Nothing else for *something else*: A variable-free account

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1. Introduction

Implicit variables (Mitchell 1986, Partee 1989) are variables that can be bound but that do not have overt syntactic forms. For example, the words *local* and *enemy* in (1a) and (1b) are most naturally understood as 'local for *him/her*' and 'enemy for *him/her*', respectively, with the subject quantifiers binding the hidden pronouns.

(1) a. Every sports fan in the country was at a *local* bar watching the playoffs.
b. Every participant had to confront and defeat an *enemy*. (Partee 1989)

The proper treatment of implicit variables is a controversial issue in contemporary formal semantics, as it directly pertains to one of the central questions currently under extensive debate: the need for an abstract, intermediate representation for semantics. Some authors (e.g. Stanley (2000) and Culicover and Jackendoff (1995)) have argued that the existence of expressions containing implicit variables provides evidence for assuming variables in abstract semantic representations such as LF. Such an argument, if valid, would seriously undermine non-representational theories such as Jacobson's (1999) Variable-Free Semantics (VFS), which admits *neither* abstract semantic representations *nor* variables. Thus, in order to test the empirical viability of VFS and thereby elucidate the larger theoretical issue, working out a full-fledged analysis of implicit variables in VFS is an urgent task.

The goal of this paper is to develop just such an analysis, focusing on the expression *(something) else*. As noted by Culicover and Jackendoff (1995), this expression exhibits parallel behaviors with overt anaphoric expressions in a wide range of contexts and is thus ideal for our purposes. As we will see below, an analysis of *else* in VFS is quite straightforward, and, moreover, turns out to be more successful than alternative LF-based (i.e. representational) treatments both empirically and theoretically.

2. Data

Culicover and Jackendoff (1995) (henceforth C&J) noted that the word *else* behaves as if it contained a pronoun in that it exhibits various kinds of anaphoric dependencies that parallel the interpretations of overt pronouns. Following the standard terminology in the literature, we call such hidden pronouns *implicit variables*. [1]

[1] For convenience, throughout this paper we loosely talk in terms of 'variables', '(variable) binding', some expression 'contain(ing) an implicit variable', etc., when describing empirical patterns.

First, the examples in (2) show that, just like overt pronouns, the implicit variable in *someone else* can take a discourse antecedent. [2]

(2) a. John met Bill$_i$. Mary met *him*$_i$.

b. John met Bill$_i$. Mary met *someone else*$_{j\neq i}$.

The second sentence in (2b) is understood as asserting the disjointness of the person that Mary met and the previously mentioned (and thus salient) individual Bill. Second, just like ordinary pronouns, implicit variables in *else* can be bound by quantifiers, as shown in (3):

(3) a. Every American$_i$ boy loves *himself*$_i$.

b. Every American$_i$ loves *someone else*$_{j\neq i}$.

Unlike (2b), the interpretation of (3b) (on the relevant reading) does not depend on any antecedent in the discourse. Rather, the sentence asserts the disjointness of the lover and the loved for each loving pair where the lover is an American. Again, this behavior is parallel to the interpretation of pronouns in sentences like (3a).

Pronouns are known to exhibit the so-called *paycheck readings* (Karttunen 1969). Specifically, *it* in (4) allows for a construal that can be paraphrased by a definite description containing a hidden bound pronoun, i.e., '*his* paycheck'.

(4) John$_i$ spent his$_i$ paycheck on food but Bill$_j$ spent *it* (= his$_j$ paycheck) on clothes.

C&J note that the paycheck reading is also available for implicit variables in *else*. The following sentence exemplifies this point:

(5) Every Englishman$_i$ loves his$_i$ daughter, but every American$_j$ loves *someone else*$_{k\neq \textbf{daughter-of}(j)}$.

Here, *someone else* can be understood as 'someone other than *his/her* (own) daughter' with the bound-variable reading of 'his/her'. The point is that, in order to accurately paraphrase the relevant reading, the hidden complement of *else* needs to be paraphrased by a complex expression which itself contains a bound variable (rather than just by a simple bound variable).

So far, the data uniformly point to a strict parallel between the behaviors of ordinary pronouns and *else.* However, it turns out that the parallel is not quite complete—there are certain cases in which *else* does not behave like any overt anaphoric expression. Interestingly, though, the way in which the implicit variable in *else* diverges from overt anaphoric expressions is itself systematic in a certain

This should not be taken to indicate any commitment to any theoretical standpoint. In fact, the actual analysis in Variable-Free Semantics that we propose in section 4 entirely does away with variables and variable binding.

[2]The notation $j \neq i$ in (2) (and similar notations throughout) is meant to indicate the disjointness of the 'someone' in question (j) and its 'antecedent' (i). Like other uses of indices, this is just a notational device.

sense: in all of the non-parallel cases, the implicit variable in *else* invariably exhibits a *freer* distribution than its overt counterparts. At an intuitive level, this should make sense: by definition, an implicit variable is a variable that is devoid of syntactic form. But then, it is natural to expect that the distribution of such an expression would not be constrained by any overt morpho-syntactic properties (such as the singular vs. plural number distinction).

The first such case comes from the neutralization of the singular vs. plural number distinction with *else*. The overt third person pronoun has different singular (*he*, *she*, *it*) and plural (*they*) forms, but *else* does not morphologically encode the equivalent distinction for its implicit variable (that is, there is no 'plural' form **elses* which would mean 'other than them/themselves'). But semantically, the implicit variable can be either singular (as in the examples that we have seen above) or plural, as in the following 'split antecedent' example from C&J:

(6) John$_i$ told Mary$_j$ that someone else$_{k\neq i+j}$ was going to be asked to do that work. (C&J:254)

An example like (7), which involves quantificational antecedents, more clearly shows that we really need some way of handling split antecedence, rather than just discourse anaphora to a plural entity:

(7) (Context: *Every instructor for Ling 201 is a male and teaches three sections of that course. For each section, there is a unique female TA who is responsible for recitation sessions. Students are allowed to talk about homework assignments with only the instructor whose lectures they are attending or the TA whose recitation sessions they are attending. Since this rule is somewhat confusing, the department asked every instructor to make sure that the policy be known to every student clearly and unambiguously.*)
Every instructor$_i$ made sure that every TA$_j$ communicated clearly to the students that they can talk with either him$_i$ or her$_j$ about questions they have on homework assignments but that they are not allowed to discuss homework assignments with anyone else$_{k\neq i+j}$.

Second, the distinction between entity and kind anaphora (which is morphologically encoded in the distinction between *it* and *one* in overt anaphoric expressions) is also neutralized with *else*. Consequently, examples like (8) are ambiguous between two readings paraphrased along the lines in (9), as noted by C&J: [3]

(8) John saw a red balloon, but Bill saw *something else*. (C&J:257)

(9) a. Bill saw something other than *the balloon that John saw*. (entity anaphora)

[3]Of the two readings, the entity anaphora reading is more difficult to obtain. This can be explained in terms of a Gricean quantity implicature. That is, the only situation in which (9a) can be true without (9b) being true is when Bill saw some other red balloon. But if so—the hearer infers—and if the speaker knew that that was the case, s/he should have used the less ambiguous expression *another red balloon* instead of uttering (8). But then, what the speaker must have meant by uttering (8) can only be what (9b) means. Thus, practically, a situation would never arise where (8) would be used to convey anything other than (9b).

b. Bill saw something other than *a red balloon*. (kind anaphora)

With overt anaphoric expressions, distinct forms are responsible for entity and kind anaphora and thus this kind of ambiguity is not observed:

(10) a. John saw a red balloon, and Bill saw *it*, too. (entity anaphora)

b. John saw a red balloon, and Bill saw *one*, too. (kind anaphora)

Again, the fact that (8) is ambiguous unlike its overt counterparts in (10) is not surprising given that the distinction between *it* and *one* necessarily fails to manifest itself in the case of implicit variables.

To summarize, we have seen in this section that implicit variables in *else* strictly parallel overt anaphoric expressions in the range of construals that they entertain, that is, bound-variable and discourse-anaphoric readings as well as the more complex functional readings. This makes sense given our pre-theoretical characterization of the phenomenon: *else* semantically 'contains' a variable. Thus, the word is expected to behave just like expressions containing overt manifestations of variables. We have also seen cases in which *else* apparently behaves differently from overt anaphoric expressions. These are all cases in which its distribution is freer than its overt counterparts. This also makes sense given the nature of implicit variables: they are variables that don't have syntactic forms; but then, it is hardly surprising that they are systematically exempt from overt morpho-syntactic constraints. A desirable account of implicit variables must account for all of the phenomena observed above in a uniform and principled manner. In the next section, we consider possible analyses of *else* in two most prominent approaches to anaphora in the standard, LF-based theory, and show that both fall short of this standard. We then propose an analysis in Variable-Free Semantics in section 4 and show that our analysis satisfies the above criterion adequately and is hence superior to LF-based alternatives.

3. Two possible LF-based approaches

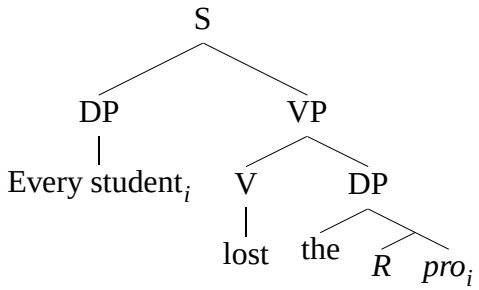
In this section, we consider possible analyses of implicit variables in *else* in two most prominent approaches to anaphora in the standard, LF-based approach: Heim and Kratzer's (1998) (henceforth H&K) implementation of Cooper's (1979) E-type disguised definite analysis, and a recent refinement of the disguised definite analysis by Elbourne (2005) in terms NP-deletion. We show that these alternatives lead to several undesirable consequences both empirically and theoretically.

3.1. Cooper/Heim-and-Kratzer-style E-type analysis

In Heim and Kratzer's (1998) LF-based E-type analysis (which builds on an idea originally due to Cooper (1979)), a paycheck pronoun like *it* in (11) is translated as a complex definite description involving a relational variable *R* and a simple individual-denoting pro-form along the lines of (12).

(11) Every professor$_i$ deposited his$_i$ paycheck. Every student $_j$ lost *it* (= *his* $_j$ *paycheck*).

(12)



As shown in the coindexation in (12), the individual pro-form is bound by the subject quantifier whereas the value of the relational variable is resolved contextually. In the case of (11), it is resolved as the relation **paycheck-of**, which holds of an individual and the paycheck that belongs to that individual. The binding of the individual pro-form by the subject quantifier *every student* ensures that the interpretation of the paycheck pronoun *it* covaries with the quantifier (that is, in the relevant reading, the entailment of the sentence amounts to the claim that, for each student, the losing relation holds between that student and the paycheck *of that student*). One important point to note here is that, in this analysis, pronouns are assumed to be lexically ambiguous between the E-type translation along the lines in (12) and an ordinary translation as a simple variable, despite the fact that such a distinction is not indicated in any way in surface morphology.

Adopting this E-type analysis for the paycheck readings of *else* is straightforward. In order to account for examples like (5), repeated here as (13), one merely needs to assume that *else* is ambiguous in two ways, just like ordinary pronouns.

(13) Every Englishman$_i$ loves his$_i$ daughter, but every American $_j$ loves *someone else*$_{k \neq \textbf{daughter-of}(j)}$.

More specifically, in addition to the ordinary translation involving a simple individual variable in the position of the implicit argument, *else* is assigned an additional entry involving a complex definite description that is isomorphic to the E-type translation of a pronoun in the position of the implicit argument. In this account, (13) is given the following LF translation:

(14) Every American$_i$ loves someone *other than the R pro*$_i$

By resolving the value of the relational variable *R* as the **daughter-of** relation and by binding the individual variable by the subject quantifier, the relevant paycheck interpretation is obtained.

It then appears as though this E-type approach would account for the functional interpretations of implicit variables in *else* quite nicely. So, what is the problem? The first problem is conceptual rather than empirical. Note that the E-type readings are obtained for both ordinary pronouns and implicit variables by adding extra entries for each kind of expression. But then, in this account, the fact that both pronouns and *else* exhibit the same kind of ambiguity remains to be a complete accident. This is a case of a generalization being missed, since such functional

interpretations are available for *any* expression containing an implicit variable (see Jacobson (2006) for other kinds of cases to which the parallel extends).

The difficulty of the Cooper/H&K-style analysis is actually more serious. Besides the above conceptual problem, it suffers from an empirical shortcoming as well. That is, the implicit variable in *else* can induce more complex functional interpretations than in (13). The following sentence exemplifies this point, where the meaning of *something else* is dependent on two quantifiers scoping over it:

(15) Every novice instructor$_i$ thinks that every student$_j$ will complain about the grade that he$_i$ gives him$_j$, but every experienced instructor$_k$ knows that some students$_l$ will complain about *something else*$_{m \neq \mathbf{grade}(k,l)}$.

For (15), we need a lexical entry for *else* that is distinct from the one in (14)—specifically, one that involves one free relational variable of arity 3 and two individual variables. More complex examples can analogously be constructed, although we omit them due to space limitations. The important point is that the number of anaphoric dependencies that *else* can host is in principle unlimited.

The problem, however, is not just lexical redundancy. Rather, the more serious aspect of the problem is that there is another dimension in which a generalization is being missed here. That is, the fact that more complex functional interpretations are available in examples like (15) with *else* is is exactly parallel to the situation found with ordinary pronouns (for relevant examples, see, e.g., Jacobson (2000)). However, if the only way to cope with such a situation is to multiply distinct lexical entries, then there is no explanation for the fact that implicit variables exhibit such a striking parallel to ordinary pronouns—not only do they both induce functional interpretations, but such functional interpretations can be arbitrarily complex in both cases, a fact that is highly unlikely to be a pure coincidence.

Still, one might think that the weakness of the Cooper/H&K analysis discussed above can be overcome by allowing LF representations to be somehow more flexible. That is, if we uniformly translated variables (whether implicit or explicit) at LF as some kind of underspecified representation which could subsequently be instantiated as a complex object capable of hosting variable-binding relations with a potentially unlimited number of binders, then that would dissolve the lexical redundancy problem for the Cooper/H&K-style E-type approach, and a unified analysis of implicit and explicit variables would become available in the LF-based setup. In fact, a recent proposal by Elbourne (2005) can be seen as an approach that attempts to do exactly this for a wide range of complex phenomena pertaining to nominal anaphora. Thus, in the next subsection we consider another possible analysis of implicit variables in *else* in the LF-based setup, one along the lines of Elbourne's approach to nominal anaphora in terms of NP-deletion.

3.2. Elbourne-style NP-deletion analysis

Drawing on the insight of the E-type analysis of pronouns, Elbourne (2005) proposes a uniform analysis of pronouns in which *all* pronouns (that is, not just special

instances such as paycheck pronouns) are treated as definite descriptions. The rough idea is that pronouns are semantically equivalent to definite determiners, but the NP that supplies the descriptive content (of type $\langle e,t\rangle$) undergoes obligatory deletion when the determiner surfaces as a pronoun.[4] This NP-deletion is assumed to be licensed under identity with a *linguistic* antecedent in the preceding context, just like VP ellipsis. According to this analysis, *it* in the paycheck sentence (4) acts as a determiner of the definite description 'the paycheck of him'. The descriptive content is deleted on the surface, as shown in (16), but is recovered at LF.

(16) John$_1$ spent [$_{\text{DP}}$ the [$_{\text{NP}}$ paycheck of him$_1$]] on food but Bill$_2$ spent [$_{\text{DP}}$ *it* [$_{\text{NP}}$ ~~paycheck of him$_2$~~]] on clothes.

The binding of *him* in the second sentence by *Bill* is trivially achieved by the ordinary binding process at LF via coindexation. Note that no extra lexical entry is introduced in this analysis to account for paycheck readings of pronouns.

In this setup, the implicit variable in *else* can also be treated as a definite description that gets deleted. That is, *something else* is translated at LF as 'something other than THE NP', with an invisible definite article hosting NP-deletion. The bound variable reading of implicit variables in *else* can then be derived as follows:

(17) every American$_1$ believes that [someone other than [THE ~~American~~]$_1$] is clever

By coindexing the subject quantifier and the recovered definite description at LF, the bound-variable reading ensues.

An advantage of this approach is that paycheck readings of *else*, including the more complex cases, are now automatically available. For example, (5) (= (13)) is derived as follows (note crucially the occurrence of a bound pronoun within the deleted material, which ensures the covariational interpretation):

(18) every Englishman$_1$ loves [the [daughter of him$_1$]], but every American$_2$ loves [someone other than [THE [~~daughter of him$_2$~~]]]

In any example, *else* just translates as 'other than THE' at LF, with the descriptive content for THE being recovered from the preceding context no matter how complex it is. We omit illustration, but it should be straightforward to see how the more complex examples like (15) are derived in this approach.

Thus, the problems for the Cooper/H&K-style analysis are now solved. Note first that there is no longer any need to stipulate multiple lexical entries for *else*. This is because the hidden descriptive content (rather than the lexical content of *else*) is made responsible for hosting arbitrarily complex anaphoric dependencies in this Elbourne-style approach. And, perhaps more significantly, this assumption also solves the more serious problem for the Cooper/H&K-style analysis: the fact

[4] In explaining LF-based approaches, we adopt the terminology conventional in those approaches. Thus, in this context, 'NP' refers to the part of the nominal expression *without* the determiner. (But when we talk about our own analysis, by 'NP', we refer to the whole nominal expression including the determiner.)

that implicit variables in *else* parallel ordinary pronouns in inducing arbitrarily complex functional readings is no longer an accident; the parallel directly follows from the fact that the same mechanism of NP-deletion is involved in the two cases.

Notwithstanding this achievement, there are at least two empirical problems for this Elbourne-style analysis: it runs into problems accounting for sentences involving the kind/entity antecedent ambiguity and split antecedent sentences. The problem in short is that there is simply no way to paraphrase the relevant readings using a full-fledged definite description in these cases, which casts doubts on the plausibility of the assumption that all anaphoric expressions can be reduced to definite descriptions.

The first problem comes from the the kind/entity antecedent ambiguity of *else* in examples like (8). As outlined above, analyzing anaphoric dependency in terms of NP-deletion presupposes the existence of a definite article hosting the elided NP. This, then, entails that (8) receives an interpretation identical to (19), where the covert definite description in (8) is spelled out in the surface string.

(19) John saw a red balloon. Bill saw something other than the red balloon.

However, this is obviously problematic since (19) is not ambiguous the way (8) is, lacking the kind-antecedent reading (9b). A way out of this problem in the Elbourne-style analysis might be to assume a different LF for the kind antecedent reading, namely (20), which contains an *indefinite* article A instead of a definite article THE. Such a solution, however, is evidently ad hoc: we do not see why *else* can be translated sometimes as 'other than A' and sometimes as 'other than THE' while overt pronouns are uniformly translated as definite descriptions.

(20) John saw a red balloon, but Bill saw [something other than [A [~~red balloon~~]]].

Another case where the Elbourne-style analysis fails is that of split antecedent sentences. To obtain the correct interpretation, the LF for the split-antecedent sentence (7) would have to be something like (21), but this LF cannot be derived by NP-deletion, which requires a string-identical linguistic antecedent (see Elbourne (2005) for a motivation for this assumption). In (21), there is no linguistic antecedent that is string-identical to the elided NP.

(21) Every instructor made sure that every TA communicated to the students clearly that they are not allowed to discuss homework assignments with anyone other than [the [~~instructor and TA~~]].

Thus, the Elbourne-style analysis of implicit variables of *else* faces serious difficulties in dealing with kind-antecedent and split-antecedent sentences.

Summarizing this section, both of the two approaches considered above suffer from empirical and/or theoretical problems: the Cooper/H&K-style analysis suffers from the lexical proliferation problem and the further inability to capture the parallel between implicit variables and ordinary pronouns in inducing that problem; the Elbourne-style analysis solves this problem neatly, but it suffers from two empirical problems: cases involving kind antecedence and split antecedence are at the very least not straightforward.

4. Analyzing *something else* in Variable-Free Semantics

In this section, we spell out our analysis of *else* in Variable-Free Semantics (VFS) (Jacobson 1999). As we will see, the proposed analysis captures the parallels and non-parallels between implicit variables and overt pronouns straightforwardly and is free from any of the problems that the LF-based alternatives suffer from.

4.1. Overview of Variable-Free Semantics

VFS is a theory of semantics that maintains *direct compositionality*, a thesis that dictates that every linguistic expression directly receive a well-defined model theoretic interpretation without the mediation of any extra machinery such as abstract representations or variable assignments. The theory thus totally does away with variables except as shorthand devices for notating the interpretations of expressions, hence its name.

As a way to treat anaphoric dependence of pronouns without variable assignments, expressions containing pronouns are treated as denoting functions whose outputs depend on the type *e* arguments that they take. Pronouns are the bottom case of expressions that contain pronouns and are thus treated as identity functions; intuitively, this means that the meanings of pronouns are entirely dependent on the meanings of their antecedents. The lexical entry for the pronoun *him* is thus defined as in (22) (we notate a linguistic expression as a tuple consisting of its phonological form, syntactic category and semantic translation):

(22) $\langle$ *him*; NP^{NP}; $\lambda x.x$ $\rangle$

The syntactic category NP^{NP} transparently represents the semantic type. That is, it indicates that the meaning of this pronoun is a function (of type $\langle e,e\rangle$) from an NP-type meaning (this is what the superscript means) to an NP-type meaning. [5]

The anaphoric dependence originating from the pronoun is recursively passed up to larger constituents by means of a rule called the G rule, defined as in (23):

(23) $\langle\ \alpha;\ B/A;\ f\ \rangle\ \Rightarrow_{\mathsf{G}}\ \langle\ \alpha;\ B^C/A^C;\ \lambda g\lambda x.f(g(x))\ \rangle$

This rule states that, for any expression that is a function of semantic type $\langle a,b\rangle$, G produces an additional expression of the same phonological form α but of a different semantic type $\langle\langle c,a\rangle,\langle c,b\rangle\rangle$ that is designed to deal with a case where its argument has an anaphorically dependent meaning. The anaphoric dependence (of type *c*) from the argument is simply passed on to the result category. Note that the syntactic category is adjusted appropriately in accordance with this shift in semantic type.

[5] Thus, the superscript does not have any syntactic relevance; a pronoun of category NP^{NP} has the same syntactic distribution as any run-of-the-mill NP.

The derivation in (25) illustrates how the discourse-anaphoric reading of *him* in the second sentence of (24) is licensed with this G rule. [6,7]

(24) John met Bill$_i$. Mary met him$_i$, too.

(25)
$$\dfrac{\dfrac{\dfrac{\dfrac{\textit{Mary}}{\mathrm{NP};\mathbf{m}}}{\mathrm{S}/_{\mathrm{R}}(\mathrm{S}/_{\mathrm{L}}\mathrm{NP});\lambda P.P(\mathbf{m})}\,\mathsf{T}}{\mathrm{S}^{\mathrm{NP}}/_{\mathrm{R}}(\mathrm{S}/_{\mathrm{L}}\mathrm{NP})^{\mathrm{NP}};\lambda f\lambda x.f(x)(\mathbf{m})}\,\mathsf{G} \qquad \dfrac{\dfrac{\dfrac{\textit{met}}{(\mathrm{S}/_{\mathrm{L}}\mathrm{NP})/_{\mathrm{R}}\mathrm{NP};\lambda x\lambda y.\mathbf{met}(x)(y)}\,\mathsf{G} \qquad \dfrac{\textit{him}}{\mathrm{NP}^{\mathrm{NP}};\lambda x.x}\,\mathsf{A}_{>}}{(\mathrm{S}/_{\mathrm{L}}\mathrm{NP})^{\mathrm{NP}};\lambda x\lambda y.\mathbf{met}(x)(y)}}{\mathrm{S}^{\mathrm{NP}};\lambda x.\mathbf{met}(x)(\mathbf{m})}\,\mathsf{A}_{>}$$

Here, the application of G to the verb *met* and to the type-raised subject *Mary* makes it possible to successively transmit the anaphoric dependence originating from the pronoun up to the whole sentence. Thus, the whole sentence is analyzed as a function from an individual x to the proposition that Mary met x. We assume, following Jacobson (1999), that when this sentence is interpreted in the discourse, this final translation of the whole sentence is applied to an individual that is salient in the discourse, namely, Bill, to resolve the anaphoric reference.

The G rule only passes up the anaphoric dependence originating from a pronoun. Thus, we need another rule to deal with cases where a quantifier 'binds' a pronoun. Binding is done by a rule called the Z rule, which is defined as follows:

(26) $\langle\ \alpha;\ \ (B/\mathrm{NP})/A;\ \ f\ \rangle\ \Rightarrow_{\mathsf{Z}}\ \langle\ \alpha;\ \ (B/\mathrm{NP})/A^{\mathrm{NP}};\ \ \lambda g\lambda x.f(g(x))(x)\ \rangle$

This rule creates from an expression that is semantically a function of type $\langle a,\langle e,b\rangle\rangle$ (which takes as its first argument an expression A with an ordinary non-context-dependent interpretation) a new expression with the same phonological form α but of semantic type $\langle\langle e,a\rangle,\langle e,b\rangle\rangle$. This new expression takes as its first argument an expression A^{NP} with an anaphorically dependent interpretation and resolves that anaphoric dependence by identifying the meaning of the NP that this argument is dependent on with the meaning of the higher argument NP. The variable x in the semantic term designates the identified type e meanings. In other words, the upper argument position binds into the lower argument position. In contrast to G, this rule does not pass up the anaphoric dependence of its lower argument to the result either syntactically or semantically, which is exactly the desired result: once a variable is bound, the interpretation of the expression containing that variable is no longer context-dependent.

By applying Z as defined in (26) to the verb *loves*, we can derive the local binding reading of the reflexive *himself* in (27), as shown in derivation (28).

(27) John$_i$ loves himself$_i$.

[6] We use boldface for constants and italics for variables in the logical formulas we write as the semantic translations of linguistic expressions. These formulas do not have any significance except as a convenient tool for notating the model theoretic interpretations that linguistic expressions receive.

[7] $/_{\mathrm{L}}$ and $/_{\mathrm{R}}$ designate left- and right-slashes (more standardly written as / and \), respectively. As in Steedman's (2000) notation for / and \, the argument category always appears to the right of the slash. Thus, $\mathrm{S}/_{\mathrm{L}}\mathrm{NP}$ is the category for intransitive verbs—an expression looking for an NP to its left to become a sentence.

(28)
$$\dfrac{\dfrac{\textit{John}}{\mathrm{NP};\mathbf{j}} \quad \dfrac{\dfrac{\dfrac{\textit{loves}}{(\mathrm{S}/_{\mathrm{L}}\mathrm{NP})/_{\mathrm{R}}\mathrm{NP};\lambda x\lambda y.\mathbf{love}(x)(y)}\mathsf{Z} \quad \dfrac{\textit{himself}}{\mathrm{NP}^{\mathrm{NP}};\lambda x.x}}{(\mathrm{S}/_{\mathrm{L}}\mathrm{NP})/_{\mathrm{R}}\mathrm{NP}^{\mathrm{NP}};\lambda f\lambda x.\mathbf{love}(f(x))(x)}\mathsf{A}_{>}}{\mathrm{S}/_{\mathrm{L}}\mathrm{NP};\lambda x.\mathbf{love}(x)(x)}\mathsf{A}_{<}}{\mathrm{S};\mathbf{love}(\mathbf{j})(\mathbf{j})}$$

Here, by applying Z to *loves*, the meaning of *John* and the NP-meaning that *himself* depends on are identified, resulting in a local binding reading of the reflexive.

4.2. Binding (something) else in VFS

With the Variable-Free approach illustrated above, all of the data concerning the binding of *else* shown in section 2 fall out without any additional assumptions, once we assign *something else* the following lexical entry: [8]

(29) $\langle$ *something else*; $(\mathrm{S}/_{\mathrm{R}}(\mathrm{S}/_{\mathrm{L}}\mathrm{NP}))^{\mathrm{NP}}$; $\lambda x\lambda Q.\exists y[y \neq x \wedge Q(y)]$ $\rangle$

This lexical entry says that *something else* is semantically a function (of type $\langle e,\langle et,t\rangle\rangle$) from an entity to a quantifier meaning. The superscript NP in the syntactic category corresponds to this extra semantic argument. Note that this treatment of the anaphoricity of *something else* (which follows a suggestion made by Jacobson (1999) for the treatment of implicit variables in general) is completely parallel to the treatment of pronouns in VFS described above: in both cases, the first argument slot of type *e* encodes the anaphoric dependence. As we will see below, this parallel treatment of *else* and ordinary pronouns, together with the assumption that G and Z are applicable to any linguistic expression, automatically explains the systematic parallel between the behaviors of *else* and pronouns.

4.2.1. Discourse-anaphoric vs. bound-variable readings

Given the translation of *something else* in (29), the discourse-anaphoric reading of the sentence *Every American loves someone else* can be derived as in (30): [9]

[8] For simplicity, we treat the whole quantified noun phrase containing *else* as a lexical unit, but it can be compositionally derived by assigning the following lexical entry for *else* and an additional lexical entry for the quantifier that takes a modifier of type $\langle e,t\rangle$ to its right as an argument (which is independently needed to deal with cases where a postnominal modifier follows a quantifier, e.g., *something interesting*):

(i) $\langle$ *else*; $(\mathrm{S}/_{\mathrm{L}}\mathrm{NP})^{\mathrm{NP}}$; $\lambda y\lambda x.x \neq y$ $\rangle$

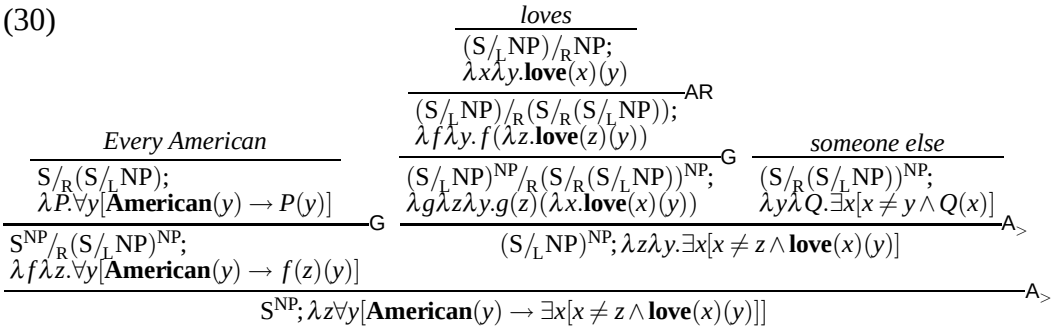
(ii) $\langle$ *someone*; $(\mathrm{S}/_{\mathrm{R}}(\mathrm{S}/_{\mathrm{L}}\mathrm{NP}))/_{\mathrm{R}}(\mathrm{S}/_{\mathrm{L}}\mathrm{NP})$; $\lambda P\lambda Q.\exists x.[P(x) \wedge Q(x)]$ $\rangle$

Then, (29) can be derived by applying G to (ii) and then giving (i) as an argument to it.

[9] AR (argument raising) is an operation from Hendriks (1993) that lifts the type of an argument position of a predicate from an individual type to a generalized quantifier type. Its syntax and semantics are defined as follows:

(i) $\langle$ α; $(\mathrm{S}/_{\mathrm{L}}\mathrm{NP})/_{\mathrm{R}}\mathrm{NP}$; f $\rangle$ $\Rightarrow_{\mathsf{AR}}$ $\langle$ α; $(\mathrm{S}/_{\mathrm{L}}\mathrm{NP})/_{\mathrm{R}}(\mathrm{S}/_{\mathrm{R}}(\mathrm{S}/_{\mathrm{L}}\mathrm{NP}))$; $\lambda\mathscr{P}\lambda x.\mathscr{P}(\lambda z.F(z)(x))$ $\rangle$

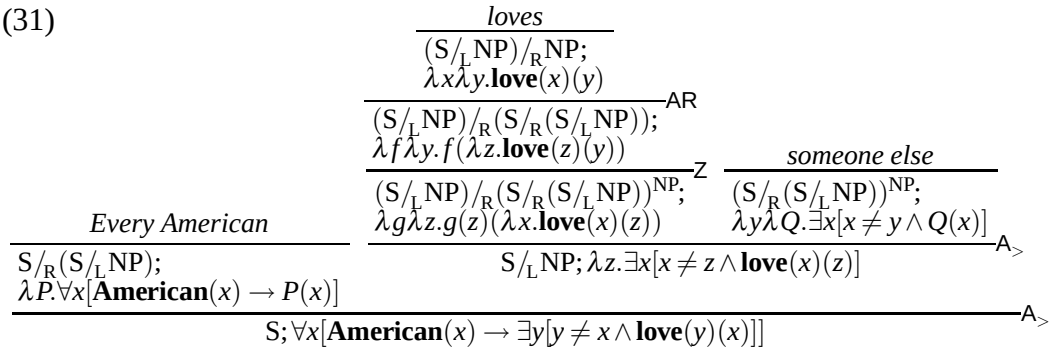
(30)



Here, the derivation is exactly parallel to that for the discourse-anaphoric reading of an ordinary pronoun in (25). The application of G to *loves* and to *every American* passes up the dependence on a type *e* meaning originating from the implicit variable in *else* to successively larger expressions, until it is passed up to the whole sentence. This context dependence is then resolved by applying this function to an appropriate individual.

By contrast, applying the binding rule Z in (26) to the verb *loves* yields the bound-variable reading, as in (31). Z identifies the subject slot of the verb *loves* and the implicit variable inside *else* that has been passed up. Again, the derivation is exactly parallel to the case of ordinary pronouns.

(31)



4.2.2. Paycheck readings

Given the strict parallel in the treatments of pronouns and implicit variables in the proposed analysis, the fact that it predicts the existence of paycheck readings of *else* should be unsurprising. All we need in order to account for the paycheck example (5) from section 2 is the following slightly modified version of G, which Jacobson (1999) introduces for the purpose of deriving the paycheck readings of ordinary pronouns.[10]

(32) $\langle\ \alpha;\ A^B;\ f\ \rangle\ \Rightarrow_{G_2}\ \langle\ \alpha;\ (A^C)^{(B^C)};\ \lambda g \lambda x.f(g(x))\ \rangle$

[10] Following Jacobson (1999), we assume that the definition of G can be generalized appropriately so that both (23) and (32) are just specific instances of a more general definition. But we will not work out the relevant details of the necessary generalization here.

As will become clear in a moment, the application of G_2 to *someone else*, which is shown in (33), produces the appropriate meaning for the paycheck reading:

(33) G_2 ((29)) =

$\langle$ *someone else*; $((\mathrm{S}/_{\mathrm{R}}(\mathrm{S}/_{\mathrm{L}}\mathrm{NP}))^{\mathrm{NP}})^{(\mathrm{NP}^{\mathrm{NP}})}$; $\lambda f\lambda y\lambda Q.\exists x[x \neq f(y) \wedge Q(x)]\rangle$

This essentially has the effect of creating a functional variable (whose value is determined in the discourse context) which the interpretation of the pronoun is dependent on.

The derivation goes as follows:[11]

(34)

$$\dfrac{\dfrac{\dfrac{\textit{Every American}}{\lambda P.\forall x.[\mathbf{American}(x) \rightarrow P(x)]}}{\lambda f\lambda g.\forall x.[\mathbf{American}(x) \rightarrow f(g)(x)]}\,\mathsf{G} \quad \dfrac{\dfrac{\dfrac{\dfrac{\textit{loves}}{\lambda f\lambda y.f(\lambda z.\mathbf{love}(z)(y))}}{\lambda g\lambda z.g(z)(\lambda x.\mathbf{love}(x)(z))}\,\mathsf{Z}}{\lambda f\lambda p\lambda z.f(p)(z)(\lambda x.\mathbf{love}(x)(z))}\,\mathsf{G} \quad \dfrac{\dfrac{\textit{someone else}}{\lambda x\lambda Q.\exists y[y \neq x \wedge Q(y)]}}{\lambda f\lambda y\lambda Q.\exists x[x \neq f(y) \wedge Q(x)]}\,\mathsf{G}_2}{\lambda p\lambda z.\exists y[y \neq p(z) \wedge \mathbf{love}(y)(z)]}\,\mathsf{A}_{>}}{\lambda g.\forall x[\mathbf{American}(x) \rightarrow \exists y[y \neq g(x) \wedge \mathbf{love}(y)(x)]]}\,\mathsf{A}_{>}$$

There are two key aspects in this analysis: the application of Z to the verb *loves* and the application of G to the verb and to the type-raised subject NP. The former binds the type *e* variable inside *someone else*, ensuring the covariation of the subject quantifier and *someone else*. The latter passes up the functional variable created by the application of G_2 to *someone else* to the sentence level. Just like any other variable that is not bound by a linguistic antecedent, the value of this functional variable is contextually resolved. Specifically, in (5), it is resolved as the function that maps each individual to his/her daughter. With this contextual resolution of the value of the functional variable, the predicted meaning for (5) is that, for each American *x*, there exists some individual that is different from *x*'s daughter and who is loved by *x*. This is exactly the right result. This analysis of the paycheck reading is, again, completely parallel to that of corresponding paycheck readings of ordinary pronouns proposed in Jacobson (2000).

Importantly, our VFS analysis is free from the redundancy and lack of generality found with the LF-based E-type analysis. As we have just illustrated, in the VFS analysis, no special lexical entry is needed for handling the paycheck readings of *else*. Moreover, the more complex cases exemplified in (15) are also automatically taken care of without any further stipulation. Once we have the most basic lexical entry for *else*, which is anaphorically dependent on a single type *e* expression, the entries necessary for the more complex cases as in (15) are immediately available by applying G_2 recursively to this basic entry, in a way exactly parallel to how the more complex paycheck readings for pronouns are made available (cf. Jacobson 2000). Due to space limitations, we omit a detailed illustration here, but it is straightforward to see that the derivation for (15) is parallel to that for the corresponding case involving an ordinary pronoun illustrated in Jacobson (2000), just like other cases where the derivations for the two cases are parallel to one another.

[11] From now on, we omit the syntax from the derivations since the details of the syntax are either unambiguously reconstructable from the lexical entries and combinatory rules we give and/or are not of central importance. Also, in what follows, we simplify the derivations by assuming that transitive verbs are lexically specified for the argument-raised category as well, rather than explicitly applying AR in the derivations.

Thus, like the Elbourne-style analysis but unlike the Cooper/H&K-style E-type analysis, the present analysis captures the parallel between implicit variables and ordinary pronouns in inducing (potentially arbitrarily complex) functional interpretations in a principled manner—in our analysis, this is an immediate consequence of the fact that *else* is given a semantic translation that is completely parallel to that of an expression containing a pronoun. An important difference between the present proposal and the Elbourne-style analysis is that the former totally dispenses with LF, which the latter crucially depends on in order to achieve this result. Thus, other things being equal, our analysis should be favored over the Elbourne-style analysis for its theoretical parsimony. Now, it turns out that the present proposal is superior to the Elbourne-style analysis empirically as well. More specifically, it can straightforwardly deal with cases that present problems for the Elbourne-style analysis, namely, split antecedent sentences and kind/entity antecedent ambiguity, as we will demonstrate in the next subsection.

4.2.3. Split antecedence and entity/kind antecedent ambiguity

As far as we are aware, the question of how to treat split antecedence in VFS has not been addressed in the literature. However, it turns out that an adequate analysis is available without introducing any additional machinery in the theory, as we will show below. Once we have that analysis of split antecedence and once we generalize the lexical entry for *else* to accommodate plural antecedents, our analysis immediately accounts for sentences like (7) from section 2.

We first generalize the lexical entry for *else* as in (35) to accommodate cases where the antecedent for the implicit variable is semantically plural:

(35) $\langle$ *else*; $(\mathrm{S}/_{\mathrm{L}}\mathrm{NP})^{\mathrm{NP}}$; $\lambda y \lambda x.x \not\leq y$ $\rangle$

This entry says that whatever *something/everything/nothing else* ends up ranging over (i.e. x) cannot be 'part of' (in the technical sense of the term in the standard lattice-theoretic plural semantics due to Link (1983)) whatever (singular or plural) entity the antecedent of the implicit variable ends up designating (i.e. y). If we assume, following the standard assumption in plural semantics (cf., e.g., Link 1998), that the only 'part' that an atomic entity has is its whole, the 'part of' relation reduces to the simple identity relation in the special case where both relata are atomic entities. Thus, (35) is more general than, and hence replaces, our earlier lexical entry for *else* (given in (i) in footnote 8).

We now propose a novel analysis of split antecedence in VFS. The analysis builds on the observation that there is a (previously unrecognized) parallel between cases of split antecedence like (36) and complex paycheck sentences.

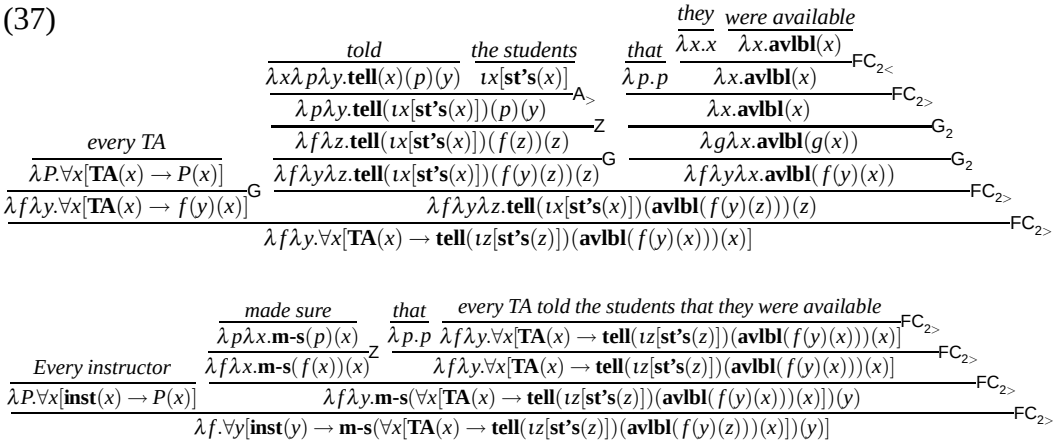
(36) Every instructor$_i$ made sure that every TA$_j$ told the students that they$_{i,j}$ were available to answer questions.

That is, in sentences like (36), the interpretation of the pronoun is dependent on two quantified NPs that 'c-command' it. This situation is analogous to cases of multiple

binding of paycheck pronouns in sentences like (15) (or its counterpart involving an overt pronoun), the only difference between the two being that the pronoun is (apparently) directly bound by the quantifiers in the case of (36). It, then, seems plausible to seek for a way to subsume the case of split antecedence as a special case of complex paycheck sentences.

Now, applying the multiple binding analysis of paycheck pronouns to (36) gives us the following derivation:[12]

(37)



Note here that, just as with ordinary complex paycheck sentences, the interpretation of the pronoun *they* is made to covary with the two binding quantifiers, due to the applications of G and Z. And just as with ordinary complex paycheck sentences, the final translation for the whole sentence in (37) does not give us the complete truth conditions for the sentence, since the value of the functional variable f is yet to be determined. Now, it turns out that the right interpretation for (36) can be obtained from this translation by specifying the value for this functional variable appropriately. Specifically, the assumption that is needed in order to yield the right interpretation for (36) is that in (37) f (which maps two individuals y and z to some object) denotes the following function, which takes two individuals and returns their sum:

(38) $\lambda x \lambda y.x \oplus y$

Since the sum of two individuals is something that is always available when there are two separate individuals, it is not unnatural to assume that, when sentences

[12] The operation $\mathsf{FC}_{2>}$ (function composition; $\mathsf{FC}_{2<}$ is the same operation for the left slash) used in (37) is defined as follows (note that this rule takes two inputs; also, $\alpha + \beta$ in the phonology of the output designates the concatenation of α and β):

(i) $\langle \alpha; A/_{R}B; f \rangle \ , \langle \beta; B^{C}; g \rangle \Rightarrow_{\mathsf{FC}_{2>}} \langle \alpha + \beta; A^{C}; \lambda x.f(g(x)) \rangle$

It does the work of G and function application at once. We employ this operation here and elsewhere solely for convenience: although the same result can be obtained with G and application alone, the derivations look simpler with the use of $\mathsf{FC}_{2>}$. Note also that this operation is different from syntactic function composition assumed in certain variants of categorial grammar such as Combinatory Categorial Grammar (Steedman 2000) (which the subscript 2 is meant to indicate).

like (36) are uttered without any previous context that makes any other two-place function over individuals salient, it is chosen as the value of f by default. And this gives us precisely the reading that we want for (36).

This analysis of split antecedence with ordinary pronouns as a limiting case of multiple paycheck binding straightforwardly carries over to corresponding cases with *else*. Analyzing (7) from the previous section along the same lines as the above (37) yields something like the following translation (here, we ignore the anaphoric dependency between *students* and *they*, which is irrelevant):

(39) $\lambda g.\forall x[\textbf{instructor}(x) \rightarrow [\textbf{make-sure}(x, \forall y[\textbf{TA}(y) \rightarrow$
$\textbf{tell-students-clearly}(y, \neg\exists z[z \not\leq g(x,y) \ \wedge \ \textbf{can-talk-to}(\textbf{students}, z)])])]]$

By instantiating the value of the functional variable g in (39) as the sum-forming function (38), we get the desired interpretation:

(40) $\forall x[\textbf{instructor}(x) \rightarrow [\textbf{make-sure}(x, \forall y[\textbf{TA}(y) \rightarrow$
$\textbf{tell-students-clearly}(y, \neg\exists z[z \not\leq x \oplus y \ \wedge \ \textbf{can-talk-to}(\textbf{students}, z)])])]]$

This says that, for any given pair of instructor and TA, their students are told that they cannot talk to anyone other than the instructor or the TA.

Finally, the ambiguity of kind/entity anaphora also falls out as a completely expected outcome of the proposed analysis. The relevant ambiguity (cf. (8) from section 2) is an immediate consequence of an interaction of the proposed analysis of implicit variables and the standard analysis of kind reference due to Carlson (1977). Within Carlson's ontology, kinds and individuals are uniformly treated as type e entities. Thus, in the current view that *else* is dependent on a type e expression as its antecedent, it is not at all surprising that kind-referring terms (in addition to individual-referring terms) can be an antecedent of *else*. As we will show below, this is precisely what gives rise to the kind-antecedent reading of *else*.

Up to this point, we have, for simplicity, ignored the distinction between individual-level and stage-level predicates. However, if we follow Carlson (1977) in characterizing the meanings of stage-level predicates by means of the 'realization' relation, the lexical entry for the stage-level predicate *saw* can be spelled out as follows, where $R(y)(z)$ is true just in case z is a spatio-temporal instantiation (i.e. a stage) of y:

(41) $\lambda y\lambda x.\exists z[R(y)(z) \wedge \textbf{saw}(z)(x)]$ (where R is the 'realization' relation)

Given this meaning of the stage-level predicate *saw*, both the entity and the kind antecedent readings of sentence (8) are analyzed as having the same translation:

(42) $\lambda z.\exists y[y \neq z \wedge \exists w[R(y)(w) \wedge \textbf{saw}(w)(\textbf{b})]]$

The ambiguity results from the way in which the antecedent for the implicit variable is determined. Crucially, in the context in which (8) is uttered, both the actual red balloon that John saw and the kind 'red balloons' (both being of type e in Carlson's ontology) are salient. Thus, if the former is identified as the antecedent of *else*, the sentence receives an interpretation that asserts that Bill saw (a particular

spatio-temporal instantiation of) an object that is different from the specific red balloon that John saw. This is the entity-antecedent reading. If, on the other hand, the latter (i.e. the kind 'red balloons') is instead identified as the antecedent, the sentence asserts that there is some kind other than the kind 'red balloons' such that Bill saw a spatio-temporal instantiation of it, from which it follows that what Bill saw does not qualify as a red balloon. This is the kind-antecedent reading. Thus, the kind/entity ambiguity of *else* is an immediate consequence of the fact that the implicit variable in *else* can take as its antecedent either an entity or a kind. [13]

Thus, both of the two cases in which *else* apparently behaves differently from its overt counterparts receive straightforward and fully adequate accounts once the analysis is suitably augmented with independently motivated assumptions about the relevant phenomena.

Concluding section 4, we have seen that all of the data reviewed in section 2—both the parallels and non-parallels in the behaviors of implicit variables and overt pronouns—are straightforwardly accounted for in the proposed VFS analysis. Our analysis is also free from the problems for LF-based approaches: the lexical proliferation problem of the Cooper/H&K style E-type analysis does not arise, and the two cases that pose problems for the Elbourne-style analysis, namely, split antecedence and entity/kind antecedent ambiguity, are both unproblematic.

5. Conclusion

Implicit variables are semantically parallel to overt pronouns in their anaphoric properties, yet they entertain freer syntactic distribution by virtue of having no syntactic forms. Our analysis captures these facts straightforwardly: the semantic parallels between implicit variables and overt pronouns are captured as such, by assigning to both functional interpretations; the syntactic non-parallels are also expected: since implicit variables do not have any overt syntactic forms, they are free from the constraints that regulate the distributions of their overt counterparts. These are both immediate consequences of the theory of VFS, which dispenses with abstract semantic representations such as LF. This result is significant and contrasts

[13] The reader might wonder why ordinary anaphoric expressions such as *it* and *one* do not allow for this kind of ambiguity. That is, why is it the case that both of the following examples unambiguously mean what they mean?:

(i) a. John saw a red balloon. He liked *it*.

b. John saw a red balloon. Bill saw *one*, too.

We presume that it is just a fact about the grammar of English that the third person singular pronoun (when they denote atomic individuals rather than masses) and the kind anaphor *one* encode in themselves what kinds of objects they are compatible with. That is, a singular third person pronoun is only compatible with real entities but not with kinds. Likewise, the kind anaphor *one*, as its name suggests, can only take as its antecedent a kind. Although we omit a detailed illustration here, these selectional restrictions regarding the sorts of objects that the specific anaphors are compatible with can be encoded by recognizing two subtypes for the type *e*.

sharply with the situation with LF-based approaches: as we have seen, LF-based approaches run into problems precisely because they posit abstract representations for implicit variables at LF. We thus conclude that the case of implicit variables provides yet another piece of evidence for the viability of the program of VFS, quite contrary to the initial expectation that it would pose significant challenges to the parsimonious theoretical architecture of VFS.

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