Local Plural Anaphora as Sub-event Distributivity

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1. Introduction

The goal of this paper is extend a neo-Davidsonian approach for distributive determiners like *each* to non-determiner occurrences. In particular, I focus on cases where a distributivity operator and a plural noun phrase form a local dependency. To this end, I will examine floating and binominal occurrences of *each* as well as reciprocity and plural reflexivity. I will argue for a single lexical entry for *each* that is suitable for all of its occurrences, and also show that this approach accounts for some subtle semantic properties often discussed in connection to these anaphoric constructions. The following section describes the crucial background assumptions on event semantics, and the remaining sections address the role of *each* in local plural anaphoric constructions. This paper abridges a portion of LaTerza (2014), to which I refer the reader for further details.

2. Neo-Davidsonian event semantics and thematic separation

In this section I will outline the particular neo-Davidsonian system that I assume throughout. Neo-Davidsonian representations of sentence meaning crucially involve thematic relations as shown in (1), a property that sets these apart from classic Davidsonian event analysis (Davidson (1967)).

(1)   a.   Brutus hugged Caesar quickly

         b. $\exists E[\text{AGENT}(E, b) \ \& \ \text{HUGGED}(E) \ \& \ \text{THEME}(E, c) \ \& \ \text{QUICK}(E)]$

Neo-Davidsonian analyses differ from one another with respect to how verbs compose with their nominal arguments. I follow others who argue for the strong neo-Davidsonian thesis that all nominal arguments are separated or severed from the verb meaning. The verb merely denotes a monadic predicate of events, and it is related to its argument indirectly through thematic relations. For arguments in favor of this approach and different varieties of implementation, I refer the reader to Schein (1993), Kratzer (1996), Pietroski (2005), and Williams (in press) among others. For the purposes of this paper, I will assume all verbs denote monadic predicates of events[1], as shown in (2).

(2) $[\![\text{hug}]\!] = \lambda E.\text{HUG}(E)$

I assume that all type e referential nominals compose with adpositions which essentially turn the type e expression into a thematic predicate of events, as shown in (3). I use v as the type name for events. See Krifka (1992) and Schein (1993) for discussion of this approach.

(3) $[\![\text{P}_\Theta]\!] = \lambda X_e.\lambda E_v.\Theta(E, X)$

The effect of an adposition is to turn a referring expression into a monadic predicate of events. Verb meanings in this approach are also monadic predicates of events. Since both nominals and verbs are type $\langle v, t \rangle$, they are able to compose by the operation of Predicate Conjunction[2]. See Pietroski (2005) especially for discussion of the role of Predicate Conjunction in neo-Davidsonian event semantics.

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[1]   I will use the term *event* throughout to refer to what Bach (1986) called *eventualities*, which denotes both events and states.

[2]   This operation is sometimes called Predicate Modification, as it is in Heim & Kratzer (1998).

After a verb and its argument compose by Predicate Conjunction, the resulting complex predicate is existentially closed by the Davidsonian event quantifier. For the purposes of this paper, I represent this quantifier as a silent element in the object language with the following lexical entry.

(4) $[\![\exists_v]\!] = \lambda P_{\langle v,t \rangle}.\exists E[P(E)]$

Above I provided only the details of event semantics needed for the proposals to come. In the next section, I add one more important piece from previous neo-Davidsonian studies; an event-based view of distributivity.

3. Sub-event distributivity: the Taylor-Schein approach

I refer to this approach as sub-event distributivity since the notion of sub-event plays a crucial role. Assuming a mereological approach to non-singular meaning (see, for example, Landman (2000)), a sub-event of some event E is any event E' that stands in the *part-of* with E: $E' \leq E$. Barry Taylor and Barry Schein have each used this idea in giving the meaning of distributive determiners.

Taylor (1985) used sub-events to represent the meaning of sentences like (5). Taylor's observation was that the two adverbs could be taken to modify different events: *gracefully* can be used to describe the totality of eating, while *quickly* describes sub-events of the eating that concern each individual crisp.

(5) Gracefully, Sally ate each crisp quickly
     (From Taylor (1985))

Taylor's idea can be regimented by having the universal quantifier associated with *each* scope above an existential sub-event quantifier. The scope of the sub-event quantifier includes the theme and the adverbial *quickly*.

(6) $\exists E[\text{GRACEFULLY}(E)\text{AGENT}(E,s) \ \& \ \text{EAT}(E) \ \& $
     $\forall x : \text{CRISP}(x)[\exists E' \leq E[\text{THEME}(E',x) \ \& \ \text{QUICKLY}(E')]]]$

In Schein's well-known argument[3] for separated all argument of the verb, he also makes use of the sub-event approach to distributivity. He argues that there are sentences that mix distributivity and cumulativity, such as (7), that can only be accounted for if one assumes separation and also the sub-event approach to distributivity (8).

(7) Josh and Ben made each customer three sandwiches
   (Based on examples from Schein (1993))

(8) $\exists E[\text{AGENT}(E, j \oplus b) \ \& \ \text{MAKE}(E) \ \& \ \forall x : \text{CUSTOMER}(x)[\exists E' \leq E$
     $[\text{GOAL}(E', x) \ \& \ \exists Y[\text{THREE}(Y) \ \& \ \text{SANDWICH}(Y) \ \& \ \text{THEME}(E', Y)]]]]$

For both Taylor and Schein, distributivity is viewed as a way of apportioning sub-events of a particular type to each atomic individual that is being quantified over. These individuals are taken to be thematic participants of some sort in these sub-events; specifically, the have the thematic role typically associated with the argument position where the distributive nominal appears. Anything within the scope of the distributive nominal contributes to the sub-event description.

Following Taylor and Schein's insights, I define the semantic value of *each* in (9). The composition of *each* with its arguments is represented schematically in (10).

(9) $[\![\text{each}]\!] =$
     $\lambda X_e.\lambda\Theta_{\langle e,\langle v,t \rangle\rangle}.\lambda P._{\langle v,t \rangle}.\lambda E_v.\forall x \leq X[\exists E' \leq E[\Theta(E',x) \ \& \ P(E')]]$

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[3] I do not give Schein's argument in this paper for reasons of space. I refer the reader to Schein (1993) and Kratzer (2000) for discussion.

(10)

$$\langle v, t\rangle$$

$$\langle v, t\rangle$$
$$P_{scope}$$

$$\Theta$$

each $X_{restrictor}$
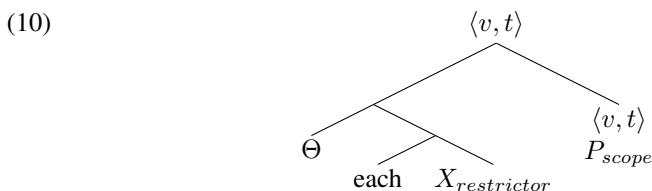
Notice that the scope argument of each is a type $\langle v, t\rangle$ predicate of events. This predicate will serve to define the properties of the sub-events introduced by *each*.

The present account relies crucially on the assumption that monadic predicates of events are ubiquitous; again, see Pietroski (2005). In the previous section, I outlined an approach where verbs, nominals, and the combination are all monadic predicates of events up to the introduction of the event quantifier. As such, these are all in principle possible scope sites of *each*. In the following sections, I will show that the definition given in (9) can be used not only for the determiner cases that Taylor and Schein were interested in, but also cases where *each* appears separated from its restrictor nominal.

In the following sections I will explore different phenomena that I argue all involves a non-determiner use of *each*. Before moving on, I present my main proposal about antecedence: for non-determiner occurrences of *each*, its restrictor value and thematic role are given by some plural antecedent noun phrase. The referent of the plural antecedent serves as the plurality of individuals that is quantified over, and the thematic role assigned to the antecedent serves as the thematic role argument of *each* (the second argument in the denotation from (9)).

4. Distance Distributivity

One empirical domain where distributivity morphemes appear separated from their restrictor argument is in canonical *distance distributivity* constructions, specifically floating and binominal *each*[4].

(11)   a. Floating *each*:
           Brutus and Caesar each drank two bottles

        b. Binominal *each*:
           Brutus and Caesar drank two bottles each

A crucial component that makes the present analysis suitable for both varieties of distance distributivity is that virtually every branching node is interpreted as a $\langle v, t\rangle$ predicate. This includes both verb phrases and nominal expressions. As mentioned earlier, the scope argument for *each* is a $\langle v, t\rangle$ predicate, which means that both verb phrases and nominals should be possible scope sites. It is this assumption that allows *each* to compose with verb phrases, as in the floating example (11a) and with nominals, as in the binominal example (11b). This approach also makes it possible for *each* to compose with these different types of expressions without type shifting.

Champollion (2012) gives a similar neo-Davidsonian account that treats floating and binominal *each* as instances of the same lexical item modulo type shifting. I take this to provide initial motivation that a neo-Davidsonian analysis can provide the means for a unified analysis of distributivity morphemes. I argue that the Taylor-Schein account can account for distance distributivity without type shifting, and furthermore can be used to give a semantics for distance distributivity in ditransitive sentences, which were not discussed by Champollion.

Ditransitive sentences, among other things, provide more options for antecedence than simple transitive sentences. At the minimum an analysis of distance distributivity be able to account for cases where the antecedent is not the next highest co-argument. Furthermore, distransitive sentences provide an example where a floating-*each* sentence and its binominal counterpart are not synonymous, as the arguable are above in the transitive (11).

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[4] I use the terms *floating* and *binominal* descriptively; the former to refer to distance distributivity constructions where *each* appears in the middle-field between the subject and the VP, and the latter to refer to cases where *each* appears immediately following a numeric host nominal. I refer the reader to Zimmermann (2002) for a thorough empirical overview of distance distributivity.

Consider the following pair. (12a) can be used describe several different types of situations, including a situation where there are six judges total, Josh gave two deserts to three of them, and Ben gave two desserts to the other three. On the other hand, (12b) has a more restricted range of readings; importantly, it cannot have the six-judge reading that (12a) can have. That is, (12b) can only truthfully describe situations in which there are at most three judges[5].

(12)   a. Josh and Ben each gave two desserts to three judges

       b. Josh and Ben gave [two desserts each] to three judges

This difference in meaning between the two constructions in accounted for since floating *each* (12a) takes scope over the entire verb phrase, include the goal nominal *three judges*. Binominal *each* (12b) scopes only over the numeric nominal that it adjoins to; as such *three judges* is outside of its scope. Recall from the previous section that being within the scope of *each* corresponds to being part of the sub-event portion of the truth conditions which describes the actions of each atom being quantified over. Thus, for the floating case, each of Josh and Ben are said to have their own sub-events where two desserts are the theme and three judges are goal. Conversely, for the binominal case the goal nominal is outside the scope of *each*, and so these are taken to be the judges of the "main events"; it is not specified for the binominal case how many judges where involved in Josh and Ben's respective sub-events. Below I provide the LF and truth conditions for the pair in (12) following the proposal made above together with a standard syntax for distransitive sentences (see Larson (1988), among others.)
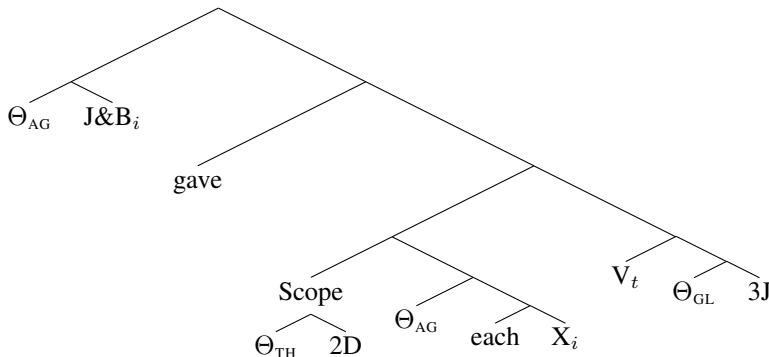
(13)   a. [Josh and Ben]$_i$ [each X$_i$ [gave two desserts to three judges]]

       b. $\exists E[\text{AG}(E, j \oplus b) \,\&\, \forall x \le j \oplus b[\exists E' \le E$
         $[\text{AG}(E', x) \,\&\, \text{GIVE}(E') \,\&\, \text{TH}(E', 2D) \,\&\, \text{GL}(E', 3J)]]]$

       c.
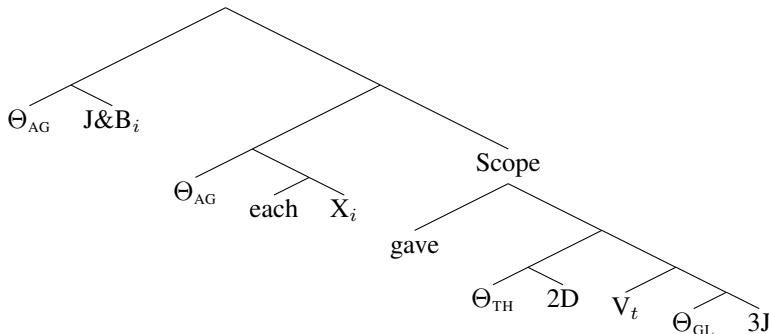
(14)   a. [Josh and Ben]$_i$ gave [[two desserts] each X$_i$] to three judges

       b. $\exists E[\text{AG}(E, j \oplus b) \,\&\, \text{GIVE}(E) \,\&\, \forall x \le 4W[\exists E' \le E$
         $[\text{AG}(E', x) \,\&\, \text{TH}(E', 2D)]] \,\&\, \text{GOAL}(E, 3J)]$

       c.

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[5] For discussion on why the truth of these sentences requires not having too many judges, see Carlson (1984) and subsequent work.

5. Reciprocity

One of the central problems in the semantics of reciprocity is accounting for the range of interpretations known to exist for reciprocal sentences; see Langendoen (1978) and Dalrymple et al. (1998) among others. The issue can be demonstrated by considering the various types of situations that make (15) true.

(15)   The dots are pointing at each other

The sentence (15) can be true if every dot is pointing and being pointed at by every other dot; though it may also be true of situations with less pointing also. Researchers have taken stock of the range of interpretations available to reciprocal sentences like (15); I borrow the following range of interpretations from Beck (2001).
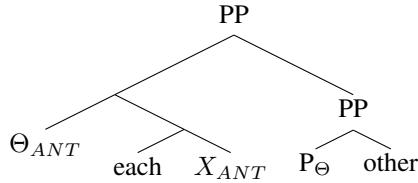
(16)

The range of reciprocal interpretations	
Strong Reciprocity (SR)	$\forall x \in A[\forall y \in A[x \neq y \rightarrow xRy]]$
Partitioned SR (PSR)	There is a partition PART of A such that $\forall X \in \text{PART}[\forall x \in X[\forall y \in X[x \neq y \rightarrow xRy]]]$
Intermediate Reciprocity (IR)	$\forall x \in A[\forall y \in A[\exists z_i...z_n \in A[x = z_i$ $\& \ y = z_j \ \& \ z_i R z_n \ \& \ ...z_{n-1} R z_n]]]$
Weak Reciprocity (WR)	$\forall x \in A[\exists y \in A[x \neq y \rightarrow xRy]$ $\& \ \forall y \in A[\exists x \in A[x \neq y \rightarrow xRy]$
One-way Weak Reciprocity (OWR)	$\forall x \in A[\exists y \in A[x \neq y \ \& \ xRy]]$
Inclusive Alternative Ordering (IAO)	$\forall x \in A[\exists y \in A[x \neq y \ \& \ (xRy \ \lor \ yRx)]]$

Langendoen (1978) was the first to observe that there exists certain entailment properties among the description above used for the various reciprocal interpretations. Specifically, he noticed that if a situation satisfies the conditions of a strong type of reciprocity, say Strong Reciprocity from above, then it will also satisfy the conditions of a weaker type of reciprocity. This lead Langendoen to propose that there is a single weak semantics for reciprocals, since these weak conditions are satisfied by any type of "stronger" reciprocal situation. Although Langendoen's strategy been criticized in works such as Dalrymple et al. (1998), I propose that a single-weak-meaning strategy is correct for reciprocal semantics. Although I cannot present arguments in favor of this approach here, I refer the reader to LaTerza (2010) and LaTerza (2014) for discussion.

The specific type of weak reciprocity that I adopt is not chosen arbitrarily. Instead, it can be shown that the Taylor-Schein approach to distributivity yields truth conditions for reciprocal sentences that are roughly equivalent[6] to One-Way Weak Reciprocity. This is derived by assuming a certain syntactic decomposition of bipartite[7] reciprocals; in particular it is the same configuration involved with binominal *each* constructions where the distributor adjoins to a host nominal, though in this case the host nominal is an *other* morpheme instead of a numeric noun phrase. The subscript ANT below indicates that the reference of the restrictor and the thematic role of *each* both come from its antecedent plural noun phrase.

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[6]   The present account uses events, thematic relations, and mereology, which is absent from traditional renditions of One-Way weak reciprocity. However, both types of truth conditions express that each individual in the antecedent plurality did something to at least one other from the same plurality, and the action was no necessarily reciprocated.

[7]   Strictly speaking, this account is just about bipartite reciprocals of the *each other* type. *One another* reciprocals can be accounted for by assuming a silent distributor, treating them essential as **each** *one another*; see LaTerza (2010).

(17) Proposed syntactic decomposition of *each other*

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                              PP
                    ╱                  ╲
                  ╱                      PP
                ╱                     ╱      ╲
       Θ_ANT                      ╱          ╲
              each    X_ANT    P_Θ    other
```

With this LF for reciprocals, the truth conditions for (15) under the current approach are given below.

(18) Truth conditions of (15):
$\exists E[\text{AGENT}(E,\text{the dots}) \,\&\, \text{POINT}(E) \,\&\,$
$\forall x \leq \text{the dots } [\exists E' \leq E[\text{AGENT}(E', x) \,\&\, \text{THEME}(E',\text{another dot})]]$

To paraphrase (18): there are events E of the dots pointing, and for each single dot x, there are sub-events of E where x points at another dot among the dots. These conditions are weak enough that they can be satisfied by any of the stronger types of reciprocal situations. See LaTerza (2014) for arguments why the weakest reported interpretation, Inclusive Alternative Ordering, should not have to be accounted for by a semantic theory of reciprocity.

This approach to reciprocity also provides an account of some puzzling paradigms involving reciprocals in ditransitive constructions. The following pair of sentences was introduced by Williams (1991). He observed that the non-reciprocal sentence (19a) has a bizarre interpretation where each patient received a plurality of noses. While the reciprocal sentence (19b) the same interpretation, it also allows a plausible reading where each doctor received just one new nose from another doctor. This second interpretation is missing from (19a).

(19)   a. The doctors gave each patient new noses

        b. The doctors gave each other new noses

The explanation for these different meaning is on par with the discussion of floating versus binominal *each*: it is an issue of scope. Like floating *each*, the determiner *each* in (19a) has a wide enough scope to include other noun phrases, in this case direct object *new noses*. As such, the direct object is interpreted as the theme of sub-events related to each doctor, and thus we have the interpretation that each doctor received a plurality of new noses. Conversely, like binominal *each*, the *each* of the bipartite reciprocal scopes over just its host nominal; in (19b) this is the *other* morpheme. For (19b), the direct object is outside the scope of *each*, and so it does not express anything about how the themes were involved in each doctor's sub-events. Instead, what is expressed that the main event have new noses as themes, which can be satisfied if each sub-event had only a single nose as theme.

To show that this paradigm does not rely on a peculiar property of bare plurals, consider the following pair.

(20)   a. The doctors gave each patient a new car

        b. The doctors gave each other a new car

Notice that (20a) has a covariance interpretation where each patient received a different car, though (20b) is missing this interpretation; (20b) expresses that the same car was passed back and forth among the doctors. As is well-known, a singular indefinite can receive a covariance interpretation only when it is within the scope of a distributive quantifier. This paradigm is accounted for by the proposed syntax and semantics of distributivity. For (20a), *each* scopes over the direct object, and so covariance is permitted, though in (20b), *a new car* is not within the scope of *each*, and so a covariance interpretation is not possible.

6. Plural reflexivity

Several authors have observed that plural reflexives in languages like English have a certain distributive interpretation to them: plural reflexives sentences typically report that each individual in the plurality performed some action on himself; see Cable (2014) for discussion and references. To give an example, if it is true that Brutus and Caesar kicked themselves, then it seems to follow that each of Brutus and Caesar kicked himself.

Cable (2014) provides an account where this distributive interpretation is given by the presence of a silent distributivity operator adjoined to the VP. I agree with Cable that a silent distributivity operator account for this interpretation; however, I propose that the silent distributivity operator adjoins to a different position than the VP. Like binominal *each* adjoins to a numeric nominal, and the *each* in bipartite reciprocals adjoins to an other morpheme, I propose that the silent distributivity operator of plural reflexive constructions adjoins directly the *self* morpheme. This decomposition[8] is shown below.

(21) Proposed syntactic decomposition of plural reflexives
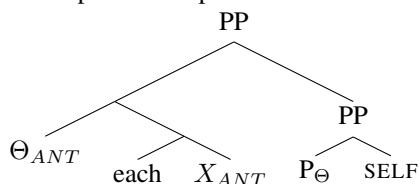
Adjoining *each* directly to a nominal projection is made possible by the particular neo-Davidsonian framework assumed here. This syntax is not possible given the classic definitions of distributivity operators (see for example Schwarzschild (1996)) that are assumed by Cable. I thus provide the truth conditions of the plural reflexive sentence (22a) in (22b). I will assume here that the semantic value of the *self*-morpheme is a variable bound by the universal quantifier introduced by *each*.

(22) a. Brutus and Caesar kicked themselves

b. $\exists E[\text{AGENT}(E, b \oplus c) \,\&\, \text{KICK}(E) \,\&\, \forall x \le b \oplus c[\exists E' \le E[\text{AGENT}(E', x) \,\&\, \text{THEME}(E', x)]]]$

The benefit of having the distributivity operator attach to a nominal instead of at the VP-level can be seen in ditransitive sentences. The VP-level approach assumed by Cable works only when the antecedent of the reflexive is the subject, since the VP-level distributivity operator only distributes over subjects. However, certain ditransitive sentences have plural reflexives whose antecedent is also within the VP.

(23) God showed us to ourselves

A VP-level distributivity operator does not help when distributivity is required within the VP. If the VP is free to attach to nominals also, then it can have other antecedents aside from just subject. See LaTerza (2014) for discussion and further arguments in favor of this approach to reflexives.

7. Conclusion

Following insights from Taylor (1985) and Schein (1993), I have argued for a single event-based lexical entry for ⟦each⟧ that accounts for the semantic composition of distributivity DPs in argument position as well as certain adverbial occurrences of *each*. The adverbial occurrences of *each* share the property of forming a referential dependency with a plural noun phrase within the same clause as *each*. Binominal *each*, reciprocals, and plural reflexives all involve a local composition of *each* to a nominal projection; more specifically, a nominal projection that is interpreted as a thematic $\langle v, t \rangle$ predicate. As a final remark, I will make some suggestions about a consequence this account may have for the syntax and

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[8] Recall that this is almost the same LF schema as given for reciprocals, with the exception of the host nominal to which the distributivity operator adjoins. In the case of reciprocals, this morpheme is *other*, and in the case of reflexives, the morpheme is *self*.

semantics of binding. The account offered here suggests that all of these local anaphoric dependencies involve the same *each*. This opens the way for a novel syntactic hypothesis: the well-known locality properties of reciprocal and reflexives, usually captured by some version of Principle A, can be reduced to the well-known locality properties of distance distributivity elements like floating and binominal *each*.

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Proceedings of the 32nd West Coast Conference on Formal Linguistics

edited by Ulrike Steindl, Thomas Borer, Huilin Fang, Alfredo García Pardo, Peter Guekguezian, Brian Hsu, Charlie O'Hara, and Iris Chuoying Ouyang

Cascadilla Proceedings Project   Somerville, MA   2015