Presupposition Projection as Anaphora Resolution [vdS92, KP97, Kra98]

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1 Overview

Quite a few authors have noted that presuppositions behave in certain ways like anaphora, to the point that some have proposed that they be given a fully unified treatment.

This is essentially the motivation behind Van der Sandt's influential paper 'Presupposition Projection as Anaphora Resolution' [vdS92], which has essentially become the 'canon' way of looking at presupposition in Discourse Representation Theory [Kam02, GBM24].

The whole idea

Presuppositions behave like anaphors. Therefore, they are anaphors [vdS92].

They differ from other anaphors (like pronouns) only in two respects.

- Presuppositions contain enough descriptive content to allow them to be *accommodated* when a likely antecedent cannot be found in the discourse.
- Presuppositions can have an internal structure of their own, (e.g. they can contain free variables, can be incomplete and thus bound by external quantifiers).

2 A brief primer on Discourse Representation Theory

Discourse Representation Theory (DRT) [Kam02], like Heim's *File Change Semantics* [Hei83] is a dynamic theory of sentence meaning.

- Knowing the meaning of a sentence amounts not to knowing when it is true, but to knowing how it updates an information state [NBvEV22].
- In DRT, these information states are represented as Discourse Representation Structures (DRSs)

2.1 Discourse Representation Structures

DRSs are essentially taken to be mental representations built up by the hearer as the discourse unfolds.

A DRS consists of two parts:

- a set of discourse referents (drefs), and
- a set of 'conditions' that encode the information that has accumulated on them.

The following DRS represents the information that there are two individuals, a farmer and a donkey, and the the information that the farmer chased the donkey.

(1)

x, *y*
farmer(x)
donkey(y)
chased(x,y)

This is intended to reflect the intuitive meaning of the English sentence:

(2) A farmer chased a donkey.

We can give the DRS above a straightforward model-theoretic interpretation via embedding functions, partial functions from drefs to individuals [GBM24].

- An embedding function f verifies (1) in M iff the domain of f includes at least x and y, and according to M it is the case that $f(x)$ is a farmer, $f(y)$ is a donkey, and $f(x)$ chased $f(y)$.

2.2 Update in DRT

One of the main motivations for the establishment of DRT was to provide an account for *cross-sentential anaphora*.

Suppose that the sentence in (2) was immediately followed by the following sentence.

(3) He caught it.

In nearly all contexts, the *he* in (3) would not refer to just any male individual in the world, but specifically the farmer in the preceding sentence. And similarly, the *it* would refer to the donkey in the previous sentence.

We can give this a DRS as follows:

(4)

$\underline{v}$, $\underline{w}$
caught(v,w)

The DRS in (4) reflects the semantic content of (3) before the pronouns are resolved.

- We represent the anaphoric pronouns as v for *he* and w for *it*.
- The variables v and w are underlined to indicate that they require an antecedent.

To interpret this sentence, we can merge it with the previous DRS:

(5)

x, y, $\underline{v}$, $\underline{w}$
farmer(x)
donkey(y)
chased(x,y)
caught(v,w)

Now, since v and w likely (but not necessarily[1]) correspond to x and y respectively, we can equate them in our DRS as follows.

(6)

x, y, v, w
v = x
w = y
farmer(x)
donkey(y)
chased(x,y)
caught(v,w)

x, y
farmer(x)
donkey(y)
chased(x,y)
caught(x,y)

Either DRS is verified in a model M iff M features a farmer who chased and caught a donkey.

2.3 Complex DRSs

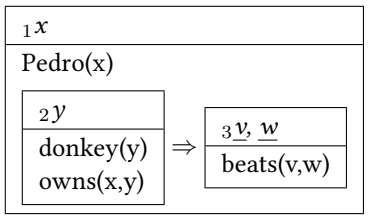
The previous examples have used only DRSs with simple conditions, but many constructions require complex conditions, i.e., DRSs within DRSs.

I'll use conditionals as an illustrative example here, but negation and (as will be discussed shortly) presupposition requires a similar process. I'll label each DRS with a numerical label for ease of reference.

[1] In DRT, this is a non-deterministic process, which has been a source of controversy as it means standard DRT is not fully compositional. Whether or not this is a problem is up for debate, but there have been many efforts at making DRT compositional in the past (see [Zee89, Sto90, Mus96] for a few such examples!).

(7) a. If Pedro owns a donkey, he beats it.

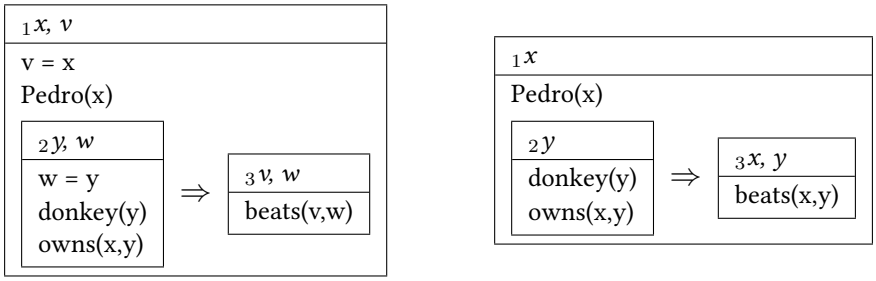
b.



The complex condition in this structure must be interpreted as follows:

- If f is to verify (7b$_1$) in M, then $f(x)$ must be an individual called 'Pedro', and every extension of f which verifies (7b$_3$) must be extendable to a function that verifies (7b$_3$).
- From this, it can be shown that (7b$_1$) is accessible to (7b$_2$), which itself is accessible to (7b$_3$).
- Hence, v and w may be linked up to x and y respectively.
- We can get a result as follows:

(8)



3 Presupposition Projection and Anaphora

The first attempt to give a systematic account of presupposition projection is Karttunen's [Kar73]. He presents the following example as his paradigm cases:

(9) a. Jack has children and *all of Jack's children* are bald.

b. If Jack has children, then *all of Jack's children* are bald.

c. Either Jack has no children or *all of Jack's children* are bald.

Compare these sentences to ones that include cross-sentential anaphora that we just talked about, the kinds of examples that motivated the development of Discourse Representation Theory [Kad01].

(10) a. John owns a donkey. He beats it.

b. If John owns a donkey, he beats it.

c. Either John does not own a donkey or he beats it.

Of course, the problem as formulated by Karttunen was quite different to that of cross-sentential anaphora.

> How do we model the fact that presuppositional inferences generally do not participate in standard scope-taking behaviour, but instead project to the level of the whole sentence?

By contrast, the problem posed by the donkey sentences is as follows:

> How can we account for the anaphoric links between the pronouns and their antecedents?

Van der Sandt [vdS92] observes, however, that wherever we find a full NP in (9), we find a pronoun in the corresponding sentences in (10):

(11) a. If Jack has children, then they are bald.

b. If John owns a donkey, he beats *his* donkey.

And indeed, this parallelism extends to other forms of anaphora as well.

VP-Anaphora

(12) a. If someone solved the problem, it was Julius who {solved it / did}.

b. If Harry stopped smoking, John {stopped / did} too.

Propositional Anaphora

(13) a. If John is ill, Mary regrets {that / that he is ill}.

b. If John died, he did see his children before {that / he did / he died}.

In fact, the only apparent difference seems to appear when we find anaphora that cannot be linked directly with a proper antecedent.

- Presupposition can typically be accommodated.
- But pronominal anaphora generally cannot be.

So, at the very least, it seems plausible that a similar mechanism underlies both pronoun resolution and presupposition projection.

Idea: Presuppositions are a subspecies of anaphora.

- Presuppositions are not suspended, cancelled, or neutralised.
- Instead, they are linked or bound to a previously established antecedent.

And why is it that we see differences in the case of accommodation?

- Presuppositional constructions usually have sufficiently rich semantic content to construct an antecedent when the discourse fails to supply one.
- Pronominal anaphora, in contrast, are too semantically impoverished for this to be possible.

Conclusion. Presuppositions are a form of anaphora, just with richer descriptive content than the typical pronominal case.

4 Presupposition Projection as Anaphoric Binding in DRT [vdS92, Kra98]

There are a few differences between Van der Sandt's account and the 'traditional' account of anaphoric binding in DRT, the most important being the following:

- Anaphoric elements are encoded separately in a sub-DRS (local context) within the main DRS.
- They are not resolved straight away against the content of the main DRS, but are processed only after the DRS is constructed.
- If a presupposition is not bound, it is *accommodated* (typically in the top-level DRS).

We'll refer to DRSs where all anaphora are resolved 'proper' DRSs, and DRSs that still have unbound anaphora as proto-DRSs.

Definition 4.1. [**Proto-DRS**, [Ven15]]
A proto-DRS is a triple $\langle U_K, C_K, A_K \rangle$ such that:

- U_K is a set of discourse referents
- C_K is a set of (atomic or complex) conditions
- A_K is a set of "anaphoric" (a-) DRSs of the form azK' where z is a discourse referent and K' is a proto-DRS.

Definition 4.2. [**DRS**, [Ven15]]
A (proper) DRS is a proto-DRS $\langle U_K, C_K, A_K \rangle$ such that $A_K = \varnothing$.

Example - Binding [Ryg21]

(14) a. John has a cat.

b.

x, y
John(x)
cat(x)
owns(x,y)

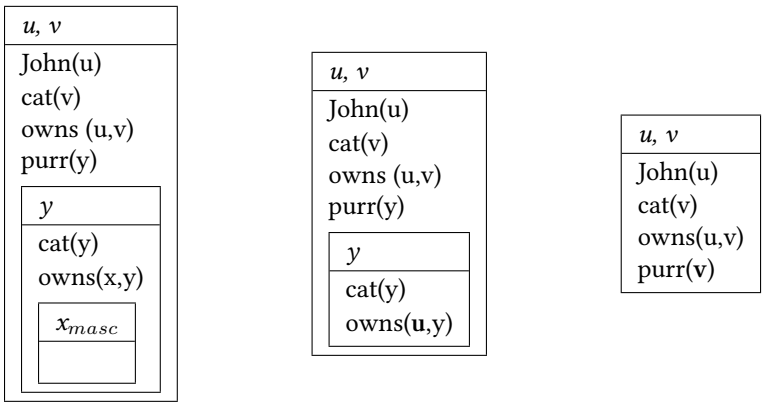
(15) a. His cat purrs.

b.

purr(x)
y
cat(y)
owns(x,y)
x_{masc}

(16) a. John has a cat. His cat purrs.

b.

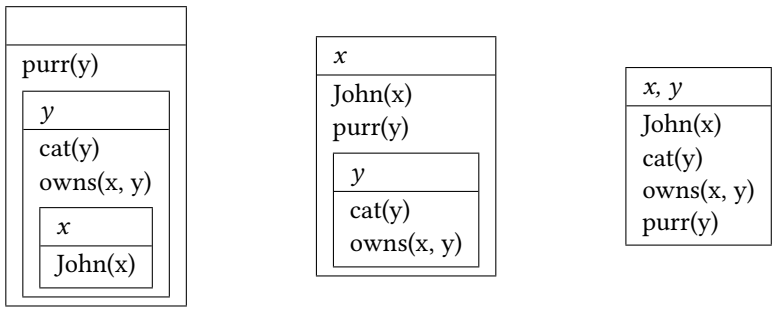


Example - Accommodation [Ryg21]

Importantly, expressions that trigger presuppositions can be used even if the context does not satisfy the presupposition. That is, Van der Sandt's theory allows presuppositions to be accommodated.

(17) a. John's cat purrs

b.



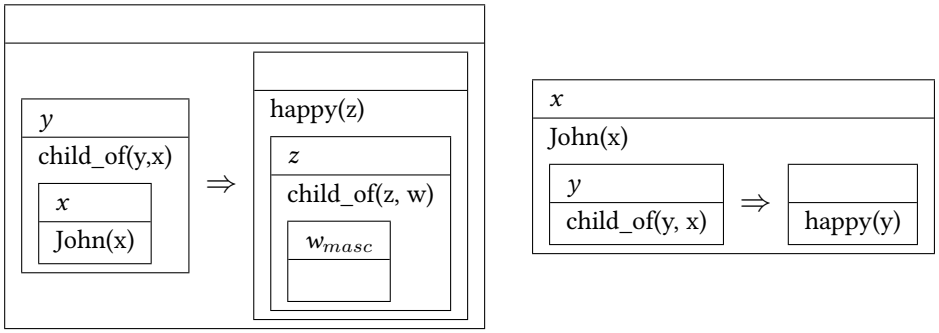
4.1 Neutralisation

Presuppositions typically appear to be 'neutralised' if they appear in a conditional consequent where the antecedent entails the presupposition.

Under Van der Sandt's theory, this too is basically just anaphoric binding.

(18) a. If John has a child, his child is happy

b.



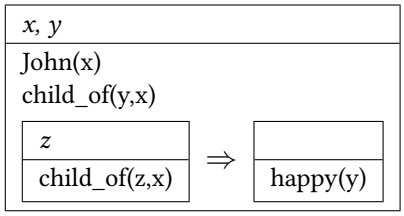
Interestingly, Van der Sandt's account predicts genuine ambiguity between:

- Binding (neutralisation)
- Accommodation (presuppositional reading)

That is, even in some case where the antecedent entails the presupposition of the consequent, the presupposition can be accommodated and remain.

It is perfectly plausible instead that a new dref is created out of *his child*, in which the resulting DRS would look something like this.

(19)



Compare this to Karttunen [Kar74] & Heim's [Hei83] version of contextual satisfaction.

- A presupposition is satisfied just in case the local context entails it. Once entailed, the presupposition is neutralised.
- The first possible antecedent is always chosen.
- Once satisfaction takes place, no alternatives remain.

How can we test these two accounts?

4.1.1 Antecedent Accessibility [NN10]

Consider the following example:

(20) If John has grandchildren, his children will be happy.

That John has grandchildren entails that he has children. Under Heim's account, this should mean the there is no presupposition that John has children.

But for an anaphoric theory of presupposition, *grandchildren* is not actually a valid antecedent for the presupposition that John has children.

Hence, only accommodation can take place for the presupposition that John has children, and this presupposition projects.

(21) a. It's not the case that if John has grandchildren, his children will be happy.

b. If John has grandchildren, will his children be happy?

c. If John is retiring soon, then if he has grandchildren, his children will be happy.

d. Perhaps if John has grandchildren, his children will be happy.

4.1.2 Optionality of binding [NN10]

If Van der Sandt is right in claiming that in many cases presuppositions may, but need not be bound (hence, neutralised) to a potential antecedent, then we should see variability in examples like the following:

(22) If John has a Spanish girlfriend, his girlfriend won't be happy.
Bound Reading: *"his girlfriend" = The Spanish girlfriend*
Accommodated reading: *John has a (possibly different) girlfriend, who won't be happy*

The example below is supposed to eliminate the presupposing reading.

(23) But if John has a Spanish girlfriend, his girlfriend won't be happy. But if he has one from France…

4.2 Disjunctions

Van der Sandt's account actually makes certain incorrect predictions when it comes to disjunctions [NN10, Kra98].

(24) Either there is no bathroom in this house, or the bathroom is in a strange place.

Under Van der Sandt's account:

- There is no binding of the presupposition that 'there is a bathroom', because there is nothing in the left disjunct that the presupposition can bind to.
- There is no global accommodation of the presupposition that 'there is a bathroom', as it contradicts with the proposition in the left disjunct.

Hence, Van der Sandt's account forces us to locally accommodate the presupposition in the right disjunct, leading to a reading like the following:

(25) Either there is no bathroom in this house, or there is a bathroom in this house and it is in a strange place.

This reading is problematic. Suppose that there are two bathrooms in the house, one in a strange place and one not. Intuitively, (24) should be false in this scenario, but under the locally accommodated reading in (25), the sentence would be true.

4.2.1 A potential solution in 'Double-Negation' DRT [Kra98]

Krahmer [Kra98] shows that the problem dissolves if Van der Sandt's resolution algorithm is applied within a non-standard variant of DRT, **Double Negation DRT** (DN-DRT).

In DN-DRT, the negation of the left disjunct is accessible from the right disjunct, as any discourse referent introduced by a proposition p remains as a 'passive' discourse referent when p is negated, and this 'passive' discourse referent can serve as an antecedent to presuppositions.

Hence, the presupposition in the right disjunct can be bound to the dref introduced by the negated left disjunct.

For (24), the schematic representation in DN-DRT is:

$$\neg\Phi \vee \Psi_{\langle\Upsilon\rangle}$$

Where:

- Φ = "there is a bathroom in this house"
- Υ = the presuppositional DRS for "there is a bathroom"
- Ψ = "it is in a strange place"

Despite the fact that Φ is negated, its 'passive' discourse referent is accessible to the presupposition Υ, where the passive discourse referents of $\neg\Phi$ are the active discourse referents of Φ. In this case, binding is now possibl and preferred.

The resulting interpretation is then equivalent to:

(26) If there is a bathroom in this house, then it is in a strange place.

This seems to match the intuitive reading of (24). Moreover, in a situation where there are two bathrooms (one in a strange place and one not), then both (24) and (26) are both corrently judged to be false.

Conclusion

Van der Sandt's account seems to have been described quite a few times among papers in the 1990s as the account of presupposition that makes the best empirical predictions about projection (see Beaver [BK01], Krahmer & Piwek, [KP97, Kra98] etc.).

But the literature surrounding the 'Presuppositions as Anaphors' perspective is truly monumentous at this point, and it's flaws are well known.

Among things commonly mentioned are:

- 'Proto'-DRS objects remain uninterpretable (i.e., truth values cannot be derived for presuppositions alone) - Only full DRSs can be interpreted [Kra98].
- Van der Sandt's account uses a bivalent semantics in which sentences with presupposition failure are evaluated as false [Mus95].
  - Further, a dynamic semantics that includes no notion of partiality/trivalence seems to struggle to account for quantificational sentences like that in "Every fat man pushes his bicycle".
- Van der Sandt's account does not account for cases where inferences are required to establish anaphoric links, such as in the case of sentences like *'If John buys a car, he checks the motor first'*.
  - A proof-theoretical account of this is provided by Krahmer & Piwek [KP97], which I unfortunately did not have time to fit into this handout.
- Difficulty with Double Negation
  - In a discourse segment like 'It is not true that John didn't bring an umbrella. It was purple and stood in the hallway', Van der Sandt's account treats double negation as a double plug, blocking anaphora when it should in fact permit it.
  - It's examples like this that motivated DN-DRT, briefly talked about above and introduced by Krahmer & Muskens [Kra98].

That being said the 'presuppositions as anaphors' perspective remains popular, and most of the fixes to the flaws above generally try to find solutions within the broad framework of DRT!

Acknowledgments

This handout was inspired by similar ones made by Mark Norris & Oliver Northrup [NN10], Noortje Venhuizen [Ven15] and Ivan Rygaev [Ryg21], as well as by all the readings, especially Emiel Krahmer's book 'Presupposition and Anaphora' [Kra98], which I wish I finished by the time I presented this.

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