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QUANTIFICATION AND NEGATION IN EVENT SEMANTICS

ABSTRACT: Recently, it has been claimed that event semantics does not go well together with quantification, especially if one rejects syntactic, LF-based approaches to quantifier scope. This paper shows that such fears are unfounded, by presenting a simple, variable-free framework which combines a Neo-Davidsonian event semantics with a type-shifting based account of quantifier scope. The main innovation is that the event variable is bound inside the verbal denotation, rather than at sentence level by existential closure. Quantifiers can then be interpreted in situ. The resulting framework combines the strengths of event semantics and type-shifting accounts of quantifiers and thus does not force the semanticist to posit either a default underlying word order or a syntactic LF-style level. It is therefore well suited for applications to languages where word order is free and quantifier scope is determined by surface order. As an additional benefit, the system leads to a straightforward account of negation, which has also been claimed to be problematic for event-based frameworks.

1. INTRODUCTION

Formal semantic accounts of verbs and their arguments can be distinguished, broadly speaking, along two parameters: First, are events

present in the logical language (Davidson 1967)? Second, is the scope of quantificational arguments determined syntactically, for example by quantifier raising (May 1985), or semantically, for example by type-shifting (Hendriks 1993)? This paper explores the interaction between these two questions. Recently, it has been claimed that analyses of event semantics and quantification form an unhappy marriage. Thus, Beaver & Condoravdi (2007) hold that "[i]n Davidsonian Event Semantics the analysis of quantification is problematic: either quantifiers are treated externally to the event system and quantified in (cf. Landman 2000), or else the definitions of the quantifiers must be greatly (and non-uniformly) complicated (cf. Krifka 1989)". They suggest as an alternative a nonstandard framework in which verbal denotations hold of partial functions that map designated constants like "agent" and "theme" to individuals. For related criticism and a similar proposal, see Eckardt (2010).

Contrary to such claims, I argue that the analysis of quantifier scope does not pose any special problems in an event semantic framework. That is, adopting one or the other view on quantifier scope does not entail a commitment on whether events are present in the system. For semanticists who reject quantifying-in as an option, such as Beaver & Condoravdi and Eckardt, it is possible to adopt a semantic approach to quantifier scope in a completely standard event-based framework. Conversely, adopting one or the other view on the presence of events does not force the semanticist to take a stance on whether quantifier scope is determined syntactically or semantically. Schematically, my strategy consists in filling a corner in the 2-by-2 matrix that is opened by the parameters mentioned above (see Table 1).

	No Events	Events
Syntactic account	e.g. May (1985)	e.g. Landman (2000)
Semantic account	e.g. Hendriks (1993)	*this paper*

Table 1: Analyses of quantification and events

This paper does not present in detail syntactic approaches to quantifier scope, since they can be extended to event semantic frameworks straightforwardly; see Landman (1996, 2000) for an overview. However, let me briefly mention why syntactic approaches have been considered problematic. In these approaches, type mismatches between verbs and quantificational arguments are resolved by movement. This is sometimes perceived as cumbersome. As Eckardt (2010) observes, "the semantic composition of even a simple sentence like *John likes most Fellini movies* requires quantifier raising, interpreted traces, coindexing, and lambda abstraction." Since syntactic approaches rely on covert movement, they entail the presence of a representational level (Logical Form) that is distinct from the surface level. As such, they are not directly compositional (Jacobson 1999; Barker 2002). Finally, there is an overgeneration worry: In languages and configurations where surface scope determines semantic scope (see e.g. Beghelli & Stowell (1997) for English), nothing short of additional assumptions ensures that raised quantifiers keep their relative order the same as before they raised.

Two caveats before we begin. First, the nonstandard systems in the papers cited above are motivated not only by the representation of quantificational arguments but also by additional considerations, such as the representation of stacked temporal modifiers as in *On most days, it rained in the afternoon* (Beaver & Condoravdi 2007) and the ability to make all arguments of a verb semantically accessible at any point in the derivation (Eckardt 2010). I will not discuss these motivations in detail, and I defer a comparison between these systems and my own to further work. (A comparison with Winter & Zwarts (2011), a recent type-logical implementation driven by similar motivations as mine, must also await another occasion because I only became aware of it just before finishing this paper.) Second, I do not consider scopeless readings of quantifiers, such as cumulative quantification. When nonincreasing quantifiers are involved, these readings increase the complexity of both event-based and eventless grammars because it is not possible to derive these readings by giving one quantifier scope over the other. My omission is justified because the claims by Beaver & Condoravdi and Eckardt about the difficulty of integrating quantifier scope and event semantics are not based on these complex cases. See Krifka (1999), Landman (2000) and Brasoveanu (2010) for discussion of relevant issues.

I now show that in the presence of type shifting rules, event semantics does not require a commitment to a representational level distinct from surface form (Section 2). I then show that fixed-scope operators like negation and modals can be given a straightforward and standard treatment (Section 3). Section 4 concludes.

2. QUANTIFICATION IN A NEO-DAVIDSONIAN FRAMEWORK

The difference between syntactic and semantic approaches to quantifier scope is traditionally studied in classical Montagovian semantic systems, where verbs are translated as n-ary relations that hold between their arguments. Such a translation draws a firm semantic distinction between (obligatory) arguments and (optional) adjuncts. Expressions in which some arguments are missing, like *kiss Mary* or *John kissed*, are not assigned a truth value. Among alternatives that treat arguments and adjuncts on a par, the best-known one is the Neo-Davidsonian approach. In a typical instantiation, verbs and all their projections up to the sentence level are translated as predicates of events, and verbal arguments modify events via thematic roles like agent and theme. At the sentence level, a silent operator (called *sentence mood operator* in Krifka (1989) or more commonly *existential closure*) then binds the event argument with an existential quantifier. Some syntactic mechanism (e.g. the theta criterion) is assumed to make sure that the operator can only apply once all the syntactic arguments of the verb have been introduced to the derivation, and not earlier. For example, a sentence like *John kissed Mary* is translated as follows, disregarding tense:

(1) $[\![\text{John kissed Mary}]\!]$
$= \exists e.\text{kiss}(e) \wedge \text{ag}(e, \text{john}) \wedge \text{th}(e, \text{mary})$

Such theories rely on syntactic devices, for example on the theta criterion, to label subjectless sentences like *kiss Mary* as ungrammatical; as far as the semantics is concerned, the system could assign such expressions a truth value, in this case, $\exists e.\text{kiss}(e) \wedge \text{th}(e, \text{mary})$.

When a verbal argument is itself quantificational, it needs to take scope above this event quantifier. This is a standard assumption in Neo-Davidsonian theories. For example, the Scope Domain Principle in Landman (1996) states that only nonquantificational noun phrases can be "entered into scope domains". In the context of Landman's theory, where "scope domain" means "verbal denotation", this principle in effect says that only nonquantificational noun phrases can be interpreted in situ, and it has the consequence that all quantificational noun phrases must take scope over the event argument. For example, the correct translation of *John kissed every girl* according to the Scope Domain Principle is (2). This represents the fact that the sentence entails that for every girl g, there is a separate event in which John kissed g. For example, the sentence *John kissed Mary* is represented as (3). It follows logically from (2) given the additional assumption that Mary is a girl (4).

(2) $[\![\text{John kissed every girl}]\!]$
$= \forall x[\text{girl}(x) \rightarrow \exists e[\text{kiss}(e) \wedge \text{ag}(e, \text{john}) \wedge \text{th}(e, x)]]$

(3) $[\![\text{John kissed Mary}]\!]$
$= \exists e[\text{kiss}(e) \wedge \text{ag}(e, \text{john}) \wedge \text{th}(e, \text{mary})]$

(4) $[\![\text{Mary is a girl}]\!]$
$= \text{girl}(\text{mary})$

The alternative translation in which the event quantifier takes wide scope, (5), expresses that there is a single event in which John kissed every girl. This contradicts not only the Scope Domain Principle and related assumptions, but also our intuitions about kissing, since we think of different kissings as different events. The following translation therefore does not seem to represent any reading of the sentence.

(5) $[\![\text{John kissed every girl}]\!]$
$= \exists e[\text{kiss}(e) \wedge \text{ag}(e, \text{john}) \wedge \forall x[\text{girl}(x) \rightarrow \text{th}(e, x)]]$

In general, the event quantifier always takes lowest possible scope with respect to other scope taking elements. For example, sentence (6) only has the reading (7a) and cannot mean (7b). While (7b) might be ruled out for independent reasons (for example because almost every event will trivially make it true), the fact remains that the quantifier *no boy* must be able to take wide scope with respect to the event quantifier in order to derive the reading (7a). Even with respect to fixed scope operators like negation, the event quantifier always seems to take low scope (8).

(6) No boy laughed.

(7) a. $\neg\exists x[\text{boy}(x) \wedge \exists e[\text{laugh}(e) \wedge \text{ag}(e) = x]]$ $\neg\exists x \gg \exists e$
"There is no laughing event that is done by a boy."
b. $\exists e[\neg\exists x[\text{boy}(x) \wedge \text{laugh}(e) \wedge \text{ag}(e) = x]]$ $^*\exists e \gg \neg\exists x$
"There is an event that is not a laughing by a boy."

(8) John didn't laugh.

(9) a. $\neg\exists e[\text{laugh}(e) \wedge \text{ag}(e) = \text{john}]$ $\neg \gg \exists e$
"There is no event in which John laughs."
b. $\exists e\neg[\text{laugh}(e) \wedge \text{ag}(e) = \text{john}]$ $^*\exists e \gg \neg$
"There is an event in which John does not laugh."

An additional reason for giving low scope to the event quantifier is more theory-internal: Many Neo-Davidsonian frameworks assume that thematic roles are functions (the Unique Role Requirement, Carlson 1984; Parsons 1990; Landman 1996, 2000). This has the effect of making the wrong translation (5) a contradiction in all models in which there is more than one girl, since the Unique Role Requirement entails that no more than one girl can be the theme of a kissing event. The analysis to be developed here can accommodate the Unique Role Requirement. For clarity, I will represent thematic roles using functional notation from now on, e.g. "$\text{th}(e) = x$" instead of "$\text{th}(e, x)$".

As described above, the typical instantiation of the Neo-Davidsonian framework applies existential closure to the event quantifier at sentence level. Therefore, any theory of quantifier scope needs to give all argument quantifiers the ability to take scope above the sentence level to derive the correct truth conditions. It is here that a difference between syntactic and semantic theories of quantifier scope arises.

For syntactic theories such as May's Quantifier Raising (QR), it is no problem to raise a quantifier above sentence level; this is in fact their normal operating mode. This is illustrated in Figure 1. For convenience, I have followed Landman (1996, 2000) in placing the thematic roles directly into the verb meaning, but this is not crucial.

By contrast, many semantic theories are designed to allow quantifiers to be interpreted in situ. Some examples are the argument raising rule of Hendriks (1993), the type-shifting rule for quantifiers presented in the textbook by Heim & Kratzer (1998), and the CPS (continuation passing style) transforms used in more recent continuation-based

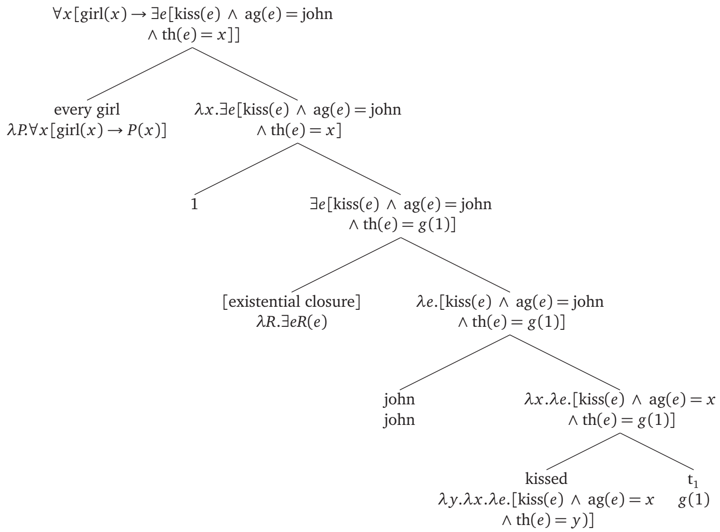

Figure 1: "John kissed every girl" in an event framework, using quantifier raising.

work (Barker 2002). Many such theories amount to lifting the type of the verb or verbal projection so that it expects a quantifier instead of an individual-type argument. In case a verb combines with multiple quantifiers, its type can be lifted several times. The order in which these lifting operations are applied to the verb determines the scope of its arguments. For example, in Hendriks' system, the order in which the argument raising rule is applied to a transitive verb determines the scope that its quantificational arguments take towards each other.

In the Neo-Davidsonian framework described above, the event quantifier is introduced by existential closure after any other quantifiers, but it always has to take scope under all of them. In a Hendriks-style system, this requires that every verb be type-lifted for the event quantifier that comes in the guise of existential closure. But since every sentence contains this event quantifier, one might then as well rewrite lexical entries of verbs to incorporate the existential closure over their event argument.

My formal proposal, then, is that verbs are not interpreted as predicates of events (10a), but as generalized existential quantifiers over events (10b). I let the variable f range over event predicates.

(10) a. Old Neo-Davidsonian approach: $[\![\text{kiss}]\!] = \lambda e[\text{kiss}(e)]$
b. This approach: $[\![\text{kiss}]\!] = \lambda f \exists e[\text{kiss}(e) \wedge f(e)]$

The entry in (10b) can be derived from the one in (10a) by the type-shifting principle *A* in Partee (1987), but this parallel should be taken with a grain of salt. Type shifting is generally understood to occur "online" during the computation of the meaning of a sentence, while the present proposal applies it "offline" in the lexicon. As Chris Potts pointed out to me (p.c.), the move from (10a) to (10b) is better understood as an operation that rewrites an entire grammar, similarly to the continuization procedure in Barker (2002).

As an added bonus compared to syntactic approaches, putting existential closure into the lexical entry of the verb will automatically derive the fact that all other quantifiers always have to take scope above existential closure. As one of my reviewers observes, this move is reminiscent of the way Carlson (1977) puts existential quantification over stages into the lexical semantics of stage-level predicates, thereby ensuring that bare plurals can denote kinds and their existential import takes narrowest scope.

Conceptualizing Neo-Davidsonian event semantics this way requires a shift in thinking. Instead of denoting the set of all kissing events, think of "kiss" as being true of any set that contains a kissing event. We will let not only verbs but all their projections hold of sets of events. Thus, we can think of a verb phrase like "kiss Mary" as being true of any set that contains a kissing event whose theme is Mary, and so on up the sentence.

(11) $[\![\text{kiss Mary}]\!] = \lambda f\, \exists e[\text{kiss}(e) \wedge f(e) \wedge \text{th}(e) = \text{mary}]$

This perspective gives us a handle on interpreting quantifiers in situ. On the old approach, a verb phrase had to be true of an event, so it was not clear what kind of event a verb phrase like "kiss every girl" could be true of. Now that verb phrases hold of sets of events, we can formulate the meaning of verb phrases containing quantifiers in an intuitive way: "kiss every girl" is true of any set of events that contains a potentially different kissing event for every girl.

(12) $[\![\text{kiss every girl}]\!]$
$= \lambda f\, \forall x[\text{girl}(x) \rightarrow \exists e[\text{kiss}(e) \wedge f(e) \wedge \text{th}(e) = x]]$

For simple declarative sentences, we still need a sentence-level operator, but it has a function somewhat different from existential closure: It asserts that the predicate is true of the set of all events. Intuitively, one might think of the world as the set of all events that exist. Then, the sentence-level operator asserts that the sentence is true of the world. As usual, I assume that syntax is responsible for making sure that the operator only applies once all the syntactic arguments of the verb have been introduced.

(13) $[\![[\text{closure}]]\!] = \lambda e.\text{true}$

A reviewer points out that this closure operator is similar to the downarrow operator of Dynamic Montague Grammar, which maps the dynamic interpretation of a sentence to a truth value (Groenendijk & Stokhof 1990), and to the Lower operator of Barker & Shan (2008), which does the same for a continuized interpretation by applying it to a trivial continuation. All these type shifters are used to similar effect in their respective systems: They strip away the layers of complexity introduced by the semantic machinery and map a predicate to what are intuitively its truth conditions.

Back to the present proposal. I treat noun phrases as generalized quantifiers over individuals (type $\langle et, t\rangle$). This part of the analysis is completely standard. I use P for predicates of individuals (type $\langle et\rangle$):

(14) $[\![\text{every girl}]\!] = \lambda P \forall x[\text{girl}(x) \rightarrow P(x)]$

(15) $[\![\text{a diplomat}]\!] = \lambda P \exists x[\text{diplomat}(x) \wedge P(x)]$

Thematic roles can be introduced either as part of the verbal denotation or through other means. For concreteness, I assume that they are provided by separate syntactic heads that combine noun phrases with verbal projections and provide the necessary semantic type-lifting. In particular, a thematic role head like *theme* combines a quantificational noun phrase with the denotation of a verbal projection, which is a generalized quantifier over events, and returns another generalized quantifier over events. This ensures that all verbal projections have the same type, namely $\langle vt, t\rangle$, where v stands for the type of events. Here is the denotation of such a thematic role head (I use V for predicates of type $\langle vt, t\rangle$, and Q for predicates of type $\langle et, t\rangle$). Prepositions can follow exactly the same scheme:

(16) $[\![[\text{th}]]\!] = \lambda Q \lambda V \lambda f[Q(\lambda x[V(\lambda e[f(e) \wedge \text{th}(e) = x])])]$

After this head combines with a quantificational noun phrase such as the one in (14), the resulting constituent is of type $\langle\langle vt, t\rangle, \langle vt, t\rangle\rangle$.

Under these assumptions, we can derive the meaning of a sentence like *John kissed every girl* in a variable-free manner, without the application of movement or traces, and with function application as the only operation. This is shown in Figure 2 for *John kissed every girl*. Compare this with Figure 1, where movement, trace interpretation, and lambda abstraction have been used for the same sentence.

The framework can be extended in different ways to derive quantifier scope ambiguities. For example, this could be done as in Hendriks (1993) by argument raising, or as in Beaver & Condoravdi (2007) by applying arguments to the verb in different orders. Another possibility is to lift the type of the thematic role heads, as shown in Figures 3

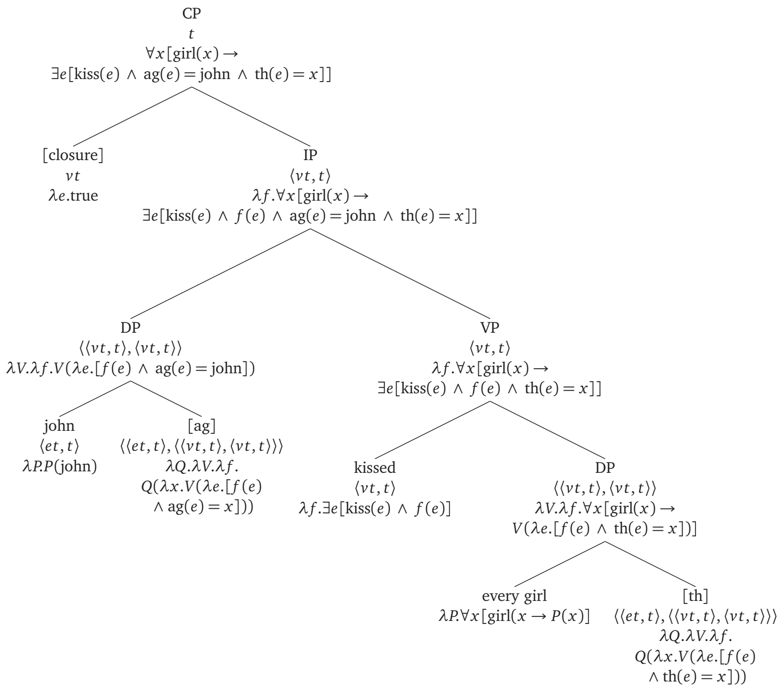

Figure 2: Basic illustration of the present framework, using the sentence "John kissed every girl."

and 4. These figures show the surface and inverse scope readings of *A diplomat visited every country* respectively. The only difference between them is that the thematic role head [th] in the former has been replaced by [th-lift] in the latter. This results in inverse scope. We can capture the difference between languages in which surface order determines semantic scope and languages in which scopal order is free by adding or removing type-lifted thematic role heads like [th-lift] in Figure 4 from the lexicon.

3. NEGATION

In the system presented here, all verbal arguments and modifiers, no matter what their syntactic category is, uniformly have the semantic type $\langle\langle vt, t\rangle, \langle vt, t\rangle\rangle$. This applies in particular to scope-taking operators like negation and modals. In this section, I sketch an analysis of these operators, concentrating on negation. I compare the resulting treatment of negation to the fusion-based system in Krifka (1989).

Just like quantification, negation has been considered particularly difficult for event semantics because it leads to apparent scope paradoxes (Krifka 1989). As observed by Smith (1975), *for*-adverbials like *for two hours* can take scope both above negation and below it. For example, (17) can be interpreted both as (17a) and as (17b):

(17) John didn't laugh for two hours.
  a. For two hours, it was not the case that John laughed.
  b. It was not the case that John laughed for two hours.

We have seen above, in connection with examples like (6) and (8), that negation always seems to take scope above the event quantifier. This would mean that in order to lead to interpretations like (17a), the *for*-adverbial must be able to take scope above the event quantifier. If one assumes, as Krifka does, that the event quantifier is introduced at the sentential level via existential closure, this means that the *for*-adverbial must be able to take scope at the sentential level. Krifka considers this conclusion undesirable. Let us adopt this point of view as well here and require of our framework that we must be able to interpret *for*-adverbials at VP-level. One certainly does not want to be forced by the choice of one's framework to take a position on the scope

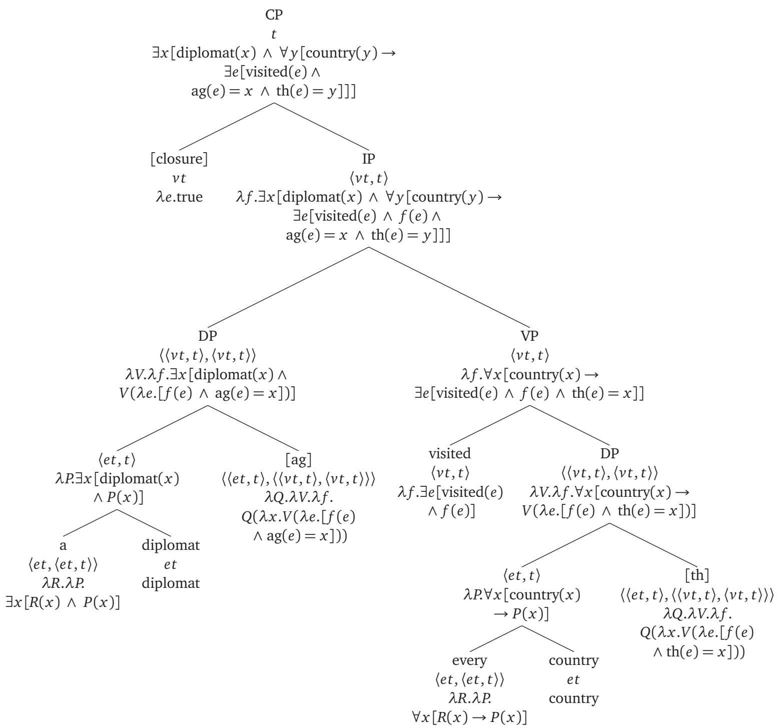

Figure 3: A diplomat visited every country (surface scope)

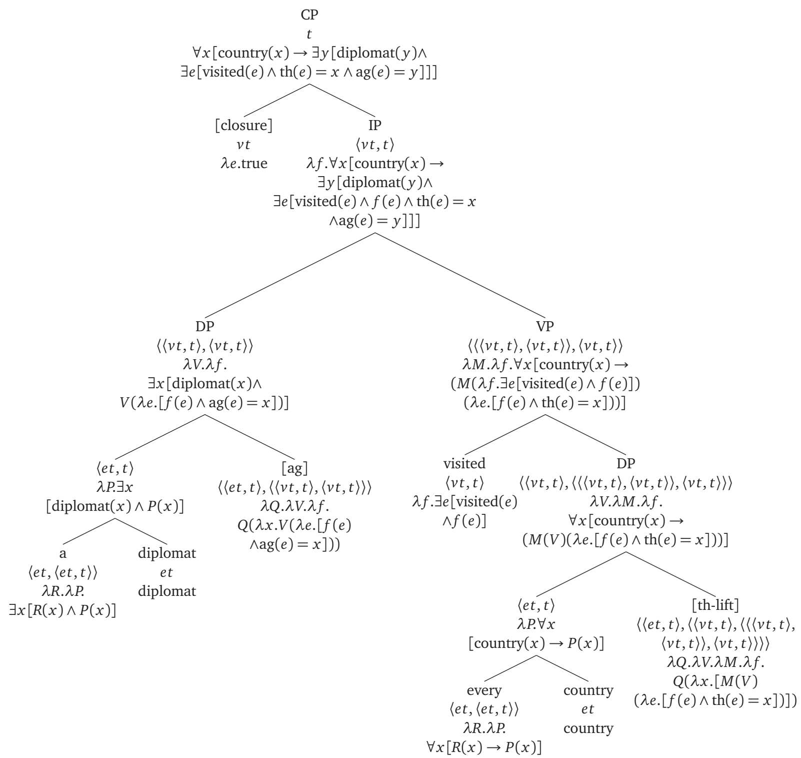

Figure 4: A diplomat visited every country (inverse scope)

of *for*-adverbials, as there is currently no consensus on whether they attach below or above the subject. This issue is relevant in connection with the interaction of *for*-adverbials and the Perfect. See Rathert (2004) for a discussion of the relevant issues and literature.

Krifka himself resolves the apparent scope paradox by concluding that negation, after all, takes scope under and not over the event quantifier, contrary to what is suggested by the facts in (6) and (8). Given the background assumption that *for*-adverbials do not take scope at the sentential level, this decision is necessary for Krifka in order to explain why *for*-adverbials take scope both above and below negation. But this decision requires translating negation in a nonstandard way. Krifka uses the mereological concept of fusion for this purpose. Simply put, the fusion of an event predicate is something which has the type of an event and which is obtained by merging all the events that satisfy the event predicate. Krifka translates *did not* as involving the fusion of all the events that take place within some time interval. Parthood is shown as $\leq$ here:

(18) $[\![\text{did not}]\!]_{\text{Krifka}}$
$= \lambda P \lambda e \exists t[e = \text{FUSION}(\lambda e'[\tau(e') \leq t])$
$\wedge \neg \exists e''[P(e'') \wedge e'' \leq e]]$

Based on this entry, Krifka translates a sentential event predicate like *John didn't laugh* as a predicate that is true of any fusion of events that all take place within some time, so long as none of them is an event of John's laughing:

(19) $[\![\text{John did not laugh}]\!] =$
$\exists e \exists t[e = \text{FUSION}(\lambda e'[\tau(e') \leq t])$
$\wedge \neg \exists e''[e'' \leq e \wedge \text{laugh}(e'') \wedge \text{ag}(e'') = \text{john}]]$

Since this translation wrongly predicts that the sentence is incompatible with John ever laughing at all, Krifka introduces further modifications inspired by the anaphoric treatment of tense in the style of Partee (1973). The net effect of these modifications is that the existentially quantified time variable t is restricted to be a part of the reference time introduced by the past morpheme.

Krifka's fusion-based negation system has been both influential and controversially debated in the literature. For example, it plays an important role in the account of scopal effects of *for*-adverbials in Zucchi & White (2001) and in the formal reconstruction of various analyses of the meaning of *until* in de Swart (1996), Condoravdi (2002). One of the main questions in these discussions regards the ontological status of fusions. Some authors (de Swart 1996; de Swart & Molendijk 1999) embrace these fusions and even take them as support for the popular claim that "negation is a stativizer", that is, negation yields predicates of states. However, this claim is controversial (Giannakidou 2002; Condoravdi 2002; Csirmaz 2006). In the absence of a consensus on the status of negation-based fusions, it is worth revisiting the evidence that led to their introduction in the first place.

In the present system, we do not need to resort to mereological fusion, because one of the premises of the argument that leads to Krifka's scope dilemma is missing from our system. Since our event quantifier takes scope at the lowest possible level, the scopal interaction between *for*-adverbials and negation does not force us to conclude that negation takes scope under the event quantifier. This is so even if we also maintain, as Krifka does, that the *for*-adverbial never takes scope at the sentential level. As a result, we can formulate the meaning of *not* in terms of logical negation, without fusions.

(20) $[\![\text{not}]\!] = \lambda V \lambda f \neg V(\lambda e[f(e)])$

I treat *did* as semantically vacuous. Its presence only morphologically signals the presence of past tense. This idea is common in semantic treatments of tense; see for example von Stechow (2009), Section 6, for details and references.

Sentence (19) receives the LF in (21a), which results in a straightforward translation that does not involve reference to fusions (21b):

(21) a. $[_{\text{CP}}$ [closure] $[[_{\text{DP}}$ john [ag]] $[_{\text{VP}}$ did not laugh]]]
b. $\neg \exists e[\text{laugh}(e) \wedge \text{ag}(e) = \text{john}]$

This translation ignores tense. Let us now add an anaphoric treatment of tense to restrict the translation to the reference time (written t_r), again following Partee (1973). Since Krifka assumes such a treatment too, this move does not change the relative complexities of the two systems under comparison. Here and below, I write temporal inclusion (which may or may not be conceptualized as mereological parthood) as $\subseteq$ and temporal precedence as $\ll$. The following closure operator represents the meaning of the past tense:

(22) $[\![$[past-closure]$]\!]$
$= \lambda V[t_{\mathrm{r}} \ll \text{now} \wedge V(\lambda e[\tau(e) \subseteq t_{\mathrm{r}}])]$

In this entry, the subformula $t_{\mathrm{r}} \ll \text{now}$ is not in the scope of V. This, together with the fact that nothing ever takes scope above the closure operator, ensures that it is always interpreted with wide scope.

On the assumption that negation and *for*-adverbials can combine with the verb phrase in any order, the following translation of a *for*-adverbial generates the desired readings for (17).

(23) $[\![$for two hours$]\!]$
$= \lambda V \lambda f \exists t[\text{hours}(t) = 2 \wedge t \subseteq t_{\mathrm{r}}$
$\wedge \forall t'[t' \subseteq t \rightarrow V(\lambda e[f(e) \wedge \tau(e) = t'])]]$

My analyses of (17a) and (17b) are shown in (24) and (25) respectively. The full derivations are shown in Figures 5 and 6. In both LFs, the *for*-adverbial takes scope at VP level. Thus, we avoid resorting to the assumption that Krifka viewed as problematic, namely that the *for*-adverbial is able to take scope at sentential level. The occurrence of t_{r} in (23) is crucial; it prevents (24) from being trivially verified by any two-hour interval outside of the reference time.

(24) a. For two hours, it was not the case that John laughed.
b. $[_{\text{CP}}$ $[[_{\text{DP}}$ john [ag]] $[_{\text{VP}}$ $[_{\text{VP}}$ did not laugh] $[_{\text{PP}}$ for 2 hours]]]]
c. $t_{\mathrm{r}} \ll \text{now} \wedge \exists t[\text{hours}(t) = 2 \wedge t \subseteq t_{\mathrm{r}} \wedge \forall t'[t' \subseteq t \rightarrow \neg\exists e[\text{laugh}(e) \wedge \text{ag}(e) = \text{john} \wedge \tau(e) = t' \subseteq t_{\mathrm{r}}]]]$

(25) a. It was not the case that John laughed for two hours.
b. $[_{\text{CP}}$ $[[_{\text{DP}}$ john [ag]] $[_{\text{VP}}$ did not $[_{\text{VP}}$ laugh $[_{\text{PP}}$ for 2 hours]]]]]
c. $t_{\mathrm{r}} \ll \text{now} \wedge \neg\exists t[\text{hours}(t) = 2 \wedge t \subseteq t_{\mathrm{r}} \wedge \forall t'[t' \subseteq t \rightarrow \exists e[\text{laugh}(e) \wedge \text{ag}(e) = \text{john} \wedge \tau(e) = t' \subseteq t_{\mathrm{r}}]]]$

In (23), I have followed Dowty (1979) and others in treating the *for*-adverbial as quantifying over subintervals of a two-hour-long interval, rather than quantifying on subevents of an event whose runtime is two hours, as in Krifka (1998) for example. Otherwise, in (17a) we would need to resort to something like Krifka's fusion after all,

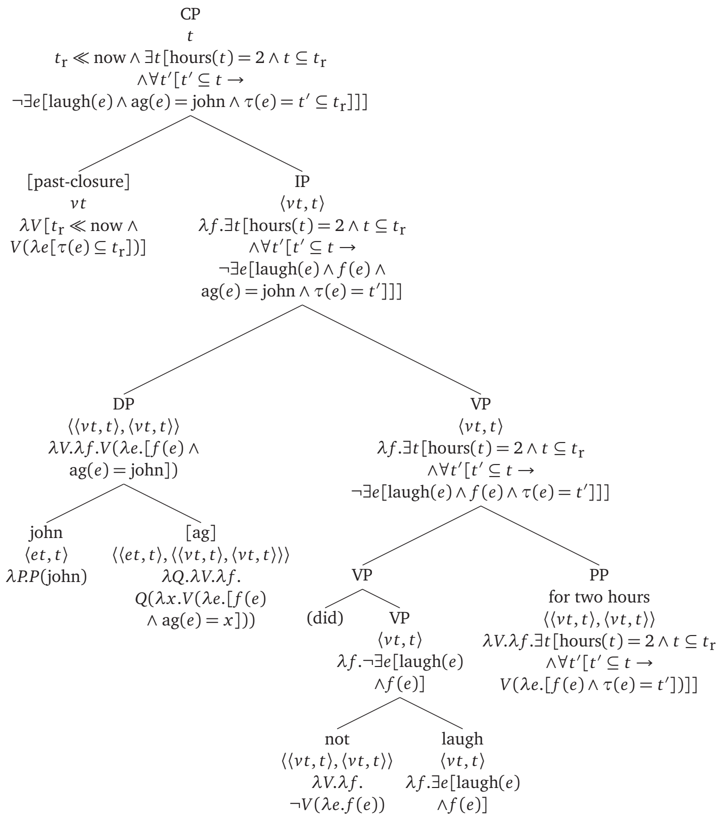

Figure 5: LF for Example (24): John [didn't laugh] for two hours

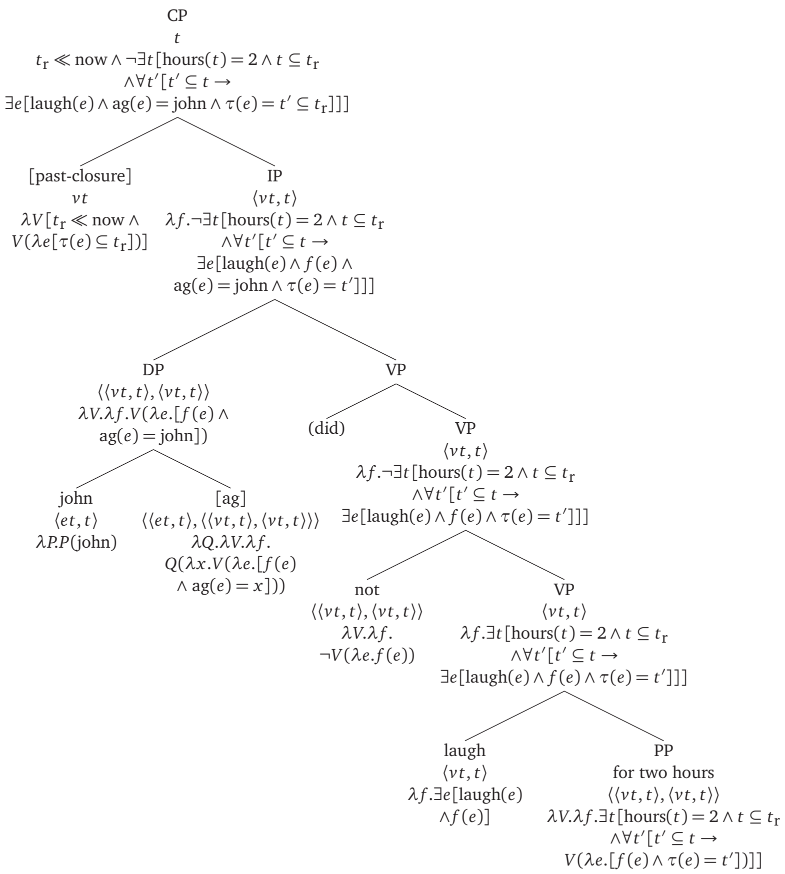

Figure 6: LF for Example (25): John didn't [laugh for two hours]

because in order for there to be a suitable two-hour event we would need to introduce a "negative event" whose runtime would be the two hours in which John didn't laugh. For independent justification of the subinterval-based translation of the *for*-adverbial used here, and for an alternative account of its scopal behavior, see Champollion (2010), Chapters 6 and 9.

Finally, let me briefly note that modals and other fixed-scope operators can be treated in the same way as negation. Setting aside the well-known intricacies of possible-world semantics, the lexical entry for modals like *may* and *must* will look like this:

(26) $[\![\text{may}]\!] = \lambda V \lambda f \Diamond V(\lambda e[f(e)])$

(27) $[\![\text{must}]\!] = \lambda V \lambda f \Box V(\lambda e[f(e)])$

For these entries to lead to interpretable formulas, the interpretation of the representation language must of course be suitably intensionalized. The details do not interact with my proposal.

4. DISCUSSION

The present proposal shows that Neo-Davidsonian event semantics does not pose a particular problem when it is combined with standard accounts of quantification, be they syntactic or semantic. It furthermore allows us to use a standard translation of *not* in terms of logical negation. Previous researchers have considered quantification and negation particularly problematic for event semantics. The specific framework proposed here differs from business as usual only in that it places existential closure of the event variable inside the verb, rather than at sentence level. This then provides a simple account for the fact that quantifiers always take scope above existential closure, a fact which is difficult to model otherwise since it requires stipulating that quantificational arguments obligatorily take wide scope. Such a claim would be problematic especially in case of languages where quantifiers otherwise take scope in situ. By making it possible to interpret all quantifiers in situ, the framework proposed here combines the strengths of event semantics and type-shifting accounts of quantifiers and thus does not force the semanticist to posit either a default underlying word order or a syntactic LF-style level. It is therefore well suited for applications to languages where word order is free and quantifier scope is determined by surface order. Unlike the accounts in Beaver & Condoravdi (2007) and Eckardt (2010), it is completely standard in its assumptions and its underlying logic and should therefore be highly compatible with accounts of other phenomena formulated in the literature.

NOTE

The formal system presented in this paper has been developed with the help of the Penn Lambda Calculator (Champollion et al. 2007). This software tool has also been used to check the derivations for correctness and to generate the figures in this paper. Information on the calculator, as well as a basic version of the tool, is available at http://www.ling.upenn.edu/lambda. Please contact me via email at champoll@gmail.com for a more advanced version of the calculator, along with a file that implements the formal system and derivations presented here.

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