vdash \text{S}}{\text{DP}\circ(\text{DP}\circ\lambda y\lambda x((x\cdot(\text{said}\cdot(y\cdot\text{left})))\cdot(\text{or}\cdot(\text{Bill}\cdot\text{VPEGAP}))))\vdash \text{S}}\equiv,\equiv}{\lambda y\lambda x((x\cdot(\text{said}\cdot(y\cdot\text{left})))\cdot(\text{or}\cdot(\text{Bill}\cdot\text{VPEGAP})))\vdash \text{DP}\backslash(\text{DP}\backslash\text{S})}\backslash R,\backslash R \qquad \text{John}\circ\text{DP}\backslash\text{S}\vdash\text{S}}{\text{John}\circ((\text{DP}\backslash\text{S})/\!/(\text{DP}\backslash(\text{DP}\backslash\text{S}))\circ\lambda y\lambda x((x\cdot(\text{said}\cdot(y\cdot\text{left})))\cdot(\text{or}\cdot(\text{Bill}\cdot\text{VPEGAP}))))\vdash\text{S}}/\!/L}{\text{John}\circ(\text{he}\circ\lambda y\lambda x((x\cdot(\text{said}\cdot(y\cdot\text{left})))\cdot(\text{or}\cdot(\text{Bill}\cdot\text{VPEGAP}))))\vdash\text{S}}\text{LEX}}{\text{John}\circ\lambda x((x\cdot(\text{said}\cdot(\text{he}\cdot\text{left})))\cdot(\text{or}\cdot(\text{Bill}\cdot\text{VPEGAP})))\vdash\text{S}}\equiv}{(\text{John}\cdot(\text{said}\cdot(\text{he}\cdot\text{left})))\cdot(\text{or}\cdot(\text{Bill}\cdot\text{VPEGAP}))\vdash\text{S}}\equiv$$

The left branch of the derivation continues by using the VP corresponding to *said* · (DP · *left*) to bind VPEGAP. The interpretation is that John said John left or Bill said John left.

Although the analyses of verb phrase ellipsis sketched here are, as far as I know, novel to this paper, I offer them purely for comparison with the analysis of sluicing below. It is beyond the scope of this paper to evaluate how robust this strategy is for verb phrase ellipsis in general, though I'm not currently aware of any fatal shortcoming.

3 Basic sluicing

We are now almost ready to give a complete derivation of a sluicing example. In order to deduce the syntactic category of the sluicegap, we need to briefly consider the syntax of interrogatives. In order to avoid dealing with subject auxiliary inversion, we'll limit consideration to embedded interrogatives, such as *who left* in *I know who left*.

(17) a. I know [who (__ left)].
b. I know [who (John ((saw __) yesterday))].

The bracketed phrases are what I am calling embedded interrogatives.

In general, wh-phrases take as their complement a clause missing a DP somewhere inside of it. Then if Q is the category of embedded interrogatives, *who* will have the syntactic category Q/(DP\S): something that must merge with a gapped clause to its right in order to form an interrogative.

Finally, we reason that if what is missing in a sluice is the complement of a wh-phrase, and the complement of a wh-phrase has category DP\S, then the silent proform

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SLUICEGAP must have the anaphoric category $(\mathrm{DP}\backslash\mathrm{S})^{(\mathrm{DP}\backslash\mathrm{S})}$: anaphora to a continuation.

(18) Someone left, but I don't know who SLUICEGAP.

$$\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{(\text{someone} \circ \mathrm{DP}\backslash\mathrm{S}) \cdot (\text{bidk} \cdot (\text{who} \cdot \mathrm{DP}\backslash\mathrm{S})) \vdash \mathrm{S}}{\mathrm{DP}\backslash\mathrm{S} \circ \lambda y((\text{someone} \circ y) \cdot (\text{bidk} \cdot (\text{who} \cdot \mathrm{DP}\backslash\mathrm{S}))) \vdash \mathrm{S}}\equiv}{\lambda y((\text{someone} \circ y) \cdot (\text{bidk} \cdot (\text{who} \cdot \mathrm{DP}\backslash\mathrm{S}))) \vdash (\mathrm{DP}\backslash\mathrm{S})\backslash\mathrm{S}}\backslash R}{\mathrm{DP}\backslash\mathrm{S} \circ \lambda z\lambda y((\text{someone} \circ y) \cdot (\text{bidk} \cdot (\text{who} \cdot z))) \vdash (\mathrm{DP}\backslash\mathrm{S})\backslash\mathrm{S}}\equiv}{\lambda z\lambda y((\text{someone} \circ y) \cdot (\text{bidk} \cdot (\text{who} \cdot z))) \vdash (\mathrm{DP}\backslash\mathrm{S})\backslash((\mathrm{DP}\backslash\mathrm{S})\backslash\mathrm{S})}\backslash R \qquad \dfrac{\dfrac{\dfrac{\mathrm{DP} \cdot \mathrm{DP}\backslash\mathrm{S} \vdash \mathrm{S}}{\mathrm{DP} \circ \lambda x(x \cdot \text{left}) \vdash \mathrm{S}}\equiv, \text{LEX}}{\lambda x(x \cdot \text{left}) \vdash \mathrm{DP}\backslash\mathrm{S}}\backslash R \qquad \mathrm{S} \vdash \mathrm{S}}{\lambda x(x \cdot \text{left}) \circ (\mathrm{DP}\backslash\mathrm{S})\backslash\mathrm{S} \vdash \mathrm{S}}\backslash L$$

$$\dfrac{\dfrac{\dfrac{\dfrac{\lambda x(x \cdot \text{left}) \circ (((\mathrm{DP}\backslash\mathrm{S})\backslash\mathrm{S})/\!\!/((\mathrm{DP}\backslash\mathrm{S})\backslash((\mathrm{DP}\backslash\mathrm{S})\backslash\mathrm{S})) \circ \lambda z\lambda y((\text{someone} \circ y) \cdot (\text{bidk} \cdot (\text{who} \cdot z)))) \vdash \mathrm{S}}{\lambda x(x \cdot \text{left}) \circ (\text{SLUICEGAP} \circ \lambda z\lambda y((\text{someone} \circ y) \cdot (\text{bidk} \cdot (\text{who} \cdot z)))) \vdash \mathrm{S}}\text{LEX}}{\lambda x(x \cdot \text{left}) \circ \lambda y((\text{someone} \circ y) \cdot (\text{bidk} \cdot (\text{who} \cdot \text{SLUICEGAP}))) \vdash \mathrm{S}}/\!\!/L}{(\text{someone} \circ \lambda x(x \cdot \text{left})) \cdot (\text{bidk} \cdot (\text{who} \cdot \text{SLUICEGAP})) \vdash \mathrm{S}}\equiv}{(\text{someone} \cdot \text{left}) \cdot (\text{bidk} \cdot (\text{who} \cdot \text{SLUICEGAP})) \vdash \mathrm{S}}\equiv$$

Here, *bidk* is an abbreviation of but-I-don't-know, and behaves as if it had syntactic category $(\mathrm{S}\backslash\mathrm{S})/\mathrm{Q}$.

The first step in the derivation (reading from the bottom up) is to allow *someone* to take scope over the antecedent clause (second line from the bottom). Next (third line from the bottom), the scope remnant $\lambda x(x \cdot \text{left})$ takes scope over the entire utterance. At this point (fourth line), the silent proform takes parasitic scope in order for the scope remnant to provide the content of the sluice gap.

3.1 Immediate good prediction: scope of inner antecedent

One of the main clues that sluicing is about scopability rather than movability is that, as CLM (1995, p. 255) note, and as mentioned above, sluicing is only possible when the inner antecedent takes scope over the rest of the antecedent clause.

(19) Everyone selected a book, but I don't know which book. (repeated from ex. (6))

In order for a sluice to be possible, not only must the sluiced clause be interpreted giving the wh-phrase scope over the universal (in which case there must be a single book that everyone selected), the antecedent clause must also receive a parallel interpretation on which the indefinite takes wide scope over the universal. This follows from the basic analysis:

(20) Someone saw everyone, but I don't know who.

$$\dfrac{\dfrac{\dfrac{\lambda x(x \cdot (\text{saw} \cdot \text{everyone})) \circ (\text{SLUICEGAP} \circ \lambda z \lambda y((\text{someone} \circ y) \cdot (\text{bidk} \cdot (\text{who} \cdot z)))) \vdash \text{S}}{\lambda x(x \cdot (\text{saw} \cdot \text{everyone})) \circ \lambda y((\text{someone} \circ y) \cdot (\text{bidk} \cdot (\text{who} \cdot \text{SLUICEGAP}))) \vdash \text{S}} \equiv}{(\text{someone} \circ \lambda x(x \cdot (\text{saw} \cdot \text{everyone}))) \cdot (\text{bidk} \cdot (\text{who} \cdot \text{SLUICEGAP})) \vdash \text{S}} \equiv}{(\text{someone} \cdot (\text{saw} \cdot \text{everyone})) \cdot (\text{bidk} \cdot (\text{who} \cdot \text{SLUICEGAP})) \vdash \text{S}} \equiv$$

In order for the remnant $\lambda x(x \cdot (saw \cdot everyone))$ to become available to serve as an antecedent for the sluicegap, the inner antecedent *someone* must first (second line from bottom) take scope over the rest of the antecedent clause, forcing an interpretation on which the indefinite takes wide scope with respect to the universal.

3.2 Case matching

On the analysis here, just as in Jäger (2001, 2005), guaranteeing that the wh-phrase in the sluiced clause will match the case of the inner antecedent is a matter of syntactic bookkeeping.

The bookkeeping mechanism in question is independently needed in order to enforce agreement in phi features for bound pronouns. For instance, in English pronouns must match their antecedents in number:

(21) Every boy$_i$ said he$_i$/*they$_i$ left.
Most boys$_i$ said they$_i$/*he$_i$ left.

If we refine the syntactic category DP into the subcategories DP.SG and DP.PL, then as long as the bound pronoun has category $\text{DP.SG}^{\text{DP.SG}}$ or $\text{DP.PL}^{\text{DP.PL}}$, the parasitic scope mechanism will enforce number agreement.

In the sluicing case, naturally, we will have wh-phrases that are distinguished according to their case properties:

(22) who: $\text{Q}/(\text{DP.NOM} \backslash \text{S})$
whom:$\text{Q}/(\text{DP.ACC} \backslash \text{S})$

Then as long as sluicegaps require that the syntactic category of its antecedent (the exponent) is identical to the syntactic category of its syntactic role (the base), case matching will be enforced.

(23) a. $\text{SLUICEGAP.NOM} : (\text{DP.NOM} \backslash \text{S})^{(\text{DP.NOM} \backslash \text{S})}$
b. $\text{SLUICEGAP.ACC} : (\text{DP.ACC} \backslash \text{S})^{(\text{DP.ACC} \backslash \text{S})}$

Why do pronouns and sluicegaps differ in which features they select for agreement? Well, if pronouns had to match their antecedents in case, that would severely restrict the range of grammatically appropriate possible antecedents. However, as far as the

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simple fragment here is concerned, there is no obvious formal reason why a language could not enforce such restrictions.

In any case, as Jäger (2001, 2005) observes, a type-logical analysis with suitably fine-grained syntactic categories is perfectly capable of accurately describing the observed patterns of case matching.

4 How to sprout

4.1 Simple sprouting

If some wh-phrases can be S modifiers, the analysis handles certain cases of sprouting immediately. For instance, *why* may be able to take a clausal complement:

(24) I want to know why Mary decided John left.

Note that (24) can only be used to raise the issue of Mary's motivations, not John's. This suggests that the syntactic category of *why* can be Q/S—something that combines with a complete clause. If so, then the reason (24) is unambiguous is that *why* is only able to combine with an adjacent, complete clause, in this case, *Mary decided John left*. Then if we have a silent proform WHYSLUICEGAP with category S^S, we have the following simple derivation of *John left, but I don't know why*:

$$\dfrac{\dfrac{(\text{John} \cdot \text{left}) \circ (\text{WHYSLUICEGAP} \circ \lambda y \lambda x (x \cdot (\text{bidk} \cdot (\text{why} \cdot y)))) \vdash \text{S}}{(\text{John} \cdot \text{left}) \circ \lambda x (x \cdot (\text{bidk} \cdot (\text{why} \cdot \text{WHYSLUICEGAP}))) \vdash \text{S}} \equiv}{(\text{John} \cdot \text{left}) \cdot (\text{bidk} \cdot (\text{why} \cdot \text{WHYSLUICEGAP})) \vdash \text{S}} \equiv$$

On this analysis, the antecedent for the sluicegap is the complete clause *John left*.

4.2 Embedded sprouting: motivating a silent empty structure

If all sprouting could always be analyzed as anaphora to a full clause, it would be easy to generalize Jäger's (2001, 2005) analysis to cover sprouting. However, this strategy is unlikely to generalize to the full range of sprouting examples.

(25) I want to know when John wanted to leave.

Unlike (24), (25) is ambiguous: it can be used to raise the issue of when John felt a particular desire, or else John's preferred departure time. We can suppose that *when* has category $\text{S}/(\text{ADV} \backslash\!\!\backslash \text{S})$, where $\text{ADV} = (\text{DP} \backslash \text{S}) \backslash (\text{DP} \backslash \text{S})$. Then the corresponding proform WHENSLGAP will have category $(\text{ADV} \backslash\!\!\backslash \text{S})^{(\text{ADV} \backslash\!\!\backslash \text{S})}$.

(26) John wanted to leave, but he didn't say when (he wanted to (leave __)).

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In order to arrive at the most natural interpretation of (26), *when* must be interpreted as modifying the embedded verb phrase *leave*, rather than modifying the entire antecedent clause. Therefore anaphora to a clause will not work here.

On Jäger's (2001, 2005) approach, the only way to build an antecedent that will accept a temporal adverbial meaning and apply it to an embedded constituent is to make use of his inference rule for introducing a discourse referent. But that rule requires the presence of an overt indefinite in the position of the inner antecedent.

The approach for dealing with such examples here will resemble sprouting as conceived by CLM in some respects, notably in that it will involve adding structure that is motivated only by the need to license a sluice. It will differ, however, in that it involves adding structure to the antecedent clause, rather than to a recycled clause within the gap site as in the CLM analysis. That is, in order to derive this sluice, we must find an adverb position inside of the antecedent clause.

The formal technique that will allow embedded sprouting depends on allowing inferences with empty antecedents. This technique has motivation independent of sluicing: in the type logical analysis of Barker and Shan (2006), this kind of inference allows deriving silent categories that can be used as gaps in derivations involving syntactic movement.

We begin by assuming that the empty structure is an identity element for both the merge mode and for the continuation mode, i.e., $\Gamma \cdot ()^{\cdot} \equiv \Gamma \equiv ()^{\cdot} \cdot \Gamma$, and $\Gamma \circ ()^{\circ} \equiv \Gamma \equiv ()^{\circ} \circ \Gamma$. The justification for this equivalence is that adding a silent empty structure does not change the resulting syntactic structure.[3]

As argued in Shan and Barker (2006), empty antecedents are motivated independently of any consideration of sluicing, in order to analyze syntactic movement in general, including (unsluiced) wh-interrogatives. In order to show this, note that if we allow the empty structure as a syntactic identity element, we can prove that the silent empty structure is a member of the following category:

$$\dfrac{\dfrac{\mathrm{DP}\backslash\!\!\backslash \mathrm{S} \vdash \mathrm{DP}\backslash\!\!\backslash \mathrm{S}}{()^{\circ} \circ \mathrm{DP}\backslash\!\!\backslash \mathrm{S} \vdash \mathrm{DP}\backslash\!\!\backslash \mathrm{S}}\equiv}{()^{\circ} \vdash (\mathrm{DP}\backslash\!\!\backslash \mathrm{S})/\!\!/(\mathrm{DP}\backslash\!\!\backslash \mathrm{S})}/\!\!/R$$

In general, silence will be a member of any category of the form $X|X$, where '|' is any of the four category-forming connectives ('\', '/', '$\backslash\!\!\backslash$', '$/\!\!/$').

If we have empty antecedents, we can derive interrogatives with fronted wh-phrases such as *Who does John like?* as follows, where GAP abbreviates the identity category derived immediately above, namely, $(\mathrm{DP}\backslash\!\!\backslash \mathrm{S})/\!\!/(\mathrm{DP}\backslash\!\!\backslash \mathrm{S})$:

[3] It is necessary to distinguish the empty merge structure ('$()^{\cdot}$') from the empty continuation structure ('$()^{\circ}$') in order to prevent overgeneration: if the empty merge structure can be mistaken for the empty continuation structure, the grammar becomes commutative.

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$$\dfrac{\dfrac{\dfrac{\dfrac{\dfrac{\text{does}\cdot(\text{John}\cdot(\text{like}\cdot\mathrm{DP}))\vdash\mathrm{S}}{\mathrm{DP}\circ\lambda x(\text{does}\cdot(\text{John}\cdot(\text{like}\cdot x)))\vdash\mathrm{S}}\equiv}{\lambda x(\text{does}\cdot(\text{John}\cdot(\text{like}\cdot x)))\vdash\mathrm{DP}\backslash\!\!\backslash\mathrm{S}}\backslash\!\!\backslash R \qquad \mathrm{DP}\backslash\!\!\backslash\mathrm{S}\vdash\mathrm{DP}\backslash\!\!\backslash\mathrm{S}}{(\mathrm{DP}\backslash\!\!\backslash\mathrm{S})/\!\!/(\mathrm{DP}\backslash\!\!\backslash\mathrm{S})\circ\lambda x(\text{does}\cdot(\text{John}\cdot(\text{like}\cdot x)))\vdash\mathrm{DP}\backslash\!\!\backslash\mathrm{S}}/\!\!/L}{\mathrm{GAP}\circ\lambda x(\text{does}\cdot(\text{John}\cdot(\text{like}\cdot x)))\vdash\mathrm{DP}\backslash\!\!\backslash\mathrm{S}}\text{LEX}}{\text{does}\cdot(\text{John}\cdot(\text{like}\cdot\mathrm{GAP}))\vdash\mathrm{DP}\backslash\!\!\backslash\mathrm{S}}\equiv$$

On the semantic side, the Curry–Howard labeling of empty categories is always the identity function. In the syntax, they have a null effect, taking an X as complement and returning an identical X as the resulting syntactic category; and likewise in the semantics, they have a null semantic effect, taking x as an argument and returning that same x as the resulting value. To take an arithmetic analogy, deriving an empty category is like multiplying by $2/2$, or by $(3/2)/(3/2)$, etc. But this is just multiplying by 1, which amounts to recognizing that the empty category is an identity element. In slogan form: adding nothing to a structure does not change that structure.

Empty antecedents are usually disallowed in type logical grammar. One reason to suppose they may be problematic, at least for natural-language applications, is that they can lead to trouble with adjunct modifiers. If we assume that adjectives have category N/N, and that adjective modifiers such as *very* have category (N/N)/(N/N), then we can derive a silent identity-function denoting adjective with category N/N. The prediction is that in addition to (*very* · *tall*) · *man*, we should be able to say *(*very*(· ()˙) · *man*. Thus using empty antecedents requires finding a different analysis for adjectival modifiers. For instance, we might suppose that *very* can only modify gradable adjectives (**That's a very prime number*). Once we refine the category of adjectives and of *very* to track gradability, silent adjectives will presumably not count as gradable.

Empty antecedents are perfectly coherent logically, and I'm not aware of any logical or empirical argument other than the argument from *very* suggesting that empty antecedents should be disallowed. Empty antecedents do create issues for decidability, however: if it is always possible to add a new empty category, we may never be sure we have found all of the legitimate derivations. There are techniques for addressing the decidability issue, but I will not explore them here.

4.3 Sprouting in silence

If we have empty antecedents, we can derive embedded sprouting cases. Sprouting, then, will involve postulating an empty structure within the antecedent clause.

For instance, let ordinary adverbs have category $\mathrm{ADV} = (\mathrm{DP}\backslash\mathrm{S})\backslash(\mathrm{DP}\backslash\mathrm{S})$. Assume that *when* has category $\mathrm{Q}/(\mathrm{ADV}\backslash\!\!\backslash\mathrm{S})$, and WHENSLGAP has category $(\mathrm{ADV}\backslash\!\!\backslash\mathrm{S})^{(\mathrm{ADV}\backslash\!\!\backslash\mathrm{S})}$. Then we have the following derivation of the sprouting example *John left, but I don't know when*:

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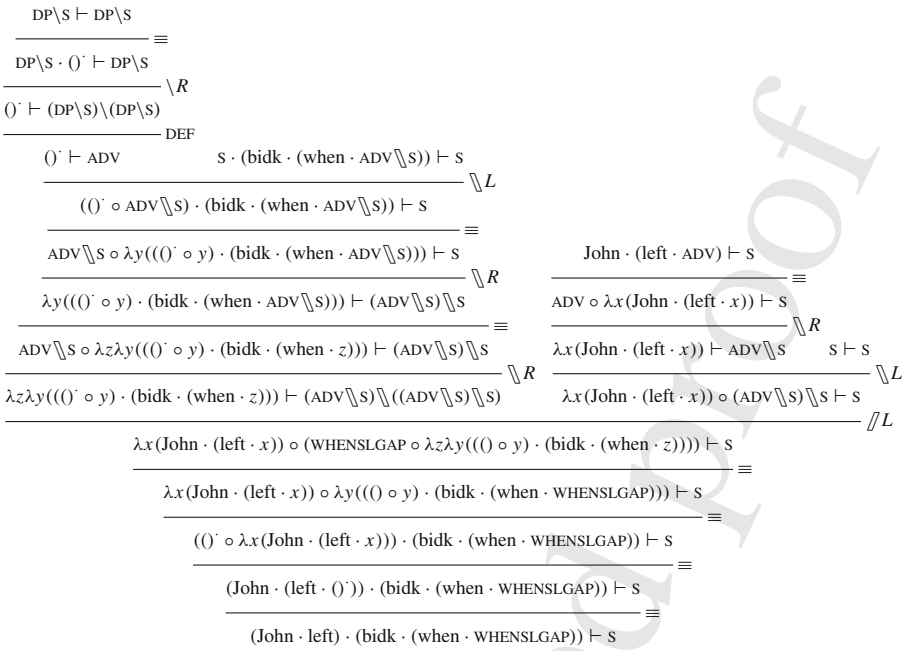

The first step in the proof (reading from the top downwards) is to recognize that because the empty structure is an identity element, DP\S is structurally equivalent to (DP\S · ()˙). The proof proceeds as usual, until the final step, when we remove the empty structure. Although the silent adverbial is syntactically and semantically inert, it serves to mark the position with respect to which the remainder (continuation) of the antecedent clause is defined. This is enough to complete the sluicing derivation in the normal way.

Thus, given independently-motivated empty antecedents, we can sprout silent identity-function denoting modifiers that are syntactically and semantically harmless, and we can sprout them whenever we need them in order to nucleate a sluicing analysis.

Note that this technique only sprouts adjuncts, such as VP modifiers, and not arguments or specifiers.

(27) a. Someone's dogs barked, but I don't know who.
b. Dogs barked, but I don't know *who.

As discussed in Chung (2013), a possessor can be sluiced as long as there is an appropriate overt inner antecedent, as in (27a), but a possessor can't be sprouted, as shown in (27b). (The fact that *whose* is a grammatical sluice is irrelevant, since it takes the entire DP as the inner antecedent, with the nominal *dog* deleted via an independent ellipsis process common to possessives.) On the analysis here, the reason we can't sprout possessors is that they have category DP/N, which is not an identity category.

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4.4 Implicit argument sluices

There is a class of examples in which the missing inner antecedent is an argument rather than an adjunct. This is generally possible only when the argument in question is optional:

(28) John ate/*dined, but I don't know what.

Whether an argument is optional is specified in the lexicon on a per-item basis.

Because implicit-argument sprouting is lexically governed, type logical grammar makes available an analysis involving product categories: if A and B are syntactic categories, then so is $A \otimes B$, the product of A and B. Products have the logic of (multiplicative) conjunction:

$$\frac{\Sigma[A \cdot B] \vdash C}{\Sigma[A \otimes B] \vdash C} \otimes L \qquad \frac{\Gamma \vdash A \qquad \Delta \vdash B}{\Gamma \cdot \Delta \vdash A \otimes B} \otimes R$$

Product categories are related in an intimate way to the slash categories by the residuation law: $A \vdash C/B$ iff $A \otimes B \vdash C$ iff $B \vdash A\backslash C$.

The logical rules for the product say that when you have something of category $A \otimes B$, it will behave exactly as if you had something of category A followed by something of category B. This enables a single lexeme (say, *eat*) to behave as if it contributed two independent elements into the derivation. Thus we can suppose that the intransitive *eat* has the category $((\mathrm{DP}\backslash \mathrm{S})/\mathrm{DP}) \otimes (\mathrm{S} /\!\!/ (\mathrm{DP}\backslash\!\!\backslash \mathrm{S}))$: it functions as if it were a transitive verb followed by a (silent) quantifier. This gives rise to the following derivation for the sluiced sentence *John ate, but I don't know what*:

$$\dfrac{\dfrac{(\mathrm{John} \cdot (((\mathrm{DP}\backslash \mathrm{S})/\mathrm{DP}) \cdot \mathrm{S} /\!\!/ (\mathrm{DP}\backslash\!\!\backslash \mathrm{S}))) \cdot (\mathrm{bidk} \cdot (\mathrm{what} \cdot \textsc{sluicegap})) \vdash \mathrm{S}}{(\mathrm{John} \cdot ((\mathrm{DP}\backslash \mathrm{S})/\mathrm{DP}) \otimes \mathrm{S} /\!\!/ (\mathrm{DP}\backslash\!\!\backslash \mathrm{S})) \cdot (\mathrm{bidk} \cdot (\mathrm{what} \cdot \textsc{sluicegap})) \vdash \mathrm{S}} \otimes L}{(\mathrm{John} \cdot \mathrm{ate}_{\mathrm{INTR}}) \cdot (\mathrm{bidk} \cdot (\mathrm{what} \cdot \textsc{sluicegap})) \vdash \mathrm{S}} \textsc{lex}$$

The remainder of the proof proceeds exactly as if there had been an overt direct object.

Naturally, just as for conjunction in, say, intuitionistic logic, the semantics for a product category is an ordered pair. In this case, the denotation for the intransitive *eat* will be an ordered pair consisting of the meaning of the transitive *eat* along with the meaning of *something* (roughly, $\lambda P \exists x . P x$).

On the analysis here, once the implicit argument has entered the derivation, there is nothing to prevent it from taking scope just like any overt existential quantifier. This makes good predictions with respect to sluicing, since the scopability analysis here requires the implicit argument to take scope over the rest of the antecedent clause in order to serve as an inner antecedent for sluicing.

(29) a. Everyone ate, but I don't know what.
b. Everyone in the room was reading, but I don't know what.

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To the extent that these sentences imply that there was some particular thing that everyone ate or read, they are consistent with the claims about scoping and sluicing here.

(30) *No one ate, but I don't know what.

Likewise, the ungrammaticality of (30) can be explained by the fact that downward-entailing quantifiers such as *no one* make it difficult or impossible for an indefinite in the verb phrase to take scope over the rest of the antecedent clause.[4]

Note that implicit arguments can be prepositional phrases that require specific prepositions:

(31) a. John was flirting, but I don't know *(with) who.
b. Ralph was astonished, but I don't know *(at) what.
c. Marian was interested, but I don't know *(in) what.

As long as the categories of the intransitive versions of these predicates are $(\text{DP}\backslash\text{S}) \otimes \text{PP}.\textit{with}$, $(\text{DP}\backslash\text{S}) \otimes \text{PP}.\textit{to}$, and $(\text{DP}\backslash\text{S}) \otimes \text{PP}.\textit{in}$, where, for instance, PP.*with* is the syntactic category of a prepositional phrase headed by *with*, we correctly predict not only that the wh-phrase in the sluice must be a prepositional phrase, but which preposition is the right one.

The scope behavior of implicit arguments required for sluicing is somewhat at odds with the typical behavior of implicit arguments. Apart from sluicing, implicit arguments generally take narrowest scope: *Everyone ate* can mean that for each person, there is something that they ate, but usually isn't taken to assert that there is some particular thing that everyone ate. However, it is well known (e.g., Tancredi 1992) that focusing a determiner phrase can enable it to take unusually wide scope. It is hard to imagine focusing an implicit argument, since it is silent. However, as suggested by Sandra Chung (personal communication, 2012/06/08), if we were to assume that sluicing guarantees that the inner antecedent must be in focus, sluicing provides a way to deduce that the implicit argument must be in focus, and therefore can take wide scope. (See additional discussion of focus in Sects. 6 and 7.)

4.5 Argument structure

Distinguishing the analysis of sprouting from the analysis of implicit arguments allows the analysis here to account for the sensitivity of sluicing to variations in argument

[4] A referee points out that Romero (1998, 61ff) and Merchant (2001, p. 227) explain this contrast in a way that maintains the more usual assumption that the implicit indefinite always takes narrow scope with respect to overt quantifiers. Their explanations depend on analyzing (29a) as *Everyone ate, but I don't know what ~~they ate~~*, where *they* is anaphoric to *everyone*. Recall that having different lexical material in the silent sluiced clause compared to the antecedent clause is ok on the PF deletion strategy, as long as the mutual entailment requirement is met. Then the contrast with (30) depends on assuming that downward-entailing quantifiers including *no one* do not in general license plural anaphora. It is easy to find naturally-occuring counterexamples to this claim, for instance: *i will make jokes but no one laughs they just look at me like i'm crazy*, as well as: *No one pays attention—they have preconceived ideas*. But in any case, in addition to the pros and cons of the PF deletion strategy discussed above, I argue against the descriptive adequacy of the mutual entailment requirement in Sect. 6.1.

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structure in the antecedent. CLM (see also Chung 2013; Merchant 2013) observe that antecedents with superficially similar syntax can behave differently in sluices:

(32) a. She served the students, but I don't know what.
b. She served the soup, but I don't know to whom.
c. *She served the soup, but I don't know who.

In each case, the main verb in the antecedent is *served* followed by a DP, yet the sluices distinguish among three distinct cases, depending on whether the DP in the antecedent is interpreted as a direct object or as the goal participant in a double-object construction.

The amount of syntactic information provided by the analysis here is severely limited—merely the syntactic category of the inner antecedent—but in combination with the approach to implicit arguments, this is sufficient to make the needed contrasts. We will need to posit at least two distinct implicit-argument versions of *served*, depending on which argument has been suppressed. One version makes the theme participant implicit: $\lambda x\langle(\lambda y.\textbf{serve}\ y\ x), \textbf{something}\rangle{:}((\text{DP}\backslash\text{S})\otimes\text{DP})/\text{DP}$. The implicit argument is an inanimate DP, which matches the wh-phrase *what*, giving rise to (32a). The other version makes the prepositional indirect object implicit: $\lambda y\langle(\lambda x.\textbf{serve}\ y\ x), \textbf{someone}\rangle{:}((\text{DP}\backslash\text{S})\otimes\text{PP})/\text{DP}$. The implicit argument is a PP, which matches the wh-phrase *to whom*, giving rise to (32b). Note that the semantic values ensure that in both cases the underlying ditransitive verb meaning is applied to the participants in the same order (first the theme, then the goal). Neither of these valence-reduced versions of *served* will participate in a derivation of (32c). In particular, the implicit-goal version of *served* expects an animate PP, which is not compatible with the wh-phrase *who*. So we have accounted for the pattern in (32).

5 Andrews Amalgams: an additional case of resolving ellipsis to a continuation

In the analysis of sluicing offered here, the elided complement of a wh-phrase gets its content from a continuation, that is, from the scope remnant of a DP. The relationship between the sluice gap and its content-providing scope remnant is treated as anaphora. But there are other ways of gaining access to a DP continuation. The most common way is the method that generalized quantifiers such as *everyone* or *most girls* use, that is, by taking scope over it. Could there be a sluice-like ellipsis construction that acquired its gap content directly through scope-taking?

Strangely enough, there is a construction in English that might qualify, what Lakoff calls an Andrews Amalgam (Lakoff 1974; Kluck 2011; Johnson 2012).

(33) a. Sally will eat something today, but I don't know what __.
b. Sally will eat [I don't know what __] today.

In (33a), we have an ordinary sluice, where the inner antecedent is *someone*. The (grammatical) sentence in (33b) has roughly the same meaning, but in the place of *someone* sits an entire clause containing what appears to be a sluiced interrogative. Just as in the normal sluice, (33b) entails that the speaker does not know the answer to the question of what Sally will eat today.

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Providing an analysis for these amalgams is quite challenging on the standard approach, not least of all because it appears to be a case of ellipsis for which there is no obvious antecedent. Strategies for extending the standard formalism include positing a special merge operation that combines two complete clauses, e.g., as in Kluck (2011), or else allowing trees in which nodes have more than one mother, e.g., as in Johnson (2012).

The formalism developed here accounts for Andrews Amalgams without any extension or modification. Let $\mathrm{G} \equiv \mathrm{S}/\!\!/(\mathrm{DP}\backslash\!\!\backslash\mathrm{S})$ abbreviate the category of a scope-taking generalized quantifier, the same category as ordinary quantifiers such as *everyone* or *most girls*. Then we need only allow ourselves a silent proform, written AMALGAM, having syntactic category $\mathrm{G}/\!\!/((\mathrm{DP}\backslash\!\!\backslash\mathrm{S})\backslash\!\!\backslash\mathrm{S})$ and semantic value $\lambda F \lambda P \exists x . Px \wedge (FP)$.

In order to see how this analysis works, it is important to understand how the AMALGAM proform turns the clause in which it is embedded into a generalized quantifier:

$$\dfrac{\dfrac{\dfrac{\dfrac{\mathrm{idk} \cdot (\mathrm{what} \cdot \mathrm{DP}\backslash\!\!\backslash\mathrm{S}) \vdash \mathrm{S}}{\mathrm{DP}\backslash\!\!\backslash\mathrm{S} \circ \lambda x(\mathrm{idk} \cdot (\mathrm{what} \cdot x)) \vdash \mathrm{S}} \equiv}{\lambda x(\mathrm{idk} \cdot (\mathrm{what} \cdot x)) \vdash (\mathrm{DP}\backslash\!\!\backslash\mathrm{S})\backslash\!\!\backslash\mathrm{S}} \backslash\!\!\backslash R \qquad \mathrm{G} \vdash \mathrm{G}}{\mathrm{G}/\!\!/((\mathrm{DP}\backslash\!\!\backslash\mathrm{S})\backslash\!\!\backslash\mathrm{S}) \circ \lambda x(\mathrm{idk} \cdot (\mathrm{what} \cdot x)) \vdash \mathrm{G}} /\!\!/ L}{\mathrm{AMALGAM} \circ \lambda x(\mathrm{idk} \cdot (\mathrm{what} \cdot x)) \vdash \mathrm{G}} \equiv}{\mathrm{idk} \cdot (\mathrm{what} \cdot \mathrm{AMALGAM}) \vdash \mathrm{G}} \equiv$$

Here, 'idk' is short for 'I don't know', and has category S/Q; *what*, as usual, has category $\mathrm{Q}/(\mathrm{DP}\backslash\!\!\backslash\mathrm{S})$. This proof shows that it makes sense for the expression *I don't know what* AMALGAM to function syntactically as if it were a (scope-taking) DP. The Curry–Howard denotation of this generalized quantifier is $\lambda P \exists x . Px \wedge \text{I-don't-know}(\text{what } P)$.

With this lemma in place, it is easy to see how the complete derivation of (48b) will go. Essentially, the synthetic quantifier phrase *I don't know what* AMALGAM takes scope over the rest of the sentence:

$$\dfrac{\dfrac{\dfrac{\lambda y(\mathrm{idk} \cdot (\mathrm{what} \cdot y)) \vdash (\mathrm{DP}\backslash\!\!\backslash\mathrm{S})\backslash\!\!\backslash\mathrm{S} \qquad \mathrm{G} \circ \lambda x(\mathrm{Sally} \cdot (\mathrm{ate} \cdot x)) \vdash \mathrm{S}}{(\mathrm{G}/\!\!/((\mathrm{DP}\backslash\!\!\backslash\mathrm{S})\backslash\!\!\backslash\mathrm{S}) \circ \lambda y(\mathrm{idk} \cdot (\mathrm{what} \cdot y))) \circ \lambda x(\mathrm{Sally} \cdot (\mathrm{ate} \cdot x)) \vdash \mathrm{S}} /\!\!/ L}{(\mathrm{idk} \cdot (\mathrm{what} \cdot \mathrm{AMALGAM})) \circ \lambda x(\mathrm{Sally} \cdot (\mathrm{ate} \cdot x)) \vdash \mathrm{S}} \equiv, \mathrm{LEX}}{\mathrm{Sally} \cdot (\mathrm{ate} \cdot (\mathrm{idk} \cdot (\mathrm{what} \cdot \mathrm{AMALGAM}))) \vdash \mathrm{S}} \equiv$$

The adverbial *today* is omitted to keep the derivation as simple as possible. Reading from the bottom line upward: the first step is to allow the quantifier phrase [*I don't know what* AMALGAM] to take scope over *Sally ate* __. As a result, on the second line from the bottom, we have a generalized quantifier taking scope over a DP remnant—this is the heart of the analysis. The derivation continues by allowing AMALGAM to take scope over the quantifier phrase (third line), then targeting the $/\!\!/$ for elimination, and proceeding upwards in a manner similar to previous derivations.

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Turning to the semantics, the fact that the symbol P occurs twice in the body of the semantic denotation ($\lambda F \lambda P \exists x . Px \wedge (FP)$) is what makes this construction a form of ellipsis: the content of the continuation P is used twice to build the semantic value of the complete sentence. In the Curry–Howard semantics of the derivation just sketched, F corresponds to the function from properties P to the proposition that the speaker doesn't know what has property P; and P corresponds to the property of being something that Sally will eat today. The net result is that (48b) is predicted to mean that there exists something that Sally is going to eat today, and the speaker doesn't know what Sally is going to eat today.

A full exploration of this approach to amalgams must wait for another occasion. Nevertheless, the ease of providing a straightforward syntactic and semantic analysis for amalgams supports using continuations to analyze some forms of ellipsis. Intriguingly, the relationship between scopability and sluicing is even more intimate in amalgams than it is in ordinary sluices, since for amalgams, it is the clause containing the sluice itself that must take scope.

6 A new semantic constraint on sluicing: the Answer Ban

The anaphoric account delivers a complete semantic value for the sluiced clause. What additional semantic restrictions, if any, are necessary?

6.1 Mutual entailment

The PF deletion account relies heavily on imposing a semantic condition of mutual entailment on well-formed sluices. The reason this is necessary is that on the PF deletion account, the sluiced clause position initially contains a freely-generated clause. This freedom is needed in order for the sluiced clause to differ from the antecedent syntactically, for instance, to give rise to what we have been calling sprouting. But in order for that randomly-generated clause to be a candidate for deletion, it must semantically resemble the antecedent to a high degree.

More specifically, building on work of Rooth (1992), Schwarzschild (1999), Romero (1998) and Merchant (2001) proposes that a sluice will be well-formed only if the focus-closures of the antecedent clause and the sluice entail each other. To compute the focus-closure of an expression, replace each expression in focus with a variable, and then give an existential quantifier binding that variable scope over the rest of the expression. Simplifying considerably, we can assume here that wh-phrases (along with their traces) automatically count as being in focus. For instance:[5]

[5] Note that examples such as those in (34) show that although the traditional sluicing examples involve inner antecedents that are indefinite, it is perfectly possible for an inner antecedent to be definite, or, as (34d) shows, even quantificational. See Sect. 5.3 for an explanation for the required presence of *else* or *other*.

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(34) a. I know that [John left], but I don't know [who else ~~left~~].
b. Mary has dined at Masa, and I don't know where else.
c. John liked the collards, but I don't know which other vegetables.
d. Mary tasted each hot dish, and I don't know what else.

Establishing mutual entailment in (34a) involves checking that the focus closure of the sluice, namely, $\exists x.\mathbf{left}\ x$ entails the focus closure of the antecedent clause. Merchant (2001, p. 35) must assume that the inner antecedent is always focussed; this assumption is not obviously wrong. Then for (34a), the antecedent clause is $[[\text{John}]_F$ left], whose focus-closure is $\exists x.\mathbf{left}\ x$, and we have mutual entailment, as desired.

Although Chung (2013) adopts Merchant's mutual entailment requirement as part of her own account, she argues, building on Chung (2006), that it is not a sufficient condition. In particular, if you assume that active sentences and their passives counterparts are truth-conditionally equivalent, you incorrectly predict that sluices should be able to differ from their antecedents in voice:

(35) a. Kelly was murdered, but we don't know who *(murdered her).
b. Someone paid Mary, but we don't know by whom *(she was paid).

In general, voice mismatches are not allowed in sluices. Merchant (2013) advocates imposing some kind of syntactic identity requirement between the antecedent and the deleted clause, where clauses that differ in voice fail to be identical in the relevant sense.

On the account here, (35a) is correctly predicted to be ungrammatical for the simple reason that there is no suitable inner antecedent. The version of the passive *murdered* that takes an overt agent requires an agentive *by* preposition, which is not present; and we can't sprout an agent, since that would constitute sprouting an argument rather than a modifier. Similar remarks apply to (35b).

For a separate challenge to mutual entailment, note that truth conditions are not sufficient to distinguish among different tautologies:

(36) Some numbers are even or odd, but I'm not going to tell you which numbers (are prime or not prime).

If mutual entailment is the only constraint on the content of the sluiced clause, we would incorrectly predict that it should be possible to interpret the sluiced version of (36) as meaning the same thing as the unsluiced version: since the proposition that some numbers are even or odd is a tautology, and since the proposition that some numbers are either prime or not prime is also a tautology, we have perfect mutual entailment. This shows that simple mutual entailment is too coarse-grained to identify the appropriate kind of semantic equivalence. On the anaphoric approach here, in contrast, the only suitable antecedent for the sluiced version of (36) is the property of being even or odd, so we correctly predict that the only possible meaning for the sluiced version involves only the issue of which numbers are even or odd.

Note that the net effect of the mutual entailment requirement is that once we subtract the inner antecedent from the antecedent clause, and once we subtract the wh-phrase from the sluice, the remainders must be semantically equivalent—exactly what is guaranteed by the anaphoric analysis.

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Thus the motivation for having a mutual entailment relation melts away under an anaphoric analysis. After all, on the anaphoric account, the meaning of the sluice is entirely determined by the content of the antecedent, so there is no room for straying from the correct interpretation. Furthermore, the strategy for sprouting guarantees that the derivation with the extra sprouting in the antecedent is (provably!) logically equivalent to the unsprouted antecedent, so we don't have to worry about sprouting giving rise to unwanted non-equivalence. In every situation in which the mutual entailment requirement appears to be in force, the equivalence of the antecedent with the focus existential closure of the sluice is a theorem of the anaphoric system.

6.2 Sluice/antecedent mismatches

So far, apart from sprouting, the sluiced clause has closely resembled the antecedent clause in just about every way that remains detectable, including case marking, argument structure, and voice. However, there are examples (Merchant 2001, p. 22) that suggest that the sluice cannot always be a simple copy of the antecedent clause.

(37) John remembers meeting someone, but he doesn't remember who ~~he met~~.

The antecedent clause here is a gerundive clause with a silent PRO subject, but the unsluiced embedded question that most closely conveys the meaning of (37) must have a tensed gapped clause with an overt subject.

Chung (2013), following Merchant (2001), suggests that such facts motivate an account of sluicing that is partly semantic, since we clearly can't impose a requirement of simple syntactic identity. However, it is not clear that examples like (37) satisfy the mutual entailment restriction:

(38) a. John remembers meeting someone.
b. John remembers that he met someone.

Only (38b) entails that a meeting took place, since (38a) can be true even if John is misremembering. To emphasize the difference in meaning between the gerundive clause and a tensed one, in the gerundive in (38a), John remembers the experience of the event from the inside, as it were. In contrast, (38b) can be true if he merely believes a report about an event he no longer directly remembers. Along the same lines, (38a) requires that John remember the event in the de se way, with awareness that he is one of the participants in the meeting event; in (38b), John can remember a fact about a meeting that he (incorrectly) believes involved two people other than himself.

If GER is the syntactic category of a gerundive clause, then we have a syntactic mismatch between the sluicing antecedent on the one hand, which has category $\text{DP}\backslash\text{GER}$ (a gerundive phrase missing a DP somewhere inside of it), and the sluice gap site on the other, which must combine with a wh-phrase that is expecting a gapped tensed clause, category $\text{DP}\backslash\text{S}$. But in the same way that the parasitic scope analysis of anaphora can enforce fine-grained agreement requirements such as the case matching requirement discussed above in Sect. 2.3, it can explicitly allow syntactic mismatches. That is, we can suppose that in addition to ordinary sluicegaps of the form $(\text{DP}\backslash\text{S})^{(\text{DP}\backslash\text{S})}$,

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we can have $(\text{DP}\backslash\text{S})^{(\text{DP}\backslash\backslash\text{GER})}$ instead: something that takes a gapped gerundive as an antecedent, and supplies a meaning suitable for a gapped tensed clause.

This kind of mismatched syntax will only lead to a coherent overall analysis if it is possible to give a semantic value that will convert the gerundive meaning to a tensed-clause meaning. But this is feasible, and would involve instantiating an abstract gerundive event type with a concrete event located in time and space.

6.3 The answer ban

In view of the preceding discussion, we have some reason to suspect that mutual entailment is neither necessary nor sufficient.

We should therefore consider other semantic constraints on sluicing. AnderBois (2010) argues that sluices are anaphoric to issues, in the sense of Inquisitive Semantics (e.g., Groenendijk and Roelofsen 2009; Mascarenhas 2009). More specifically, AnderBois (2010) argues that the antecedent must raise an issue, that is, have inquisitive content, and the sluiced interrogative must raise the same issue. In Inquisitive Semantics, questions, indefinites, disjunctions, and existential modals all give rise to inquisitive content. This correctly predicts that disjunctions can serve as inner antecedents, just like indefinites can:

(39) a. Someone left, but I don't know who.
b. John or Mary left, but I don't know which one.

Clearly, licensing a sluice cannot be a purely semantic matter, in view of the case matching effects discussed above. But even on purely semantic grounds, the simple form of the anaphora-to-issues theory both overgenerates and undergenerates:

(40) a. John will leave or John won't leave, but I don't know which (one).
b. *John might leave, but I don't know which (one).

On the inquisitive-semantics account of Ciardelli et al. (2009), *might* raises the same issue as the disjunctive antecedent in (40a).[6] Yet the sentence with the modal does not license sluicing.

More seriously, on the side of undergeneration, sprouting should not be possible on a pure Inquisitive Semantics approach, since it is far from clear how an antecedent such as *John left* raises the issue of when John left. That is what would be required to license a sprouting case such as *John left, but I don't know when*. And in fact, one and the same antecedent would have to give rise to an unbounded number of potential issues; for instance, in order to license the sluice *who else* in (34a), *John left* would have to also give rise to the issue of who else besides John left.

Given these challenges to at least the simple version of the anaphora-to-issues theory, I will suggest that there is an independent semantic constraint at work in sluicing.

[6] Unfortunately, I don't provide in this paper a formal analysis of how sluicing works when the antecedent involves disjoined clauses.

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It is inspired by AnderBois' approach, but different from it.[7] In particular, it does not require that the antecedent raise an issue:

(41) **The Answer Ban**: the antecedent clause must not resolve, or even partially resolve, the issue raised by the sluiced interrogative.

Some examples will illustrate:

(42) a. #John left but I don't know who.
b. John left but I don't know who else.

In (42a), the interrogative raises the issue of who left. But the antecedent entails that John left, which settles (or at least partially settles) the issue. In (42b), however, the fact that John left does not settle the issue of who else left, and the sluice is fine.

(43) a. #John or Mary left, but I don't know who.
b. John or Mary left, but I don't know which one.

In (43a), the issue is once again who left. The proposition that John or Mary left does not completely settle the issue, but it does partially resolve the issue, since it rules out possibilities in which neither John nor Mary left. But in (43b), the issue raised by the interrogative involves only a finite set of alternatives; as long as we take that set to contain exactly two alternatives involving John and Mary, then the proposition that John or Mary left does not resolve the issue raised by the interrogative, and the sluice is perfectly fine.

I should hasten to point out that there is a well-known class of cases in which a sluice antecedent appears to partially resolve the sluice.

(44) John met a woman, but I don't know who __.

If the issue raised by the sluiced clause were exactly the question denoted by the interrogative *who John met*, then the set of possible answers would involve both men and women. But (44) is interpreted as asserting the more specific claim that the speaker doesn't know which woman John met. CLM call this effect Merger, and in their account, both the inner antecedent and wh-phrase impose semantic restrictions on one and the same variable in LF. On the face of it, Merger examples appear to be inconsistent with spirit of the answer ban, since the proposition that John met a woman is a partial answer to the question of who John met.

However, this conclusion only goes through if we assume that the issue raised by the sluice is identical with the denotation of the sluiced clause. This can't be right in general for any theory of questions: a use of the interrogative *who John met* typically does not ask for a complete specification of all the people John has ever met. Rather, it is limited in the familiar (if still mysterious) way that domain narrowing usually works. The net effect is that the question is interpreted as asking who John met out of some salient group of candidates that are relevant for some conversational purpose. If

[7] In recent work still under development, Barros (2013) argues that the Answer Ban proposed here can be derived from AnderBois' anaphora-to-an-issue theory under a certain set of assumptions, though as of this writing, I have not seen explanations of the behavior of modals or of sprouting.

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the speaker of (1) takes it for granted that the person John met was a woman, then the issue raised by the interrogative is the question of who John met from among the set of relevant women, an issue that is compatible with the answer ban.

Why would a grammar impose an answer ban? It is easy to understand the prohibition against re-raising a previously resolved issue in simple cases: it is incoherent to draw attention to the issue of who left if you already know who left. Addressing similar facts, Dayal and Schwarzschild (2010) point out that we shouldn't be surprised to discover that a sluice is infelicitous if the unsluiced discourse is infelicitous in the same way (#*John left, but I don't know who left*). But a coherence requirement fails to account for more complex situations:

(45) *Mary knows that John left, but Bill doesn't know who.

In (45), although Mary's knowledge settles the issue of who left, the issue can remain completely unresolved in Bill's mind; nevertheless, the sluice is degraded (though see discussion of focus immediately below). Note that (45) satisfies the mutual entailment requirement, so that won't help us here. The answer ban as stated in (41), however, depends only on the content of the antecedent clause *John left* and the sluice, and does not depend on anyone's epistemic state, so (45) is correctly predicted to be infelicitous.

6.4 The answer ban versus general constraints on ellipsis and focus

I have suggested that the answer ban may be a grammaticization of an obvious constraint on efficient discourse ("don't raise an issue that has already been addressed"). It is possible, of course, that the answer ban does not need to be stipulated, and follows from independently needed principles. In fact, Romero (1998) argues that limitations on the relationship between the wh-phrase and the inner antecedent fall out from general constraints on ellipsis (e.g., Rooth 1992) combined with general constraints on focus (e.g., Schwarzschild 1999). In particular, Romero (1998, p. 41) predicts that if a clause containing the sluicing antecedent entails the complete answer to the question asked by the sluice, the sluiced clause is GIVEN in the sense of Schwarzschild (1999), and cannot be put in focus, upon pain of violating Schwarzschild's Avoid F constraint. This correctly predicts, for instance, that **John left, but I don't know WHO$_F$ __* is ungrammatical with the wh-phrase in focus.

The unfocusability explanation depends on the antecedent providing a complete answer to the sluiced question. If the antecedent provides only a partial answer, as in (43a), the sluice is not GIVEN and should therefore be compatible with bearing prominence. To the extent that (43a) is infelicitous (as marked), then, the unfocusability approach needs to be supplemented with some additional constraint such as the answer ban.

The assumptions defended in Romero (1998, pp. 27–28) also predict that it should be possible to rescue a sluice from unfocusability by shifting focus outside the sluiced clause. On the hypothesis that sluices are subject to the same conditions on ellipsis and focus as verb phrase "deaccenting" (i.e., absence of phonological prominence), a sluice should be possible just in case its unsluiced version can be deaccented.

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(46) MARY knows that John left, but BILL DOESn't know who left.

In (46), prominence on Bill and on the negated auxiliary allows the GIVEN material *know who left* to be deaccented. This means there is a way of pronouncing the sluice in (45) on which all constraints on ellipsis and focus marking are satisfied; yet there does not appear to be any way of intoning (45) on which it is grammatical. The explanation suggested here is that even though (45) can be reconciled with constraints on ellipsis and focus, it is still in violation of the answer ban.

A second example supports the conclusion that the answer ban is needed independently of conditions on ellipsis and focus:

(47) a. After Ann noticed that someone had left, Carl told her who.
b. After Ann noticed that Bill had left, Carl TOLD her who left.
c. *After Ann noticed that Bill had left, Carl TOLD her who.

In (47a), a sluice is grammatical if the inner antecedent is indefinite. If the indefinite is replaced with a name as in the unsluiced example in (47b), it is possible to deaccent the GIVEN material *who left*. Yet the parallel sluice attempt in (47c) remains ungrammatical. According to the answer ban, there is something wrong with (47c) that goes beyond ellipsis licensing and focus structure, namely, the antecedent answers the very question raised by the sluiced interrogative.

We do not need to resolve this debate here. Whether constraints on the inner antecedent fall out from general constraints on ellipsis and focus, or whether there is in addition an answer ban, all that matters for the main argument is that the relevant constraints are independent of the compositional machinery that determines the content of the sluice gap. If so, we do not need to build constraints on possible inner antecedents into the grammatical mechanism in the way that the theories of CLM and of Jäger do: in those theories, the inner antecedent must be indefinite in order for the compositional mechanisms to work correctly. Like the answer ban proposed here, the reduction to general ellipsis strategy advocated in Romero (1998) explicitly refrains from placing any restrictions on the inner antecedent, as long as the overall configuration conforms to global discourse constraints. So either explanatory strategy is compatible with the main claim in this paper, namely, that sluicing is anaphora to a scope remnant.

7 Issues and conclusions

7.1 Scope, or focus?

Whatever the relationship between the inner antecedent and the rest of the antecedent clause, the fact that sluices are insensitive to syntactic islands argues that the relationship is not syntactic movability. But that does not mean that the relationship can only be scopability.

(48) I know that [John left], but I don't know who else __. (= (34a))

For instance, in (48), the proper name *John* must take scope in order for the account here to derive the sluice. In most frameworks, proper names do not undergo Quantifier

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Raising, and do not take scope, since it usually makes no difference to the semantic result whether a proper name is raised or not (proper names are in this sense 'scope-less'). So although scoping a proper name is usually unnecessary, it is also harmless, and in the present context, scoping names is crucially needed to form a suitable sluicing antecedent.

One alternative strategy that I will mention, but cannot explore in detail here, is that the relevant operation is not exactly scope-taking, but a more general kind of focussing. Then the structural rule giving in Sect. 2 would not be taken to exclusively express scope-taking, but a more general operation of articulating an expression into a foreground and a background. If so, taking scope is just one way of being in focus in a phrase. This view is explicit in the treatment of scope-taking in Barker and Shan (2006). The idea that sluicing requires not only the wh-phrase, but also the inner antecedent, to be in focus is explicit to various degrees in Romero (1998), Merchant (2001), Potsdam (2007), and especially in Baltin (2010), where sluicing is supposed to involve deletion of the complement of a Focus projection.

Whether it is better to think of what is going on as scope-taking, as I have supposed here, or some more general kind of focus operation, I take it that either conception is compatible with the formal implementation.

7.2 Constraining scope-taking

Like every theory of scope-taking, much work remains to be done to constrain scope-taking in the proposed framework. Specifically with regard to potential overgeneration of sluicing interpretations, a referee provides the following puzzle:

(49) a. John denied that he fired someone, but I don't know who.

b. $\lambda x(\text{he} \cdot (\text{fired} \cdot x))$
$\circ\lambda y((\text{someone} \circ \lambda z(\text{John} \cdot (\text{denied} \cdot (z \circ y)))) \cdot (bidk \cdot (\text{who} \cdot \text{SLUICEGAP}))) \vdash \text{S}$

c. ?'There is someone that John denied that he fired, but I don't know who ~~he fired~~.'

There is a derivation including the sequent in (49b) on which *someone* first takes scope over *he fired* __, packaging this gapped clause as a continuation ready to serve as the antecedent for the sluicegap. But nothing in the formal system prevents *someone* from taking scope again, this time over *John denied that he fired* __, leading to the truth conditions paraphrased in (49c).

In this particular example, it is not clear that we should rule out this derivation. Not every sluice interpretation will be a coherent thing to say; it only makes sense to express ignorance of who John fired if there is reason to believe that there is someone that he fired. We can control for this factor by inserting the word *falsely*: in *John falsely denied that he fired someone, and I'm going to find out who ~~John fired~~*, it is tempting to accept the derivation sketched in (49) as giving a legitimate reading of the sentence.

Nevertheless, the referee's point is well-taken. If we decide that the derivation in (49) should be blocked, we could fine-tune the structural inference rule given in Sect. 2 so as to make the left argument of the $\circ$ structural operator a scope island. On a technical level, this can be done by constraining what counts as a well-formed gapped structure. In practical terms, this would amount to forbidding a structural variable

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from appearing as the left argument to $\circ$, as z does in (49b). The net effect would be to rule out double-hopping by a scope-taking element. But what is really needed, of course, is an explanatory, comprehensive theory of limitations on scope-taking.

7.3 Remaining puzzles

There are many puzzles associated with sluicing that have not been addressed here, but that do not necessarily create insurmountable difficulties.

For instance, Merchant's (2001, p. 92) P-stranding generalization says that if a language does not allow wh-movement to strand a preposition, it also does not allow taking the DP object of a preposition as the inner antecedent. This is not problematic on the account here, as long as prepositions in such languages require a syntactic feature on the category of prepositional objects. Then any attempt to take such a DP as the inner antecedent for a sluice will cause the sluicegap to faithfully reproduce the syntactic feature. It is an easy matter for a grammar to disallow interrogatives whose wh-phrases have a particular syntactic feature. In other words, the limited syntactic information provided by the category of the sluicegap (essentially, just the syntactic category of the inner antecedent) is sufficient to enforce the P-stranding generalization.

Likewise, if a language does allow preposition stranding, the preposition can sometimes follow the wh-phrase in a sluice ('swiping'), as in *John arrived, but I don't know where from*. Larson (2012) suggest that swiping arises from the possibility that prepositional phrases can sometimes undergo extraposition. On Merchant's (2002) analysis, swiping involves inversion entirely inside the PP. As far as I can tell, either of these approaches is compatible with the analysis proposed here.

There are also semantic challenges that remain unresolved here. To mention just one, sluices can at least sometimes give rise to pair-list readings:

(50) Everyone contributed something, but I don't know what.

On the simplest version of the scopability hypothesis, (50) should force *something* to take wide scope over *everyone*, in which case there is one thing that each person contributed. But in addition to that interpretation, there is a pair-list reading: Mary contributed a book, John contributed a record, and so on. Investigating this issue, however, would require talking about domain restriction and functional indefinites; see Szabolcsi (1997, 2010) for some of the complexities of pair-list readings in general, and Romero (1998) for extensive discussion of pair list-readings of sluiced sentences. My (perhaps optimistic) assumption is that whatever enables pair-list readings will be compatible with the basic infrastructure established to handle the core examples.

7.4 Main points

I have proposed an explicit account of sluicing on which the ellipsis site is anaphoric to an anti-constituent, i.e., to a continuation. On the formal analysis, the antecedent is

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created by allowing the inner antecedent to take scope over the rest of the antecedent clause (or perhaps instead undergoing a kind of focussing operation).

This immediately explains why the inner antecedent must take scope over the rest of the antecedent clause. It also explains why situations in which the inner antecedent is blocked from taking wide scope bleeds sluicing.

If empty antecedents are allowed, the logical inference rules freely allow sprouting of adjuncts. In contrast, sluices that target implicit arguments must be lexically licensed by a product category.

Given an anaphoric treatment, there is no need for a semantic restriction of mutual entailment, since the semantic value is guaranteed to be appropriately similar to the antecedent clause by virtue of the anaphoric connection. There does, however, appear to be an independent constraint on the semantics of sluicing, namely, the Answer Ban, which says that the antecedent clause must not even partially resolve the issue raised by the sluiced interrogative.

The formal implementation given here relies heavily on silent elements, both in the case of silent proforms in the gap position, and empty antecedents in the analysis of sprouting. However, there is no sense in which these silent elements have internal syntactic structure: there is no syntax in the silence, contra Merchant (2001, 2013), CLM, and Chung (2012).

The analysis immediately accounts for Andrews Amalgams, a construction that is highly challenging for other approaches. The proposal is that amalgams are a type of ellipsis that depends on continuations and on scope-taking, but not on anaphora.

The key element in the analyses of sluicing and amalgams, namely, continuations, are motivated independently in order to account for in-situ (i.e., covert) scope-taking. In order to provide an account of sluicing we need only suppose that proforms can take continuations as an antecedent. To the extent this approach is viable, it provides additional evidence that continuations are an essential element in a complete account of natural language.

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References

AnderBois, S. (2010). Sluicing as anaphora to issues. *SALT, 20*, 428–450.
Baltin, M. (2010). The unreality of doubly-filled COMPs. *Linguistic Inquiry, 41*(2), 331–335.
Barker, C. (2002). Continuations and the nature of quantification. *Natural Language Semantics, 10*(3), 211–242.
Barker, C. (2007). Parasitic scope. *Linguistics and Philosophy, 30*(4), 407–444.
Barker, C., & Shan, C.-c. (2006). Types as graphs: Continuations in type-logical grammar. *Journal of Logic, Language, and Information, 15*(4), 331–370.
Barker, C., & Shan, C.-c. (2008). Donkey anaphora is in-scope binding. *Semantics and Pragmatics, 1*(1), 1–42. doi:10.3765/sp.1.1.
Barros, M. (2013). On sluicing and admissible inner-antecedent/Wh-correlate pairs. Ms., Rutgers University.
Büring, D. (2004). Crossover situations. *Natural Language Semantics, 12*(1), 23–62.

Journal: 10988 Article No.: 9137 TYPESET DISK LE CP Disp.:2013/7/19 Pages: 37 Layout: Small-X

Chung, S. (2006). Sluicing and the lexicon: The point of no return. In R. Cover & Y. Kim (Eds.), *BLS 31* (pp. 73–91). Berkeley, CA: Department of Linguistics, University of California, Berkeley.

Chung, S. (2013). Syntactic identity in sluicing: How much, and why. *Linguistic Inquiry, 44*(1), 1–44.

Chung, S., Ladusaw, W. A., & McCloskey, J. (1995). Sluicing and LF. *Natural Language Semantics, 3*, 239–282.

Chung, S., Ladusaw, W. A., & McCloskey, J. (2011). Sluicing(:) between structure and inference. Ms. http://ohlone.ucsc.edu/jim/PDF/chung-ladusaw-mccloskey-2011.pdf.

Ciardelli, I., Groenendijk, J., & Roelofsen, F. (2009). Information, issues, and attention. *SALT*. (A revised version is available on-line.)

Dalrymple, M., Shieber, S. M., & Pereira, F. C. N. (1991). Ellipsis and higher order unification. *Linguistics and Philosophy 14*(4), 399–452.

Dayal, V., & Schwarzschild, R. (2010). Definite inner antecedents and Wh-correlates in sluices. In P. Starverov, D. Altshuler, A. Braver, C. Fasola, & S. Murray (Eds.), *Rutgers working papers in linguistics* (Vol. 3, pp. 92–114). New Brunswick, NJ: LGSA.

Groenendijk, J., & Roelofsen, F. (2009). Inquisitive semantics and pragmatics. In J. M. Larrazabal & L. Zubeldia (Eds.), *Meaning, content and argument, Proceedings of the ILCLI international workshop on semantics, pragmatics and rhetoric* (pp. 41–72). Leioa: University of the Basque Country Publication Service.

Jäger, G. (2001). *Indefinites and sluicing*. Amsterdam: Colloquium.

Jäger, G. (2005). *Anaphora in TLG*. Dordrecht: Springer.

Johnson, K. (2012). Recoverability of deletion. In K. Nasukawa & H. C. van Riemsdijk (Eds.), *Identity relations in grammar*. Studies in generative grammar series. Berlin: Mouton de Gruyter.

Kennedy, C., & Stanley, J. (2009). On 'average'. *Mind, 118*, 583–646.

Kluck, M. (2011). *Sentence amalgamation*. Groningen: Landelijke Onderzoeckschool Taalwetenschap.

Kubota, Y., & Levine, R. (2013). Against ellipsis: Arguments for the direct licensing of non-canonical coordinations. Ms., University of Tokyo, Ohio State University.

Lakoff, G. (1974). Syntactic amalgams. In M. Galy, R. Fox, & A. Bruck (Eds.), *Papers from the 10th regional meeting of the Chicago Linguistic Society* (pp. 321–344). Chicago: CLS.

Larson, B. (2012). Swiping and decomposed merge. UMD manuscript.

Mascarenhas, S. (2009). *Inquisitive semantics and logic*. MSc in logic thesis. Amsterdam: Institute for Logic, Language and Computation.

Merchant, J. (2001). *The syntax of silence*. Oxford: OUP.

Merchant, J. (2002). Swiping in Germanic. In C. J.-W. Zwart & W. Abraham (Eds.), *Studies in comparative Germanic syntax* (pp. 295–321). Amsterdam: John Benjamins.

Merchant, J. (2013). Voice and ellipsis. *Linguistic Inquiry, 44*(1), 77–108.

Moortgat, M. (1997). Categorial type logics. In J. van Benthem & A. ter Meulen (Eds.), *Handbook of logic and language*. Amsterdam/Cambridge, MA: Elsevier/MIT.

Morrill, G., Fadda, M., & Valentın, O. (2007). Nondeterministic discontinuous Lambek calculus. In *Proceedings of the seventh international workshop on computational semantics, IWCS7*. Tilburg.

Potsdam, E. (2007). Malagasy sluicing and its consequences for the identity requirement on ellipsis. *Natural Language and Linguistic Theory, 25*, 577–613.

Romero, M. (1998). *Focus and reconstruction effects in wh-phrases*. Doctoral dissertation, University of Massachusetts, Amherst.

Rooth, M. (1992). Ellipsis redundancy and reduction redundancy. In S. Berman & A. Hestvik (Eds.), *Proceedings of the Stuttgart ellipsis workshop*, Stuttgart.

Ross, J. R. (1969). Guess who? In R. I. Binnick, A. Davison, G. M. Green, & J. L. Morgan (Eds.), *Papers from the fifth regional meeting of the Chicago Linguistic Society* (pp. 252–286). Chicago: Chicago Linguistic Society. (Reprinted from *Sluicing: Cross-linguistic perspectives*, by J. Merchant & A. Simpson, Eds., pp. 14–39, Oxford, Oxford University Press.

Schwarzschild, R. (1999). GIVENness, avoid F and other constraints on the placement of accent. *Natural Language Semantics, 7*(2), 141–177.

Shan, C.-c., & Barker, C. (2006). Explaining crossover and superiority as left-to-right evaluation. *Linguistics and Philosophy, 29*(1), 91–134.

Szabolcsi, A. (1997). Quantifiers in pair-list readings. In A. Szabolcsi (Ed.), *Ways of scope taking* (pp. 311–347). Dordrecht: Kluwer.

Szabolcsi, A. (2010). *Quantification*. Cambridge: Cambridge University Press.

Journal: 10988 Article No.: 9137 TYPESET DISK LE CP Disp.:2013/7/19 Pages: 37 Layout: Small-X

1175 Szabolcsi, A. (2012). Compositionality without word boundaries: (The) more and (the) most. In A.
1176 Chereches (Ed.), *Proceedings of the 22nd semantics and linguistic theory conference* (pp. 1–25).
1177 Ithaca, NY: CLC.
1178 Tancredi, C. (1992). *Deletion, deaccenting and presupposition*. Doctoral Dissertation, Massachusetts
1179 Institute of Technology, Cambridge.

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