Referential antecedents in Dynamic Semantics: simple, functional and otherwise

Keny Chatain

December 19, 2019

1 Non-dynamic behaviours of referential pronouns

As has been sporadically discussed in the literature, there exists a systematic difference between quantificational antecedents and referential antecedents to pronouns. The former seems to obey order constraints while the latter does not. Thus, cataphora to referential elements are natural but cataphora to quantificational elements is in general out (an effect known as *weak cross-over*):

(1) a. The person that interviewed him_1 likes the candidate_1.

b. #The person that interviewed him_1 likes some candidate or other_1.

Similarly, with more complex cases of functional anaphors, backwards donkey sentences are unintelligible but backwards paycheck sentences are flawless (also known as Bach-Peters sentences, Jacobson (2000))

(2) a. # Every applicant who filed it_1 on time got $[\text{some paperwork}]_1$ through quickly

b. Every applicant who filed it_1 on time got $[\text{the paperwork they wanted to}]_1$ through quickly

Under the framework of Dynamic Semantics, where clauses perform context updates, order constraints are natural and expected. They arise from the fact that updates must be applied sequentially, so that any update corresponding to a pronoun's clause must follow an update that makes its referent available. Schematically, dynamic theories demands the configuration in (3a) but crashes on the configuration in (3b):

(3) a. $g \xrightarrow{\text{antecedent update}} g[i \rightarrow \text{referent}] \xrightarrow{\text{pronoun update}} \ldots$

b. $^{*}g \xrightarrow{\text{pronoun update}} g \xrightarrow{\text{antecedent update}} g[i \rightarrow \text{referent}] \ldots$

Hence, the framework of Dynamic Semantics provides a shining account of order constraints for quantificational and indefinite antecedents. The case of referential antecedents, on the other hand, seem at odds with the assumption of sequential context updates. If

referential antecedents introduce discourse referents, just like indefinites and quantificational elements do, they should always precede their antecedents (in the relevant sense of "*precede*"), just as quantificational antecedents.

This problem is particularly acute in the case of crossed dependencies, like the Bach-Peters sentence in (4). In these cases, one can see that no amount of reordering of the constituents at LF will produce a structure in which all antecedents precede their anaphors, as needed for Dynamic Semantics.

(4) **Bach-Peters sentences**
[The pilot who shot at it$_2$ from above]$_1$ took down [the MIG that was chasing him$_1$]$_2$.
(Karttunen, 1971; Jacobson, 2000)

The goal of this note is to develop and explore the consequences of one solution to this problem within Dynamic Semantics, first suggested by Heim (1982). According to this solution, referential expressions do not introduce discourse referents for pronouns to pick up. Rather, they are themselves just like pronouns: they carry indices and obtain their reference from the assignment function. Pronouns co-indexed with referential expressions are therefore not bound but merely co-referent to them. Hence, the composition goes through regardless of what order a pronoun and a referential expression come in.

The second piece to this story is to explain why referential expressions do seem to introduce discourse referents, as attested by the fact that they can be used in out-of-the-blue contexts. Here, the solution assumes that referents may be accommodated if enough is presupposed about them. Referential expressions, because they carry much descriptive content, are especially liable to this process.

The process of referent accomodation is assumed to modify the input assignment to an utterance ; as such, it does not matter what order the referential expression and the pronoun find themselves in. The following schema in (5) sums up the explanation for the lack of ordering constraints with referential antecedents:

(5) a. **Anaphora:** ... the pilot$_i$ ... he$_i$

$$g \xrightarrow{\text{ACCOMMODATION}} g[i \rightarrow \textbf{pilot 1}] \xrightarrow{\text{...the pilot}_i\text{...}} g[i \rightarrow \textbf{pilot 1}] \xrightarrow{\text{...he}_i\text{...}} \dots$$

b. **Cataphora:** ... he$_i$ ... the pilot$_i$

$$g \xrightarrow{\text{ACCOMMODATION}} g[i \rightarrow \textbf{pilot 1}] \xrightarrow{\text{...he}_i\text{...}} g[i \rightarrow \textbf{pilot 1}] \xrightarrow{\text{...the pilot}_i\text{...}} \dots$$

The main contribution of this note is to spell out the accommodation procedure in details and in particular extend it to functional anaphors. Once the details have been filled in, we will derive a number of predictions beyond the lack of ordering constraints: first, we account for the possibility of paycheck pronouns ; next, we derive restrictions on the licensing of paycheck pronouns (Keshet, 2011) ; finally, we provide an account of the subordination constraint on functional anaphors (Roberts, 1987; Brasoveanu, 2007).

Our roadmap is as follows: in section 2, we spell out the accomodation procedure and how it can account for lack of ordering constraints. In section 3, we present the subordination constraint that applies to quantificational antecedents, present the accommodation

procedure requires to deal with these cases, and how paycheck pronouns avoid the subordination constraint. Section 4 presents some loose ends and extensions.

One caveat before we start: although this theory is meant to be embedded within dynamic semantics, our focus on referential elements and the theory itself permits me to present an entirely static account. Readers can substitute truth-conditions with the corresponding dynamic tests to recover the underlying dynamic account. Some talk of the dynamic aspect of the theory will be made toward the end (section 4.3)

2 Simple anaphors

2.1 Anaphoricity all the way through

So we assume that any referential expression -definite descriptions, proper names, etc.- carries an index. The referential expression acts as a presupposition on the value of this index. The presupposition that each type of referential expressions contributes is different. For proper names, the index is simply restricted to the referent of the proper name, as in (6a). For definites, the index is restricted to be part of the denotation of the NP, as in (6b).

(6) a. $[\![\text{Angela Merkel}_8]\!] = g(8)$ (**pres.:** $8 \in g$ and $g(8)$ is Angela Merkel)

b. $[\![\text{the}_8 \text{ chancellor of Germany}]\!] = g(8)$ (**pres.:** $8 \in g$ and $g(8)$ is a chancellor of Germany)

The special status of definites with respect to proper names is motivated by the known fact that previously mentioned definites lose their uniqueness presupposition, as (7) shows. Thus, we do not wish to encode uniqueness as part of the meaning of the definite[1].

(7) A man and a woman$_6$ talked to my sister in the street. The woman$_6$ told my sister the most incredible stories.
$\not\rightsquigarrow$ there is a unique woman (in the world/in the street)

With these assumptions, we predict that referential expressions may only be used if their referent is part of the assignment function, just like pronouns. Furthermore, definites used in such configurations will not trigger uniqueness presupposition, as confirmed by fact. Unwelcome is the prediction that they cannot be used in contexts where their referent is not in the assignment function, e.g. when they are discourse-new. In fact, they can:

(8) **Context:** *Speaker bursts into the room full of people he has never met.*

[1] There is a raging debate about which of the uniqueness or the anaphoric use, if any, is primitive to the English definite. Supporters of the uniqueness definite contend that anaphoric uses are uniqueness uses with so small a domain that they neutralize the uniqueness presupposition. I adopt the other position here, because I don't know of any detailed account of how the cross-sentential case illustrated in (7) is supposed to work in these theories.

a. # She$_7$ is coming.

b. Angela Merkel$_7$ is coming.

c. The chancellor of Germany$_7$ is coming.

2.2 Referent accommodation

To solve this problem, we propose that in case an assignment function g does not meet the requirements a sentence S imposes on it, it may be extended so that it can meet them. We stipulate following Heim (1982) that the proposed extension has to be minimal and unique. These stipulations are natural: minimality is motivated by the fact that we do not want speakers to accommodate discourse referents whose existence is not warranted by S ; uniqueness corresponds to the idea that accommodation is impossible if there isn't enough information to uniquely identify a missing discourse referent.

Let's make these intuitions formal.

Extension. We say that g' extends$_{\text{v1}}$ g (denoted $g \prec_{V1} g'$ iff :

1. $\mathbf{dom}(g) \subset \mathbf{dom}(g')$: the domain of g' contains the domain of g
2. $\forall i \in \mathbf{dom}(g), g(i) = g'(i)$: g' coincides with g on its domain

In other words, g' extends$_{\text{v1}}$ g if it has strictly all the discourse referents that g has, plus some more. The subscript "*V1*" is there to indicate that we will be revising this definition later, when we turn to functional anaphors.

Extension is an order on assignments, hence the notion of minimal extension of g - an extension of g which is not an extension of an extension of g - is well-defined. Given our notion of extension, a minimal extension is simply one whose domain is smallest among the set of extensions consider. With this technical background laid out, the accommodation principle can be formally stated:

Accommodation principle. If g is the input assignment to a sentence S, and g does not meet the presuppositions on it imposed by S, g may be replaced with g', the minimal extension of g satisfies the presupposition of S, provided there is such a unique minimal extension of S.

Let's see this principle at play. Consider the sentence in the assignment function g that only maps 1 to Boris Johnson:

(9) Angela Merkel$_7$ is coming.

a. **assertion:** $g(7)$ is coming

b. **presupposition:** $7 \in g$ and $g(7)$ = Angela Merkel

g does not meet the presupposition (since 7 is not in g) of (9). Consider the following extensions of g:

(10) a. $g_1 = [1 \rightarrow$ Boris Johnson, $7 \rightarrow$ Emmanuel Macron$]$

b. $g_2 = [1 \rightarrow$ Boris Johnson, $2 \rightarrow$ Emmanuel Macron, $7 \rightarrow$ Angela Merkel$]$

c. $g_3 = [1 \rightarrow$ Boris Johnson, $7 \rightarrow$ Angela Merkel$]$

g_1 does not meet the presuppositions of (9), since $g_1(7)$ is not Angela Merkel. Both g_2 and g_3 do. g_2 is not minimal because it is an extension of g_3. So g_2 is a minimal extension of g_3. It is also unique, as is easy to check. So our accommodation procedure predicts upon hearing (9) in assignment g, the hearer may accommodate the assignment function g_3.

More interesting is the case of definites. Consider the following triplet of sentences against an empty assignment function:

(11) a. The king of France$_7$ is coming.
$\rightsquigarrow$ **pres.:** $7 \in g$ and $g(7)$ is a king of France

b. The consul of Rome$_7$ is coming.
$\rightsquigarrow$ **pres.:** $7 \in g$ and $g(7)$ is a consul of Rome

c. The chancellor of Germany$_7$ is coming.
$\rightsquigarrow$ **pres.:** $7 \in g$ and $g(7)$ is a chancellor of Germany

The empty assignment function meets none of the presuppositions of these sentences. For each sentence, we ask: can the accommodation principle provide an assignment to interpret the sentence against? For (11a), the answer is no ; since there is no king of France[2], there can be no assignment function g such that $g(7)$ is a king of France ; no assignment meets the presuppositions of the sentence.

For (11b), the answer is also no. Here, there are many assignment functions (which extend the empty assignment function) that meet the presuppositions of the sentence. So long as $g(7)$ is Caesar or Mark Anthony, g will meet the presuppositions of (11b). The minimal extensions that meet these presuppositions are the ones whose domain is smallest. There are two: $g_1 = [1 \rightarrow$ Caesar$]$ and $g_2 = [1 \rightarrow$ Mark Anthony$]$. Because there are two minimal extensions that meet the presuppositions of the sentence, the accommodation principle does not apply.

(11c) is the only sentence for which the accommodation principle can apply. Because there is only one chancellor of Germany -Angela Merkel-, there is only one minimal extension of the empty assignment function that meets the condition imposed by the sentence: $g_1 = [7 \rightarrow$ Angela Merkel$]$

What we have accomplished with our accommodation principle, apart from providing an account of discourse-new referential expressions, is to replicate the Fregean presuppositions standardly encoded in the meaning of *the*. This may seem like a roundabout way of achieving that result but it explains why definites sometimes lack the Fregean presupposition, namely when their index is in the assignment function.

[2] If the sentence is evaluated in present-day…

Added to that, there may be a way to tease apart the standard picture where the presupposition is triggered locally by the definite, and one where uniqueness stems from global principles of accommodation, as has been developed here. This means looking at crossed dependencies, which I now turn to.

2.3 Crossed dependencies

Consider (12), the Bach-Peters sentence we used to evidence that referential expressions do not dynamically bind their antecedent.

(12) [The pilot who shot at it$_2$ from above]$_1$ took down [the MIG that was chasing him$_1$]$_2$.

a. $g(1)$ is a pilot

b. $g(2)$ is a MIG

c. $g(1)$ shot at $g(2)$

d. $g(2)$ was chasing $g(1)$

In this sentence, the presuppositions on discourse referent 1 and discourse referent 2 are not independent, but mixed. As a result, the accommodation procedure is only possible if the following pair uniqueness condition is satisfied:

(13) Accommodation takes place if there exists a unique pair (x, y) such that:

a. x is a pilot

b. y is a MIG

c. x shot at y

d. y was chasing x

Under the standard picture however, there are two definites. Each of them trigger a uniqueness presupposition. Thus, the presuppositions is expected to be something along the following lines:

(14) (12) is defined iff

a. there is a unique pilot who shot at $g(2)$

b. there is a unique MIG that was chasing $g(1)$

It is straightforward to see that no matter what the values of $g(1)$ and $g(2)$ are, the presuppositions of (14) are not equivalent to the felicity conditions of (13).

Thus, the standard account and the current account of the presuppositions of definite make diverging predictions. Annoyingly, there is no consensus in the literature as to what the felicity conditions of (12) are (see all claims in Jacobson (2000)) so we must leave the question open. On the bright side, notice that we have met one of our desiderata. The accommodation account is able to account for crossed dependencies, which I argued in the introduction could not be covered with standard dynamic tools of discourse referent introduction.

3 Functional anaphors

The logic of our account is now established: referential expressions, being themselves anaphoric, never truly antecede pronouns. Rather, they co-refer with them. When they seem to act as antecedents, they merely help guide the accommodation process to introduce a discourse referent. For that reason, they need not be in any particular order with respect to the pronoun that they co-refer with.

In this section, I explore the fine-grained consequences of this account. One interesting consequence is a derivation of paycheck pronouns and the subordination constraint. The subordination constraint is yet another case where referential antecedents systematically differ from quantificational antecedents. This further motivates that the two should be kept apart.

3.1 The subordination constraint

We are interested in subordination configurations, configurations where a pronoun and its antecedent are in the scope of different quantifiers that they co-vary with (or more generally, in different scope domains). The examples in (15) show that both referential and quantificational antecedents may occur in that configuration.

(15) Q [... antecedent$_i$ ...] ... Q' [... pro$_i$ ...]

a. Every child got [the toy she wanted]$_8$ but some got it$_8$ late.

b. Every child got [a toy]$_8$ but some got it$_8$ late.

Subordination is quite general. In particular, it is also felicitous when the embedding quantifiers Q and Q' are modalsRoberts (1987), as the following shows:

(16) a. Susan might get [the toy she wanted]$_8$. She might even get it$_8$ as early as Tuesday.

b. Susan might get [a toy]$_8$. She might even get it$_8$ as early as Tuesday.

Our examples are biased. In all the examples above, the second quantifier (i.e. Q' in the abstract representation of (15)) quantifies over a subset of the witnesses to the second quantifier. In (15), "*some*" quantifies over children (not cats, not dogs). In (16), the second "*might*" quantifies over worlds where Susan gets a toy/the toy she wanted.

As has been observed before, an interesting discrepancy arises when one looks at cases where this constraint does not hold. In (17), the sets of French and English tourists do not overlap. Only referential antecedents are allowed in that configuration.

(17) a. **Referential antecedents**
Every French tourist visited her favourite museum.
Every English tourist surprisingly avoided it.

b. **Quantificational antecedents**
Every French tourist visited a museum she liked.
#Every English tourist surprisingly avoided it.

The same holds of modals, although modals' lack of an overt restriction makes this more difficult to test. However, the relevant examples can be constructed if we use incompatible descriptions. In (18), the second *might* may not quantify over the set of worlds where the president is a Republican, without occuring a contradiction[3].

(18) a. [The president]$_8$ might be a Republican. But she$_8$ might not. (✓ De Dicto)

b. [An unexpected candidate]$_8$ may win the election. But she$_8$ may not. (# De Dicto)

It thus seems that quantificational antecedents in subordination configuration are subject to the following constraint:

Surbordination Constraint In a configuration like :

$$Q(\ldots \text{ant}_i \ldots)\ldots Q'(\ldots \text{pro}_i \ldots)$$

If ant_i is quantificational, then it must be that **Witness**$(Q) \subset$ **Restr**(Q'), i.e. Q is subordinated to Q'

The same does not hold of referential antecedents. So we have discovered a further discrepancy between referential and quantificational antecedents: not only are the latter exempt from any ordering constraints, but they also evade the subordination constraint. Can the present theory - which makes a principled distinction between the two types of antecedent - predict this?

3.2 Extension for functional anaphors

Functional indices. Before we can answer that question, we must settle on one way to account for functional anaphors, the like of which are found in subordination configurations. I assume simply, following **?**, that assignment function may sometimes store functions from individuals to individuals. Thus, g_0 from example (19) is a licit assignment function. It contains an individual at index 1 and a (partial) function at index 2 mapping Billy, Angela and Jenny to Mario, Puddle and Lego respectively.

(19) $$g_0 = \left[1 \rightarrow \text{Billy}, 2 \rightarrow \left\{ \begin{array}{l} \text{Billy} \mapsto \text{Mario} \\ \text{Angela} \mapsto \text{Puddle} \\ \text{Jenny} \mapsto \text{Lego} \end{array} \right. \right]$$

We must know specify how to access these enriched assignment functions. Following Schlenker (2009); Sudo (2014), I assume functional indices. If i is an index pointing to a function f, j an index pointing to an individual x, the functional index $i(j)$ points to $f(x)$:

(20) $$[\![\text{pro}_{\text{i(j)}}]\!]^g = g(i)[g(j)]$$

As an example, an anaphoric element $pro_{2(1)}$ would denote $g_0(2)(\text{Billy}) = \text{Mario}$.

[3] Also note that the sentences must be read De Dicto. Otherwise, we are not dealing with the subordination constraint

New notion of extension. Functional anaphors allows us to understand some subordination cases. Intuitively, in the sequence of (21), we want (21a) to trigger accommodation of a function (at index 8) that maps children to the toy they wanted. This way, we can use that function in the next utterance to refer back to the toy.

(21) a. Every child λ_1 got [the toy she wanted]$_{8(1)}$ ...

b. ...but some λ_1 got it$_{8(1)}$ late.

Our theory of accommodation does not predict this however. Specifically, the sentence in (21a) triggers the following presuppositions on the assignment function:

(22) a. $8 \in g$

b. for all x, (x is a child) $\rightarrow$ (x is in the domain of $g(8)$)

c. for all x, (x is a child) $\rightarrow$ ($g(8)(x)$ is a toy that x wanted)

Assume for simplicity that the sentences in (21a) is uttered against an empty assignment function and that every child wants just one toy. Even under these assumptions, there will be many many minimal extensions of the empty assignment functions, which meet the conditions in (22). This is because the conditions impose no requirement on what $g(8)$ maps non-children to. Thus, g_0, defined in (23) is as good as g_1 in meeting the conditions of (22). Because neither g_0 extends g_1 nor g_1 extends g_2 (both have the same domain), both are minimal extensions (of the empty assignment function), which satisfy the presuppositions of the utterance. Our principle of accommodation can't apply since there is no unique minimal extension.

(23) a. $g_0 = [8 \rightarrow f]$
where f is defined on children and maps x to a largest toy that x wants

b. $g_1 = [8 \rightarrow f']$
where f' is defined on children and Angela Merkel
and maps x to the largest toy that x wants and Angela Merkel to her ankle.

The shape of the problem is familiar. The notion of minimal extensions was introduced so that accommodation of referents would not result in irrelevant referents being added to the assignment function ; if the sentence only requires a referent at index 9, our accommodation principle should not introduce referents at any index but 9.

Similarly here, the function f' has in its domain an individual -Angela Merkel-, which is irrelevant to the interpretation of the sentence. Thus g_1 is less "*parsimonious*" than g_0. We can capture this intuition of parsimony by refining our definition of extension:

Extension.
g_2 extends g_1 iff $\quad \mathbf{dom}(g_1) \subset \mathbf{dom}(g_2)$
and for every i, $\quad$ either $g_1(i) = g_2(i)$
or $g_2(i)|_{\mathbf{dom}(g_1)} = g_1(i)$

Under this new notion of extension, both g_1 and g_2 extends g_0 in the example below ; g_1 because it is defined over more referents ; g_2 because the function it stores at index 2 is defined over more referents.

(24) a. $g_0 = \left[1 \rightarrow \text{Billy}, 2 \rightarrow \left\{ \begin{array}{l} \text{Billy} \mapsto \text{Mario} \\ \text{Jenny} \mapsto \text{Lego} \end{array} \right. \right]$

b. $g_1 = \left[1 \rightarrow \text{Billy}, 2 \rightarrow \left\{ \begin{array}{l} \text{Billy} \mapsto \text{Mario} \\ \text{Jenny} \mapsto \text{Lego} \end{array} \right. , \mathbf{3 \rightarrow Boris\ Johnson} \right]$

c. $g_2 = \left[1 \rightarrow \text{Billy}, 2 \rightarrow \left\{ \begin{array}{l} \text{Billy} \mapsto \text{Mario} \\ \mathbf{Angela \mapsto Puddle} \\ \text{Jenny} \mapsto \text{Lego} \end{array} \right. \right]$

This new order over assignments entails a new notion of minimality: a minimal extension will be one whose domain is the smallest (just like version 1), but also one whose functions have the smallest domain.

With this modification, the problem raised by (21), repeated in (25), vanishes. With our old definition of extension, both g_0 and g_1 (defined in) were minimal and the uniqueness condition of the accommodation principle failed. With our new definition, g_1 extends g_0 and is therefore not minimal. Consequently, if every child wants just one toy, g_0 will be the sole minimal extension. By our principle, it will be accommodated as the new assignment function.

(25) a. Every child λ_1 got [the toy she wanted]$_{8(1)}$ ...

b. ...but some λ_1 got it$_{8(1)}$ late.

(26) a. $g_0 = [8 \rightarrow f]$ where f is defined on children and maps x to a largest toy that x wants

b. $g_1 = [8 \rightarrow f']$ where f' is defined on children and Angela Merkel and maps x to the largest toy that x wants and Angela Merkel to her ankle.

g_0 is accommodated and the function at index 8 may be used by subsequent sentences, such as the one in (25b), to refer back to the toy that a child wanted.

This concludes our account of the subordinated case. We must now turn to cases where the second quantifier does not range over witnesses of the first. As we saw, in this configuration, only referential expressions can surface, not quantificational expressions.

3.3 Constraints on paycheck pronouns

Here too, our account needs to be patched up too. Take (27): by the reasoning of the previous section, (27a) will lead to accommodation of a function at index 8 defined on French tourists and mapping them to their favorite museum. This function can't be used in the second sentence on input of the English tourists. Thus, under the account above, (27b) cannot be a possible continuation of (27a).

(27) a. Every French λ_1 tourist visited [her favourite museum]$_{8(1)}$...

b. ...every English tourist λ_1 surprisingly avoided it$_{8(1)}$.

What we seem to predict then is that referential expressions do obey the subordination constraint, the exact opposite of what we want. However, I argue that there is a loophole. In fact, it is by and large true that referential expressions obey the subordination constraint ; in all the cases I presented where they don't, they happen to be under some form of contrast, as is visibly the case in (27).

This crucial observation is made and defended in Keshet (2011). He points out that in cases where contrast is independently blocked, the subordinated/paycheck reading is absent. Striking is the case where the two sentences do not bear the same aspect. For instance, (28) cannot bear the contrast intonation[4]:

(28) a. [Stuart]$_F$ [deposits]$_F$ his paycheck.

b. * [Emily]$_F$ [spent]$_F$ her paycheck.

(29) a. [Stuart]$_F$ [deposits]$_F$ his paycheck.

b. [Emily]$_F$ [sends]$_F$ her paycheck.

This is attributed to the fact that *deposits* is a generic present, while *spent* is a episodic perfective past. Note that the sequence is not out of question, with a different intonation:

(30) Because Stuart deposits his paycheck, the very contrarian newcomer spent$_F$ hers.

However, the paycheck version of these examples is quite degraded, under the relevant reading.

(31) # Because Stuart deposits his paycheck, the very contrarian newcomer spent$_F$ it.

3.4 Contrast circumvents the subordination constraint

Given the discussion of the previous section, the reason why our account fails on (27) is because we simply have been using the wrong LF. The correct LF should include some operator that encodes contrast. I adopt Rooth's ~ operator wholesale ; contrary to Keshet (2011), we will not need to modify the denotation of the ~ operator so that it can make changes to the assignment function.

(32) $[\![\sim i\ \mathrm{S}]\!]^g = [\![\mathrm{S}]\!]^g$ if $g(i) \subset [\![\mathrm{S}]\!]^g_f$ and $[\![\mathrm{S}]\!]^g \in g(i)$

Rooth's operator presupposes that the sentence it dominates belongs to a contextually salient set of proposition -*the contrast set*- and that this contrast set is a subset of the focus-value of the sentence. Informally, the general shape of contrast set can be read off

[4]The gloss of the following sentences is not accurate: the subjects must bear constrastive topic intonation, the verbs simple focus. For simplicity, I treat constrastive topic as foci.

the sentence with its F-marking. The contribution of Rooth's operator to the LF of our sentence in (33) is to introduce presuppositions on the sentence ; what this does for us is to bring about more information to identify the functional referent at index 8.

(33) a. ~ 5 Every French$_F$ λ_1 tourist visited$_F$ [her favourite museum]$_{8(1)}$...

b. ~ 5 every English$_F$ tourist λ_1 avoided$_F$ it$_{8(1)}$.

The presuppositions of both sentences relevant for accommodation are given in (34). As a side note, one may wonder why I choose to consider the presuppositions of both (33a) and (33b) for accommodation, when in our original discussion of the sentence, I only used the presupposition of (33a). The choice was actually always open to us: as we will see later in section 4.3, the domains of accommodation that this theory assumes may be sentence-sized, smaller than that or bigger. I assume that it is up to the hearer to choose which domain she performs her accommodation in.

Our discussion of (33)before the introduction of contrast remain untethered by this new possibility. As the reader can check for herself, adding the presupposition of the second sentence without incorporating the contrast operator results in failure of the accommodation procedure ; this reveals that the operator is needed for the accommodation of non-subordinated sentences.

(34) a. **presupposition of the definite:**
$8 \in g$
for all x, (x is a child) $\rightarrow$ (x is in the domain of $g(8)$)
for all x, (x is a child) $\rightarrow$ ($g(8)(x)$ is a favourite museum of x)

b. **presupposition of (33a)+(33b):**
$$g(5) \subset \left\{ \begin{array}{ll} \lambda w. & \forall x,\ x \text{ is a tourist and } p(x) \text{ in } w \rightarrow x \text{ visited } g(8)(x) \\ & [\forall x, x \text{ is a tourist and } p(x) \text{ in } w \rightarrow g(8)(x) \text{ is a favourite museum of } x] \end{array} \middle| \ p \in D_{et} \right\}$$

4 Extensions and loose ends

4.1 Maximal informativity accommodation

The particular rule for extension (repeated below) that I have argued for is quite baroque.

Extension.
g_2 extends g_1 iff $\quad$ **dom**$(g_1) \subset$ **dom**(g_2)
and for every i, $\quad$ either $g_1(i) = g_2(i)$
or $g_2(i)|_{\textbf{dom}(g_1)} = g_1(i)$

The rule can get even more idiosyncratic, if we turn to plural definites:

(35) a. The members of the triumvirat$_2$ are nice.

b. $[\![(36a)]\!]^g$ = $g(2)$ are nice [$g(2)$ are members of the triumvirat]

Suppose the three members of the triumvirat are *Julius*, *Pompey* and *Cassius*. Given these facts, there are many candidate extensions of g that satisfy the presuppositions of (36a): $g[2 \rightarrow \text{Julius} \oplus \text{Pompey}]$, $g[2 \rightarrow \text{Pompey} \oplus \text{Cassius}]$, $g[2 \rightarrow \text{Julius} \oplus \text{Pompey} \oplus \text{Cassius}]$, etc. None of these candidates extend any of the other, as per our definition of extension, so there will be no minimal extension. Accommodation cannot proceed. To guarantee that the right extension is accommodated - namely $g[2 \rightarrow \text{Julius} \oplus \text{Pompey} \oplus \text{Cassius}]$-, we would need further tweaking of our definition of extension to break the symmetry between the candidates. This can be done, but are we missing some systematic generalization?

The notion we need is that of maximal informativity. Maximal informativity has been used in many works (Beck and Rullmann, 1999; Iatridou et al., 2014) to rank objects in a structure-conscious manner. As we see, the set of candidate of extensions has some structure to it: if some candidate g' maps the index 2 to some plurality x, then there will be a candidate g'' that maps 2 to a subplurality of x, because *members of the triumvirate* is distributive. The presence of g' in the set *entails* the presence of g''. In other words, g' is more informative than g''. The most informative candidate assignment will thus be the one that contains the biggest plurality ; in other words, the desired assignment $g[2 \rightarrow \text{Julius} \oplus \text{Pompey} \oplus \text{Cassius}]$.

Before we can incorporate maximal informativity, we need to add worlds to our fragment. We simply mark the world dependencies that we have been ignoring:

(36) a. The members of the triumvirat$_2$ are nice.

b. $[\![(36a)]\!]^{g,w}$ = $g(2)$ are nice in w [$g(2)$ are members of the triumvirat in w]

Given a world w and a sentence S, let's call $\textsc{Candidates}_{S,\,G}(w)$ the set of assignment functions which 1) coincide with g wherever g is defined, 2) satisfy the presuppositions of S. The object $\textsc{Candidates}_{S,\,G}$ is thus of type sgt, where g is the type of assignment functions. This is equivalent to the type gst, the type of properties of assignment functions, up to reordering of the arguments. We can define maximal informativity on such properties, just as one would for degree or individual properties:

(37) $\textsc{Max-Inf}(\textsc{Candidates}_{S,\,G}) =$
$\lambda w.\lambda g.\ \textsc{Candidates}_{S,\,G}(w)(g) \wedge$
$\forall g' \neq g, \textsc{Candidates}_{S,\,G}(w)(g') \rightarrow \left(\lambda w.\textsc{Candidates}_{S,\,G}(w)(g')\right) \not\Rightarrow \left(\lambda w.\textsc{Candidates}_{S,\,G}(w)(g)\right)$

The maximal informativity operator sieves out from the set of candidates, those assignments whose presence in the set can be deduced from the presence of other assignments in the set. Thus, in our triumvirat example, $g[2 \rightarrow \text{Pompey} \oplus \text{Cassius}]$ would not be in the set of maximally informative candidates because the mere presence of $g[2 \rightarrow \text{Julius} \oplus \text{Pompey} \oplus \text{Cassius}]$ entails that $g[2 \rightarrow \text{Pompey} \oplus \text{Cassius}]$ is a candidate too.

Accounting for both maximal informativity and world dependency, we can rephrase our accommodation principle as follows:

Accommodation principle. If g is the input assignment to a sentence S and w the world of evaluation, and g does not meet the presuppositions on it imposed by S in world w, g may be replaced with g', the maximally informative assignment of $\text{CANDIDATES}_{S,\,G}(w)$, provided there is such a unique maximally informative assignment.

We can now revisit all the cases that have motivated our increasingly complex notion of extension and show that they fall under the more general paradigm of maximal informativity.

In the simple singular cases like (38a), the set of candidates is as in (38)c. It contains minimal extensions that only add *Merkel* to the assignment function. But it also contains assignment functions with irrelevant individuals at index 3. However, the presence of these assignment functions with spurious individuals is entailed by the presence of $g[2 \rightarrow \text{Merkel}]$; they are not maximally informative. The maximally informative assignment function is the one that adds no individuals irrelevant to the satisfaction of the presupposition

(38) a. The chancellor of Germany$_2$ is nice.

b. $[\![(36a)]\!]^g = g(2)$ is nice [$g(2)$ is chancellor of Germany]

c. $\text{CANDIDATES}_{S,\,G}(w_0) = \{g[2 \rightarrow \text{Merkel}], g[2 \rightarrow \text{Merkel}, 3 \rightarrow \text{Macron}], \ldots\}$
where w_0 is a world of the common ground.

As we saw, the case of functional anaphors like (39)a brings about another kind of irrelevant individuals, individuals that are in the domain of the accommodated function but do not contribute to satisfy the presupposition of the sentence, e.g. Angela Merkel in g_1. Maximal informativity helps sieve out these irrelevant individuals as well. Indeed, if an assignment $[8 \rightarrow f]$ satisfies the presupposition of (39) in some world, one can immediately conclude that $[8 \rightarrow f']$ will too where f' is defined over more individuals. So the presence of g_1 in the set of candidates is entailed by the presence of g_0 in that set ; it is not maximally informative.

(39) a. Every child λ_1 got [the toy she wanted]$_{8(1)}$

b. $[\![(39a)]\!]^g = \forall x \in \texttt{child}'$, x got $g(8)(x)$ [$\forall x \in \texttt{child}'$, $g(8)(x)$ is the toy x wanted]

c. $\text{CANDIDATES}_{S,\,G}(w_0) = \{g_0, g_1, \ldots\}$
where w_0 is a world of the common ground
and g_0 and g_1 is as defined in (39).

(40) a. $g_0 = [8 \rightarrow f]$ where f is defined on children and maps x to a largest toy that x wants

b. $g_1 = [8 \rightarrow f']$ where f' is defined on children and Angela Merkel and maps x to the largest toy that x wants and Angela Merkel to her ankle.

In a nutshell, the notion of maximal informativity allow us to unify the disparate notions of extensions that I have been positing through the course of the paper. This greatly reduces the amount of stipulations of the system as a whole.

4.2 Exceptional scope distributivity

We have seen two differences between referential and quantificational expressions in their anaphoric potential. Referential antecedents are order-insensitive and not subject to the subordination constraint. Quantificational antecedents are order-sensitive and subject to this constraint.

In Chatain (2019), I present yet another difference which is not related to anaphora. The difference lies in the availability of so-called exceptional scope distributive reading (wide-scope distributivity in the words of Chatain (2019)). It has been observed that even with wide-scope indefinites, the scope of distributivity operators is systematically bound by scope islands. Thus, (41) cannot have the meaning in (41)b:

(41) If three relatives of mine die, I will inherit a house.

a. **Possible reading:** There are three relative of mine such that if all of them die, I will inherit a house.

b. **Exceptional scope distributive reading:** *There are three relatives of mine such that for each x of them, if x dies, I will inherit a house.

Chatain (2019) observes that the same restriction does not obtain for referential expressions:

(42) **Context:** *the employees arrive at different times*

a. When these employees arrived this morning, Alex smiled.

b. **Exceptional scope distributive reading:** ✓ for each x of these employees, when x arrived, Alex smiled.

Using dependent plurals as a diagnostic, Chatain (2019) provides evidence for a covert index-based distributivity operator. This operator uses indices to track down the pluralities it needs to distribute over and therefore does not need to take a plurality as a semantic argument to yield the correct reading.

(43) ALL_i [when these employees_i arrived this morning, Alex smiled]

To function properly, this operator needs the assignment function to have a value at the index i. In the sentence (43), it means that already at the root of the sentence, where ALL_i composes, the index i contains a reference to *these employees*. If *these employees*$_i$ were responsible for introducing a discourse referent at index i, we would have a problem: *these employees* occur in the scope of ALL and ALL will not be able to see the discourse referent it introduces. On the story developed here, *these employees* is referential and its referent is accommodated. This means that the input assignment function to the whole sentence is modified to accommodate the missing referent of *these employees*. ALL, which occurs at the root of the sentence, will be able to access the accommodated referent.

In short, the two proposals complement each other. Descriptively, the availability of exceptional scope distributive readings with referential expressions only adds to evidence that this class should be distinguished in some way in the dynamics of discourse. Analytically, the theory of accommodation presented here completes the operator theory proposed in Chatain (2019).

4.3 And the dynamics?

The account of the current paper was aimed at solving the problem of referential antecedents in dynamic theories of meaning. To keep the presentation simple, I presented my solution in a static set-up. Embedding it in a dynamic system does not raise particular difficulties.

In a DPL-inspired framework, sentences denote partial functions from assignments to sets of assignments (type ggt) ; we use partial functions to represent presuppositions. So (44)a is interpreted as (44)b:

(44) a. The girl$_2$ saw a^7 gerbil.

b. $[\![(44a)]\!] = \lambda g.\lambda g'.\exists x,\ x$ is a gerbil and $g = g[7 \rightarrow x]$ (**pres.:** $g(2)$ is a girl)

If an input assignment g_0 is not in the domain of the function denoted by (44a), reference failure ensues. The same accommodation principle as in the static case can replace g_0 with a larger assignment that meets the presupposition of the sentence. This is not the end of the story though. There are interesting interaction between the dynamics of the sentence and the accommodation procedure presented here. The simplest case of this is when an indefinite binds into a definite description:

(45) a. A^7 child broke [the toy they$_7$ wanted]$_2$.

b. $[\![(44a)]\!] = \lambda g.\lambda g'.\exists x,\ x$ is a child that broke $g(2)$ and $g = g[7 \rightarrow x]$ (**pres.:** $g(2)$ is a toy $g'(7)$ wanted)

Here, the presuppositions constrains both the input and the output assignment functions. Our accommodation procedure does not give us the tools to deal with such cases. There are many ways one could go about solving this problem. I want to leave this issue open to future research but I will suggest one route. One lesson from Dynamic Semantics is that in terms of anaphoras, sentences compose the same way constituents composes. Any change to the context that can happen at the cross-sentential level can also happen in embedded positions. Thus the acceptability contrast in (46) is not to be treated differently from the acceptability contrast in (47).

(46) a. A^7 child came. He$_7$ smiled

b. ?He$_7$ came. A child^7 smiled

(47) a. If a^7 child came and he$_7$ smiled, I would know that I made an impression

b. ?If he$_7$ came and a^7 child smiled, I would know that I made an impression

Adapting this philosophy to our accommodation principle, we are bound to conclude that accommodation doesn't just happen at the sentential level but also at embedded positions. Let us denote the operation of accommodation with the operator $\mathscr{A}$. Then the case in (48) can be resolved if accommodation happens between the update corresponding to the indefinite and the update corresponding to the definite. If so, the referent for the indefinite is already introduced and the presupposition of the update that $\mathscr{A}$ only depends on the input assignment function:

(48) a. [A^7 child] $\mathscr{A}$ broke [the toy they$_7$ wanted]$_2$.

b. $[\![(44a)]\!] = \lambda g.\lambda g'.g(7)$ broke $g(2)$ (**pres.:** $g(2)$ is a toy $g'(7)$ wanted)

4.4 Do presuppositions genuinely help referent accommodation?

The account here relies on presupposition of definites to direct referent accommodation. In the way the system is set up however, any presupposition may guide referent accommodation. This is contrary to fact, as (49) shows:

(49) Pedro knows [the instrument in our shed]$_8$ is a theodolite.

a. **Presuppositions:**
$8 \in g$
$g(8)$ is an instrument in our shed
$g(8)$ is a theodolite

b. **At-issue:**
Pedro believes that $g(8)$ is a theodolite

Given the current statement of the accommodation procedure, the sentence is predicted to be felicitous in a context where there is a unique theodolite in our shed. This is too weak ; speakers feel that the sentence requires there to be a unique instrument in our shed. To put the problem differently, our account predicts (50) and (49)to be felicitous and true in the same contexts:

(50) Pedro knows that the theodolite in our shed is a theodolite.

So it seems that standard presuppositions trigger do not help accommodation of referents. This assertion has to be nuanced ; Hackl (2019) presents evidence that presuppositions sometimes guide referent accommodation and suggests that this could be the key to understanding Haddock definites. Whatever the case may be, I owe an account of why this case is the exception rather than the norm, as the current account seems to predict.

The only escape for the current account is to split presuppositions into two classes: the first class contain those presuppositions that can feed the accommodation procedure, let's call them *referential constraints*, following Onea (2013). Given the account I have presented, this class must contain the presuppositions of definites and the presupposition of $\sim$. The second class contain all other presuppositions that do not help referent accommodation (factives, etc.). We'll refer to them as *standard presuppositions*. That distinction being made, we could hard-wire the accommodation procedure to be sensitive to one class but not the other.

This is technically feasible but raises conceptual questions: why can't we use all common ground information to identify a referent? why are we restricted to using *referential constraints*? This is a hard challenge to the current proposal that I cannot provide a full answer to. I will simply leave the reader with a speculation on that issue.

I think the literature on presuppositions contains converging lines of evidence that standard presupposition triggers do not initially constrain the common ground. In short,

presuppositions are not immediately "*presupposed*". This is motivated by the *triggering problem* (Schlenker (2019) and refs therein). There is an observation that across languages, words that give rise to the same truth-conditions give rise to the same presuppositions. If this is correct, this suggests that these words are entirely determined by their bivalent meaning. We can take this to mean that the basic meaning of a word *is* bivalent ; it does not from its semantics alone impose any constraints on the common ground. There has to be a later step when some of the inferences of a presupposition trigger become "*backgrounded*" ; the nature of that step is not the object of a consensus but for our purposes, it just need to exists.

Conjoining this theoretical background with the current proposal, we can say this much: a) there is a stage where the "*standard presuppositions*" are part of the assertive content of an utterance, b) there is a step where some inferences of the utterance get backgrounded, c) there is a step where referents are accommodated. If the step described in c) happens before the step in b), then presuppositions from the second class will not be visible to the accommodation procedure (because they haven't been distinguished from at-issue content yet). Why should this order obtain and not the opposite one? Give uncertainty about the nature of step b), this answer cannot for now be answered. I will have to have to leave the reader with the unsatisfactory account detailed above.

5 Conclusion

Referential expression are distinguished from quantificational expressions in more than one way. First, they do not obey order constraints and freely occur after or before a pronoun they antecede (up to condition C). Second, they do not obey the subordination constraint in quantifiers sequences. An extreme version of this form of liberty is illustrated by the well-known case of paycheck pronouns

In this paper, I have given more flesh to the proposal of Heim (1982). I assumed that all referential expressions are anaphoric and constrain the values of the assignment function. Discourse-new referential expressions must be accommodated. We saw that accommodation could provide an explanation for why the order constraints and the subordination constraints did not obtain for referential expressions.

Since referential expressions are anaphoric, they never truly antecede pronouns ; rather, they co-refer with them. So long as accommodation of the referent happens before all the anaphoric expressions -definite and pronominal- appear in the sentence, there are no restrictions on the order that these expressions have to appear in.

Accommodation also explains the absence of subordination constraint for functional referential antecedents: to satisfy the requirements of contrastive intonation, an accommodated functional referent may have a wider domain than the subordinating quantifier.

While appealing, this story suffers a serious drawback that follow-ups will have to deal with. It unsatisfactorily seems to predict that presuppositions could quite generally guide the accommodation process.

References

Beck, S. and H. Rullmann (1999). A Flexible Approach to Exhaustivity in Questions. *Natural Language Semantics* (7), 249–298.

Brasoveanu, A. (2007). *Structured Nominal and Modal Reference*. Ph. D. thesis, Rutgers University.

Chatain, K. (2019). Wide-scope distributivity. In *Proceedings of NELS 38*.

Hackl, M. (2019). A Null-Theory of Haddock's Puzzle and its Implications for the Role of Presupposition in Reference Resolution. In *Workshop on "Asymmetries in Language: Presuppositions and beyond"*.

Heim, I. (1982). *The semantics of definite and indefinite noun phrases*. Ph. D. thesis, University of Massachusetts Amherst.

Iatridou, S., K. Von Fintel, D. Fox, and S. Iatridou (2014). Definiteness as maximal informativeness. *The art and craft of semantics: A festschrift for Irene Heim 1*(2005), 165–174.

Jacobson, P. (2000). Paycheck pronouns, Bach-Peters sentences, and variable-free semantics. *Natural Language Semantics 8*(2), 77–155.

Karttunen, L. (1971). Definite descriptions with crossing coreference: a study of the Bach-Peters paradox. *Foundations of Language*, 157–182.

Keshet, E. (2011). Contrastive focus and paycheck pronouns. In *Proceedings of the 47th Regional Meeting of the Chicago Linguistic Society*.

Onea, E. (2013). Indefinite Donkeys on Islands. *Semantics and Linguistic Theory; Proceedings of SALT 23*.

Roberts, C. (1987). *Modal subordination, anaphora, and distributivity*. Ph. D. thesis, University of Massachusetts, Amherst.

Schlenker, P. (2009). Hand-out for talk at MIT.

Schlenker, P. (2019). Triggering Presuppositions. pp. 1–60.

Sudo, Y. (2014). Dependent plural pronouns with Skolemized choice functions. *Natural Language Semantics 22*(3), 265–297.