On the Syntax-Semantics Interface of *Different* and *Each Other*

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Iddo Lev and Iván García

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1 Introduction

- Our goal is to develop a parsimonious account of the interpretation of sentences containing the adjective *different* and the reciprocal anaphor *each other*, starting from reasonable assumptions regarding the syntax of these expressions, and a fairly conservative view of the syntax-semantics interface.
- We're interested in addressing this question: How does the interpretation of *different* interact with an independently motivated analysis for *each other*?
- We concentrate on sentences such as the following:

(1) Overt item of comparison
   a. Sue read a different book than Bill (did/read/wrote).
   b. Sue read different books than Bill (did/read/wrote).

(2) Non-overt item of comparison
   a. These wheels are turning at a different rate (from/than each other).
   b. These wheels are turning at different rates (from/than each other).

(3) Other Constructions
   a. Different people discovered America and invented bifocals.
   b. Different boys read different books. ('double *different*')
   c. Every boy read a different book. ('Q-bound reading')

1.1 *Each Other*

- The reciprocal anaphor *each other* expresses a type $\langle 1,2\rangle$ (polyadic) quantifier (Keenan and Westerståhl, 1997). Its meaning can be characterized by the expression $\lambda z \lambda R.\textsc{recip}(z,R)$, where z is a plurality and R is a binary relation. *Each other* is anaphorically dependent on the plurality z, and the binary relation R takes z as its first argument.

- RECIP is 'underspecified' in that it appears to express different quantifications in different contexts, and can be disambiguated to specific truth conditions depending on the particular relations denoted by predicates ocurring in the sentence (Dalrymple et al., 1998).

1.2 *Different*

- The meaning of *different* typically relies on some salient dimension in the context of utterance, as indicated by its interpretation in (4). This contextually salient feature may be the item's identity, its type, etc. (Nunberg, 1984). We will not make reference to this feature explicitly in the discussion below.

(4) $diff[f](x, y) \equiv f(x) \neq f(y)$, for some salient feature f.

(5) a. John is different from Bill.
    b. $diff[f](john, bill)$
    c. e.g. $f = \lambda x.height\text{-}of(x)$

- How does the core meaning of *different* interact with reciprocal *each other*?

1.3 Beck (2000) on *different*

In a recent analysis, Sigrid Beck claims that *different* is ambiguous (Beck, 2000):

- One of its interpretations corresponds to the German *anders* and involves an overt item of comparison, as in (6)a below.
- The other corresponds to the German *verschieden* and does not involve an overt item of comparison, as illustrated in (6)b.

(6) a. Sue read a different book than Bill.
    b. Sue and Bill read different books.

Beck's analysis is somewhat limited in its scope. In particular:

- She ignores the phrasal version of overt comparison (as in (1)a).
- She does not try to explain how the interpretation of *each other* interacts with that of *different* in sentences such as (2)b.
- Her analysis rules out sentences such as (2)a, but there is plenty of evidence to the contrary (which we will discuss below in section 3.2.1).

We now explore these problems (and others) in more detail.

2 Overt Item of Comparison

Beck analyzes sentence (7)a as (7)b.

(7) a. Luise owns a different car than Otto.

b. $\mathit{anders}(\mathit{Luise}, \mathit{Otto}, \lambda z \lambda v.[\mathit{car}(v) \wedge \mathit{own}(z, v)])$
where $\mathit{anders}(x, y, R) \equiv \exists u.[Rxu \wedge \mathit{diff}(u, \iota v.Ryv)]$

There are at least three problems with this analysis.

2.1 Problem 1

- According to Beck, the example above entails the uniqueness of Otto's car.
- But it would be reasonable to utter (7)a if Otto owns more than one car and Luise owns a car which is different from some car of Otto's.
- Of course, this shortcoming can be fixed easily.

(8) $\mathit{anders}(x, y, R) \equiv \exists u \exists v.[Rxu \wedge Ryv \wedge \mathit{diff}(u, v)]$

2.2 Problem 2

Beck's analysis is not compositional.

- Beck derives the relation $\lambda z \lambda v.[\mathit{car}(v) \wedge \mathit{owns}(z, v)]$ by conjoining the meanings of the noun property ($\lambda v.\mathit{car}(v)$) and main predicate ($\lambda z \lambda v.\mathit{own}(z, v)$) directly.
- This move is problematic because it introduces a conjunction that cannot be traced back to an expression in the sentence, and does not yield an appropriate NP denotation.

Instead, we will assume that the noun property combines directly with its determiner sister. If we take that determiner to be *a-different*, we obtain:

(9) a. $\mathit{Diff}_I[\mathit{car}](\mathit{Luise}, \mathit{Otto}, \mathit{own})$

b. $\mathit{Diff}_I[B](x, y, R) \equiv \exists u, v \in B.[Rxu \wedge Ryv \wedge \mathit{diff}(u, v)]$

2.3 Problem 3

- The third problem with Beck's analysis is that it cannot be extended to sentences where *than* takes a clausal complement. The reason for this is that the predicate in the *than* clause may be different from that of the main clause, as in (10)a, with the truth conditions in (10)b (here, $\exists(P, Q) =_{\text{def}} P \cap Q \neq \emptyset$):

(10) a. Luise owns a different car than Otto sold.

b. $\exists(\lambda x.\mathit{car}(x) \wedge \exists(\lambda y.\mathit{car}(y) \wedge \mathit{sold}(\mathit{otto}, y), \lambda y.\mathit{diff}(x, y)), \lambda x.\mathit{own}(\mathit{luise}, x))$

Plural Nouns

We follow current practice in assigning to a singular noun such as *car* a set of individuals as its extension, while the extension of its plural counterpart *cars* includes both individuals and sets (or groups) of these individuals (Link, 1983; Schwarzschild, 1996; Landman, 2002). This means that the plural is semantically unmarked in that it does not imply a cardinality greater than one.

(12) i. $car = \{a, b, c, \ldots\}$
ii. $\mathbf{cars} = \{a,\ b,\ c,\ a \oplus b,\ a \oplus c,\ a \oplus b \oplus c,\ \ldots\}$

The variables x and y in (11) range over car-groups (including individuals). The quantifier a in (10) can be modified to accept sets of such groups: $a(P, Q) \equiv atom(P) \cap atom(Q) \neq \emptyset$, where $atom(S)$ is the set of atomic individuals in S (those not composed using $\oplus$ from other members of S).

- We also need to take into account cases involving plural NPs.

(11) a. Luise owns different cars than Otto sold.
b. = Luise owns cars that are different from cars Otto sold.
c. $\exists(\lambda x.\mathbf{cars}(x) \wedge \exists(\lambda y.\mathbf{cars}(y) \wedge sold(otto, y), \lambda y.diff^{\square}(x, y)), \lambda x.own(luise, x))$

- Here, **cars** denotes the set of all cars and car-groups (see the box on "Plural Nouns"), and the box in $diff^{\square}(x, y)$ indicates that this form is ambiguous and is a shorthand for more explicit forms (see the box on "Plurality Ambiguity").

- Opinions diverge regarding whether the NP after *than* in (7)a is just an NP, or whether the existence of a clause after *than* in (10)a indicates that the material after *than* in (7)a is also a clause from which everything had been elided except for the subject NP, or a nominal element, an anaphoric comparative operator that contains a free variable over propositions. (Hankamer, 1971; Moltmann, 1993; Hendriks, 1995; Merchant and Kennedy, 2000; Merchant, 2001).

3 No Overt Item of Comparison

3.1 Two Theories

3.1.1 Beck's Theory

Beck identifies in (14) three readings, as shown in (15).

(14) Sue and Bill read different books.

Plurality Ambiguity: Underspecified Representation

Sentences with pluralities may have different readings due to distributive/collective ambiguities as well as additional options: mixed, cumulative, and serial readings (as well as scope ambiguities of the quantifiers). Because the syntax gives no information about which reading was intended (and additional factors of context, processing, and convention are needed to determine that), we assume that the syntax-semantics interface should produce an *underspecified form* which describes the set of possible readings. In this form, we mark the ambiguous predicate with a $\Box$, to emphasize that we are not denoting just one possible model-theoretic object. For example:

(13) a. The kids lifted the pianos.
b. $\textit{lifted}^{\Box}(\textit{the-kids}, \textit{the-pianos})$

Note: the $\Box$ is *not* a semantic operator, and must not be confused with semantic operators in the literature on plurals (such as, e.g., the pluralization operator $*$ of Link (1983)). It is just a representational device. (cf. (Verkuyl and van der Does, 1995) for a related discussion).

(15)

NP-dependent:	The books that Sue read are different from the books that Bill read.
internal-reciprocal:	Sue and Bill read books, and those books are different from each other.
discourse-anaphoric:	Sue and Bill read books that are different from some salient books.

In all the discussion that follows, we ignore the discourse-anaphoric reading. For the two other readings, Beck claims that they are obtained through the same mechanism:

(16) a. In both the internal-reciprocal and the NP-dependent readings of (14), "different books" means "books that are different from each other with respect to some salient criterion or cover".
- In the internal-reciprocal reading, this salient cover can be any cover of the set of books which is based on some salient criterion. For example, if the criterion is identity, the cover would be $\{\{book_1\}, \{book_2\}, \ldots\}$. If the criterion is genre, the cover would be {science fiction books, linguistics books, ...}.
- In the NP-dependent reading, the salient cover is {the books that Sue read, the books that Bill read}.

b. This mechanism is different from the explanation for the overt item of comparison. The evidence Beck brings for this claim is that the overt item of comparison is expressed in German by *anders* while the two readings here are expressed by *verschieden*.

Although Beck does not make this point clear, (16)a means that when *each other* appears explicitly, it is always anaphoric to *books* and never to *Sue and Bill*. We can summarize this as follows:

> Beck's Theory
>
> In an expression "different N from each other", *each other* is always anaphoric to the plural noun N. Both the internal-reciprocal and the NP-dependent readings are obtained in this way through the use of appropriate cover sets.

3.1.2 Our Theory

In contrast, we suggest that in (17), *each other* may be anaphoric to either *books* or *Sue and Bill*.

(17) Sue and Bill read different books from each other.

We can summarize our theory as follows:

> Our Theory
>
> In an expression "different N from each other", *each other* can be anaphoric to the plural noun N, as well as to other plural nouns in the sentence. Only the first case gives the internal-reciprocal reading whereas only the second case gives the NP-dependent reading.

3.2 Evidence Against Beck's Theory

3.2.1 Singular *Different*

Beck's proposal immediately runs into a problem with sentences such as (18).

(18) a. Sue and Bill read a different book.
b. Sue and Bill read a different book from/than each other.

Beck claims that:

- (18) has only the discourse-anaphoric reading and not the NP-dependent (or internal-reciprocal) reading.
- Presumably she would claim that (18)b is ungrammatical because the NP is singular and cannot be modified by a reciprocal *different*. She reads the sentence as "Sue and Bill read a book, and that book is different from each other".

But in fact, people do say sentences such as (18)b, as shown in (20), and they do use sentences such as (18)a with a non-anaphoric reading, as shown in (19).

(19) a. Men and women have a different sense of humour![1]

[1] http://newmediasphere.blogs.com/nms/2005/02/men_and_women_h.html

b. Clearly, you and I read a different book by that title.[2]

(20) a. ... as long as the road is slick enough for the front wheels to turn at a different rate than each other around turns.[3]

b. Black folks and white folks ... are raised in a different culture than each other, even within one country.[4]

c. Where the child's parents have a different surname from each other, great care should be taken when deciding the surname by which their child will be known.[5]

The reason people use such forms seems to be to emphasize that each element of the subject is related to just one element of the NP. For example, using "different books" in (19)b might confuse the listener regarding how many books each of you and I read.

3.2.2 Plural *Different*

- If *each other* is anaphoric to the subject in (21), it is reasonable to conclude that this is also possible when *different* is followed by a plural noun, as in (22).

(21) The four wheels turn at a different speed (from/than each other).

(22) The four wheels turn at different speeds (from/than each other).

- Moreover, in languages with a richer gender morphology than English, gender marking on *each other* may force it to be anaphoric to the subject.

- For example, consider the data from Hebrew in (23) and (24).

(23) arba'at ha-galgalim$_i$ mistovevim b-mhirut shona
four.*def* wheels.*def.masc* turn.*pl* in.speed.*sing.fem* different.*pl.fem*
[ze mi-ze]$_i$ / *[zo mi-zo]$_i$
from.each-other.*masc* / *from.each-other.*fem*
"The four wheels$_i$ turn at a different speed from each other$_i$."

(24) arba'at ha-galgalim$_i$ mistovevim b-mhiruyot$_j$ shonot
four.*def* wheels.*def.masc* turn.*pl* in.speeds.*pl.fem* different.*pl.fem*
[ze mi-ze]$_{i/*j}$ / [zo mi-zo]$_{*i/j}$
from.each-other.*masc* / from.each-other.*fem*
"The four wheels$_i$ turn at different speeds$_j$ from each other$_{i/j}$."

- If the masculine version of *each other* (*ze mi-ze*) is used, it must be anaphoric to "the four wheels", and the meaning is: "each wheel turns at a different speed than the other wheels". In contrast, if the feminine version (*zo mi-zo*) is used then it must be anaphoric to the "speeds", and the meaning is: "each wheel turns at various speeds". The problem with Beck's theory is that it

[2] http://www.spinnoff.com/bb/viewtopic.php?p=31228&
[3] http://www.ford-trucks.com/forums/archive/topic/203644.html
[4] http://www.dccycles.com/arch/01/03/mar00325
[5] http://www.nottinghamshire.gov.uk/home/youandyourcommunity/registrars/registrars-births.htm

assumes that *each other* is always anaphoric to the plural noun in its NP, and so it would require the masculine version of *each other* to be anaphoric to the feminine speeds.

- A similar situation can be found in Spanish, where the reciprocal anaphor must bear the same agreement features as its antecedent. Observe that the reciprocal *los unos de los otros* (masculine form of "each other") in (25) must be anaphoric to the subject NP *los seres vivos* ("the living beings"). Thus (25) means that each living being performs actions that are different from those performed by other living beings. In contrast, sentence (26) means that living beings perform various actions.

(25) [Los seres vivos]$_i$ [...] generamos acciones$_j$
the.*pl.masc.* beings living.*pl.masc.* perform actions.*pl.fem.*
diferentes [los unos de los otros]$_{i/*j}$.
different the.*pl.masc.* ones.*pl.masc.* from the.*pl.masc.* others.*pl.masc.*
"Living beings$_i$ perform different actions from each other$_i$."

(26) [Los seres vivos]$_i$ [...] generamos acciones$_j$
the.*pl.masc.* beings living.*pl.masc.* perform actions.*pl.fem.*
diferentes [las unas de las otras]$_{*i/j}$.
different the.*pl.fem.* ones.*pl.fem.* from the.*pl.fem.* others.*pl.fem.*
"Living beings perform different actions$_j$ from each other$_j$." [6]

3.2.3 Finally

Finally, Beck's explanation does not provide a systematic syntax-semantics interface that explains how the subject NP produces a salient cover which supports the NP-dependent reading.

3.3 Our Solution

Our theory does not run into the problems mentioned above.

- In particular, for the singular case such as (27)c, our theory allows *each other* to be anaphoric to *Sue and Bill*, and predicts the NP-anaphoric reading.
- Moreover, in contrast to Beck, we provide a uniform analysis of (27)b and (27)c: we use the same meaning of *different* in both cases (the analysis in (27)b is the same as in section 2).

(27) a. Let $R = \lambda x \lambda y.\mathit{Diff}_1\,[\mathit{book}](x, y, \mathit{read})$
b. Sue read a different book than Bill.
$R(\mathit{sue}, \mathit{bill})$
c. Sue and Bill read a different book than each other.
RECIP$(\{\mathit{sue}, \mathit{bill}\}, R)$

[6] http://www.arnoldoaguila.com/finalidad.html.

As for the plural case mentioned in section 3.2.2, our theory fits the data because it allows *each other* to be anaphoric to either the plural noun *speeds* or the subject *the four wheels* in (28), and yields the correct truth conditions for the two readings in (29)a and (29)b respectively.

(28) The four wheels turn at different speeds (from/than each other).

(29) a. $\textsc{recip}(\textit{the-4-wheels},\ \lambda x\lambda y.\textit{Diff}[\mathbf{speeds}](x, y, \textit{turn}))$

b. $\exists(\lambda w.\mathbf{speeds}(w) \wedge \textsc{recip}(w,\ \lambda x\lambda y.\textit{diff}(x, y)),$
$\textit{turn-at}^{\square}(\textit{the-4-wheels}, w))$

[A comment on (27)c: The truth conditions there say: "Sue read a different book than Bill and Bill read a different book than Sue", and this has a redundancy because the first part is true iff the second part is. But the redundancy is due to the fact that *different* is a symmetric relation, i.e. $\textit{diff}(x, y)$ iff $\textit{diff}(y, x)$. With other non-symmetric relations, the redundancy disappears, as in (30).

(30) a. Sue and Bill think they read a longer book than each other.

b. One reading is: Sue thinks she read a longer book than Bill and Bill thinks he read a longer book than Sue. The two parts are different.]

4 Extra

4.1 A Few Points

A few more notes about the NP-dependent readings:

(31) Sue and Bill read different books (from each other).

(32) The books that Sue and Bill read are different (from each other).

- Sentence (31) can be true even if each person read just one book. This is supported in the theory in virtue of taking *books* to denote the set of all book-groups, including individuals (see again the box on "Plural Nouns" above).

- In (32), *each other* must be anaphoric to the books (both syntactically and semantically), and not to *Sue and Bill*. Our theory can support this case, but a subtle point (which we don't have time to get into here) is that this sentence really means: "The sets of books that Sue and Bill read are different (from each other)". The reciprocation acts on these sets. For example, if Sue read books a and b, and Bill read books c and d, then we want to say $\textsc{recip}(\{a \oplus b, c \oplus d\}, \lambda x\lambda y.\textit{diff}^{\square}(x, y))$.

4.2 Higher-Order Reciprocation

We showed above in (27), repeated here as the second-to-last pair of sentences, how our theory employs a uniform analysis of the overt and covert cases of comparison. That pair is an instance of a systematic schema as shown in the following table. This suggests that *different* and *each other* are flexible operators that may operate on complex sets, as shown in the last pair in the table.

"a R b" "a and b are R each other"	$R(a, b)$ $\text{RECIP}(\{a, b\}, R)$
Sue likes Bill. Sue and Bill like each other.	$\underline{R = \lambda x \lambda y.like(x, y)}$ $R(sue, bill)$ $\text{RECIP}(\{sue, bill\}, R)$
Sue thinks she likes Bill. Sue and Bill think they like each other.	$\underline{R = \lambda x \lambda y.think(x, like(x, y))}$ $R(sue, bill)$ $\text{RECIP}(\{sue, bill\}, R)$
Sue read a different book than Bill. Sue and Bill read a different book (than e.o.).	$\underline{R = \lambda x \lambda y.Diff_1[book](x, y, read)}$ $R(sue, bill)$ $\text{RECIP}(\{sue, bill\}, R)$
Sue read a different book than Bill wrote. Sue read and Bill wrote a different book (than e.o.).	$\underline{R = \lambda P \lambda Q.Diff_2[book](P, Q)}$ $R(read_{sue}, wrote_{bill})$ $\text{RECIP}(\{read_{sue}, wrote_{bill}\}, R)$

Notes on the table:

1. $Diff_1[B](x, y, R) \equiv \exists u, v \in B.[Rxu \wedge Ryv \wedge diff(u, v)]$ (this was defined above).
2. $Diff_2[B](P, Q) \equiv diff^{\square}(P \cap B, Q \cap B) \ \wedge \ [P \cap B \neq \emptyset \wedge Q \cap B \neq \emptyset]$
3. When V is a binary relation, $V_a \equiv \{b : Vab\}$.
4. $Diff_1[B](x, y, R) \equiv Diff_2[B](R_x, R_y)$

5 Conclusion

- We provided a uniform account for the two cases: overt and covert item of comparison, in contrast to Beck's split.
- We showed that Beck's uniform explanation for the case of a covert item of comparison in terms of salient cover sets fails in the case of singular *different*, and in cases of gender agreement.
- In contrast, our assumption that *each other* may be anaphoric to either the subject or the noun modified by *different* explains well all the cases.
- Our theory produces the NP-dependent reading through a systematic syntax-semantics interface rather than relying on a theory of pragmatic covers (which does not explain how the syntactic structure leads to the particular cover for the NP-dependent reading).

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