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Generalised Crossover*

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Abstract *Crossover (CO)* is a constraint on anaphoric dependencies, according to which, *quantifier scope* can feed *pronominal anaphora* unless the anaphoric expression precedes the quantifier. We demonstrate that effects reminiscent of CO arise with presupposition as well, and propose to generalise CO as follows: *Projective content* (quantifier scope, presupposition projection, etc.) feeds *semantic dependencies* (pronominal anaphora, presupposition satisfaction), unless the semantically dependent expression precedes the trigger of the projective content. We call this generalisation, *Generalised Crossover (GCO)*. Although we cannot offer a full explanation for GCO in this paper, we will discuss its implications for recent theories of CO.

Keywords: crossover, anaphora, presupposition, scope

1 Introduction

Pronouns in natural language can be interpreted as bound variables. As famously observed by Postal (1971), bound variable interpretations of pronouns are subject to structural restrictions. For example, a bound variable interpretation is available in (1a) but not in (1b). We represent a binder with a superscript and a corresponding bound pronoun with a subscript throughout this paper.

(1) a. Who^i aggravates their$_i$ mother?
b. * Who^i does their$_i$ mother aggravate?

Chomsky (1976) pointed out that Postal's (1971) observation extends to cases where the binder is a quantificational noun phrase (QP), as illustrated in (2).

(2) a. Every boy^i aggravates his$_i$ mother.
b. * His$_i$ mother aggravates every boy^i.

Note in particular that the lack of a bound variable interpretation in (2b) is puzzling given that QPs generally give rise to *inverse scope readings* (at least in languages like English), as illustrated by the following example.

* We're extremely grateful to audience members at our SALT 30 talk for helpful feedback.

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(3) Exactly three women aggravated every boy.

There are a number of approaches to these observations in the literature (see Safir 2017 for an overview). Those theories that assume that quantifier scope is determined by covert movement called *Quantifier Raising (QR)* seek for a uniform explanation of the above two sets of observations, by assuming that $\overline{A}$-movement operations like *wh*-movement and QR cannot feed pronominal binding. Here are some representative implementations of this idea.

- Pronominal binding is only possible from a c-commanding A-position (Reinhart 1983).
- A binder in an $\overline{A}$-position can only bind one element, including a trace (the 'bijection principle' of Koopman & Sportiche 1982).
- A binder may bind only pronouns or only traces (Safir 1984).

These theories, however, all face a major problem: quantifier scope *can* in fact feed binding (Barker 2012).

(4) a. Every boy^i's mother reviewed his$_i$ homework.

b. A boy from every city^i rhapsodised about it$_i$.

c. I gave a raise to every TA^i, before he or she$_i$ asked for it.

(5) Whose^i mother reviewed his$_i$ homework?

Out of these considerations and related developments in the theory of pronominal anaphora emerged some modern theories, most notably, Büring 2004, Barker & Shan 2014, and Chierchia 2020, which aim at explaining the following generalisation.[1]

(6) *Crossover (CO)*
Quantifier scope can feed *pronominal anaphora* unless the anaphoric expression precedes the quantifier.

The main goal of this paper is to point out that CO generalises to cases involving *presupposition*. More specifically, we will present data involving the following two patterns.

- *Presupposition projection and pronominal anaphora*: Presupposition projection feeds pronominal anaphora, unless the pronoun precedes the presupposition trigger.

1 Barker & Shan 2014 supercedes Shan & Barker 2006.

- *Quantifier scope and presupposition satisfaction*: Quantifier scope can feed presupposition satisfaction, unless the presupposition trigger precedes the quantifier.

In light of these new observations, we propose to generalise CO in the following manner, and discuss its consequences on the aforementinoed theories of CO.

(7) *Generalised Crossover (GCO)*
Projective phenomena (quantifier scope, presupposition projection) can feed *semantic dependencies* (pronominal anaphora, presupposition satisfaction), unless the semantically dependent expression precedes the trigger of the projection.

We will furthermore raise examples involving appositives in the final section, which points to the further generalisability of GCO beyond presupposition.[2]

This paper is structured as follows: We will present the main empirical observations in Sections 2–3. After discussing its theoretical consequences in Section 4, we will conclude in Section 5.

2 Presupposition projection and pronominal anaphora

It is often overlooked in the theoretical literature on presupposition that presuppositional content can feed pronominal anaphora (but see Beaver 1992). In order to see this, let's begin by considering the following example.

(8) Daniel knows that a philosopher^{i} was in the audience,
although he didn't see her$_{i}$.

Due to the presence of the factive trigger *know*, the first sentence presupposes that *a philosopher was in the audience*. We're interested in whether or not this presupposition can license pronominal anaphora in the adjunct clause. Although anaphora is clearly possible here, this example is not very telling, since anaphora might be enabled by the assertive meaning of the matrix clause. That is, the matrix clause here might have a similar assertive meaning to the matrix sentence of the following.

2 Note that we cannot test GCO effects on presupposition projection and presupposition, which would be that presuppositioin projection feeds presupposition satisfaction, unless the trigger fo the presupposition to be satisfied precedes the trigger of the projected presupposition. This is because whether or not GCO is violated, the same thing needs to be presupposed. For instance, suppose that the projected presupposition is a factive presupposition that Daniel is married and the satisfied presupposition is the existential presupposition of *Daniel's wife*. In a configuration violating GCO, we would like to obseve the presupposition that Daniel has a wife would not be satisfied by the factive presupposition, but the factive presupposition itself essentially demands the same thing to be presupposed.

(9) A philosopher^i was in the audience and Daniel knows it,
although he didn't see her$_i$.

In order to see if the factive presupposition can feed anaphora, it is more informative to look at a version of the sentence with negation, as in (10).

(10) Daniel doesn't know that a philosopher^i was in the audience,
although he clearly saw her$_i$. $\neg >$ know $>$ some philosopher

Let's focus on the interpretation where the indefinite *a philosopher* takes scope below *know*, i.e., the *non-specific opaque* reading, which is presumably the most prominent reading of this sentence. Under this interpretation, anaphora in the adjunct clause is possible. This must be due to the factive presupposition, because negation is an *externally static operator* (Heim 1982; Groenendijk & Stokhof 1991).[3] More precisely, the factive presupposition that *a philosopher was in the audience*, which is triggered by *know*, projects through negation, and feeds pronominal anaphora in the adjunct clause.

To give further support to this analysis, let us consider versions of the sentence without a factive presupposition.[4]

(11) a. * Daniel doesn't think that a philosopher^i was in the audience,
although he clearly saw her$_i$. think $>$ a philosopher

b. * Daniel doubts that a philosopher^i was in the audience,
although he clearly saw her$_i$. doubt $>$ a philosopher

c. * Daniel is wondering if a philosopher^i was in the audience,
although he clearly saw her$_i$. wonder $>$ a philosopher

In these examples without factive presuppositions, the pronominal anaphora is not licensed, as expected.

Having established that presupposition projection can feed pronominal anaphora, let us now check GCO effects. In order to do this, we will place the pronoun in a position linearly preceding the presupposition trigger, as in (12).

3 Concretely, this means that negation renders indefinites in its scope inaccessible as antecedents for subsequent pronouns, as illustrated below.

(i) a. * It's not the case that any^i philosopher is in the audience, but I saw her$_i$.

b. It's not the case that a^i philosopher is in the audience, but I saw her$_i$. $\exists > \neg$; $* \neg > \exists$

4 It appears to us that the following variant is acceptable.

(i) ? Daniel doesn't think that I have a sister^i, although he has met her$_i$.

It seems that there is something special about this predicate *have a sister*, but we need to leave this question open here.

(12) * Her$_i$ boss doesn't know that an independent contractor^i was in the audience (although he clearly saw her$_i$).

We observe that the pronominal anaphora is not licensed in this case. Note that under any theory of presupposition projection, the factive presupposition should still project out, and if the factive presupposition is interpreted *before* the pronoun is interpreted, as in the case of many theories of presupposition (such as Heim 1983; Beaver 1992, 2001; Van der Sandt 1992; Geurts 1999; Schlenker 2009), there is no reason why the pronoun cannot refer to *the postdoc*, given the above observation that presupposition projection generally feeds pronominal anaphora.[5]

One might wonder if the infelicity of (12) is due to a general constraint on cataphora. We think that this is unlikely, given that cataphora is not impossible, and its degradation effects, if any, are much milder, as demonstrated by the following example.

(13) Her$_i$ boss needs to do her$_i$ work,
if an independent contractor^i is on sick leave.

Before moving on, let us look at a few more examples in order to see that presupposition projection in general can feed pronominal anaphora and that this phenomenon obeys GCO. The following example involves the aspectual presupposition of *stop*.

(14) The PI didn't stop paying one^i of her postdocs, even after she$_i$ landed a permanent position elsewhere.

This shows a GCO effect, as shown in (15).

(15) * Her$_i$ PI didn't stop paying one^i of her postdocs, even after she$_i$ landed a permanent position elsewhere.

Similarly, the example in (16) demonstrates that the presupposition triggered by *both* can license pronominal anaphora: the pronominal anaphora is possible, even if *both* takes scope below the negation. Note again that negation should block the assertive meaning from licensing the anaphora.

(16) The editor didn't give the proofreader much time to read both papers^i, because their$_i$ reviewers were late.

When the pronoun proceeds *both*, this is not possible, as in (17).

(17) * The editor didn't give their$_i$ reviewers much time to read both papers^i.

5 Note that anaphora fed by wide scope of *an independent contractor* is independently ruled out – this would be an ordinary crossover violation.

There are certain complications that one should be aware of in checking further examples of this sort. For instance, the existential presupposition of the definite article will not be very useful — this is because, as we saw in the introduction, scope can feed anaphora, and it is difficult to constrain the scope of a definite. To illustrate, the possibility of anaphora in (18) might be due to scoping the definite description *the papers* over negation, rather than presupposition projection *per se*.

(18) The editor didn't give the proofreader much time to read the papers^{i}, because their$_{i}$ reviewers were late.

A different complication arises in the case of additive presuppositions. Pronominal anaphora is known to be subject to the so-called *formal link condition*, which militates against anaphora without linguistically expressed antecedents, and this is presumably why the additive presupposition triggered by *another* in the following example does not license the pronominal anaphora to the previous pint.

(19) * He didn't order another pint, because he didn't like it$_{i}$.

3 Quantifier scope and presupposition satisfaction

Moving on to the second set of observations about quantifier scope and presupposition satisfaction, let us first establish that quantifier scope can feed presupposition satisfaction. In order to test this, let us consider the following example.

(20) The programmers were already talking about some obvious flaw in the software, when their boss found out that something was wrong with it.

The factive presupposition triggered by *found out* seems to be satisfied by the quantifier *some obvious flaw in the software*, but this could as well be because the whole assertive meaning of the matrix sentence serves to satisfy the presupposition. To factor out this possibility, let us use a negative quantifier, as in (21).

(21) No programmer had noticed some obvious flaw in the software, when their boss found out that something was wrong with it.

Being a positive polarity item, *some obvious flaw in the software* takes scope over the negative quantifier in subject position, and that feeds satisfaction of the factive presupposition. To further support this conclusion, let us consider the following variant of the sentence, where the NPI *any obvious flaw in the software* needs to stay in the scope of the negative quantifier.

(22) No programmer had noticed any obvious flaw in the software, when their boss found out that something was wrong with it.

The factive presupposition of this example does project, unlike in (21).

Having established that quantifier scope can feed presupposition satisfaction, let us now consider the following sentence that involves a configuration violating GCO.

(23) No programmer that had realised that something was wrong with the software could spot some obvious flaw in it.

We observe that the positive polarity quantifier *some obvious flaw in it* in this example cannot filter out the factive presupposition triggered by *realised*, despite the fact that it takes scope over the negative quantifier in subject position, as expected from GCO.

We will present a few more examples that illustrate the same point. The example in (24) demonstrates that quantifier scope of the satisfaction of the presupposition of *again*.

(24) No one told us about an embarrassing mistake in our SALT presentation, so we ended up making the same mistake again in the proceedings paper.

The following example exhibits GCO effects — the presupposition of *again* cannot be filtered by the wide scope reading of *an embarrassing mistake in our SALT talk*.

(25) No one who noticed a mistake in our work again remembered an embarrassing mistake in our SALT talk that made everyone laugh.

4 Theoretical Consequences

As far as we know, the GCO effects we observed in the last two sections have not been previously discussed in the theoretical literature, and are not directly captured by current theories of CO whose primary empirical target is exclusively quantifier scope and pronominal anaphora. In this section, we will discuss challenges in extending them to account for GCO.

We mentioned in Section 1 three major modern theories of CO, namely, Büring 2004, Chierchia 2020, and Barker & Shan 2014. We will call the first two, neo-Reinhartian theories and the third one a continuation-based theory, and discuss them in turn. As we do not have enough space to go over the details of these technically sophisticated theories, our discuss here need to stay informal.

4.1 Neo-Reinhartian Approaches

Büring (2004) and Chierchia (2020) put forward theories of CO that are similar in spirit to Reinhart 1983. That is, assuming that quantifier scope is determined by QR, they pursue the idea that the binding mechanisms for pronouns and traces are distinct, and there are structural constraints on the binding mechanism for pronouns such that $\overline{A}$-movement like QR cannot semantically interact with it. As we remarked

in Section 1, this idea alone has problems with cases where the antecedent is not in a c-commanding position, as in (4). Büring 2004 and Chierchia 2020 can be seen as attempts to solve these problems while maintaining Reinhart's (1983) general idea.

More specifically, Büring (2004) proposes to solve this issue by making use of E-type pronouns and situation semantics (cf. Heim 1990; Elbourne 2005).[6] In this theory, the crucial assumption above is implemented as a condition that $\overline{A}$-movement cannot bind situation pronouns, which the semantics of pronouns as definite descriptions crucially make use of, whereas antecedents in A-positions can either bind a pronoun directly, if they c-command it, or bind the situation argument of a pronoun as a definite description, if they don't c-command the pronoun itself. Chierchia (2020), on the other hand, pursues another solution to the problem non-c-commanding antecedents by using a version of dynamic semantics, where dynamic binding is only possible from A-positions.[7]

These approaches heavily rely on the notion of A vs. $\overline{A}$-positions, and for this reason, they cannot be straightforwardly extended to our data of GCO effects observed with presupposition. In our crucial examples in Section 3, where anaphora is possible, the antecedent in the main clause does not c-command the pronoun in the adjunct clause, so something needs to be said about how the binding is done from presuppositional content. Both Büring 2004 and Chierchia 2020 are compatible with a theory of presupposition where presuppositions can feed binding e.g. Beaver 1992, but crucially, in order to capture the GCO effects, the order-sensitivity needs to be accounted for. However, the idea they propose for CO cannot be applied here, because the mechanism of presupposition projection is not considered to be a syntactic operation on a par with $\overline{A}$-movement to begin with — it doesn't make make sense to talk about A vs. $\overline{A}$-positions of projected presuppositions. It follows that the GCO effects of presupposition projection and pronominal anaphora would have to be explained in a different way from CO. We consider this to be a major issue for this family of approaches.

For the GCO effects of quantifier scope and presupposition satisfaction, Büring's (2004) theory is more promising, although it would have to be combined with a general situation-based theory of presupposition satisfaction. Such a theory of presupposition satisfaction is, we believe, yet to be developed, but does not seem to be outright impossible. On the other hand Chierchia's (2020) theory would need a radical departure from the standard assumptions about dynamic semantics, in order to prevent quantifiers satisfying presuppositions from $\overline{A}$-positions, but not from A-positions. We cannot envisage a concrete way of implementing this idea.

Certainly, it is logically possible that CO and our observations about presupposi-

6 Büring (2004) focuses on binding out of DP, and does not explicitly discuss binding into adjunct clauses, but as Chierchia (2020) discusses, it could be extended to such cases.

7 But see Elliott (2020) for some independent problems with this idea.

tion are to be accounted for differently, in which case our criticisms do not apply, but given the obvious similarities between CO and GCO effects with presupposition, we think it is conceptually more desirable to pursue a uniform analysis. Given the considerations above, such a uniform analysis is hard to come by, if one pursues these neo-Reinhartian theories.

4.2 The Continuation-Based Approach

Barker & Shan (2014) put forward another modern theory of CO, which accounts for it by a syntactic restriction on the general mechanism of scope taking, which is implemented using *continuations*. An attractive feature of this approach with respect to our observations from the previous two sections is that it allows us to capture quantifier scope and presupposition projection with essentially the same mechanism, namely continuations, and pronominal anaphora and presupposition satisfaction with another mechanism of general binding. This very idea actually has been independently explored by Grove (2019), who develops a continuation-based theory of presupposition, and one could make use of it to formulate a syntactic restriction on the scope of presupposition satisfaction.

We think this is a promising approach, but the continuation-based theory of CO is not without problems. In particular, Leong & Erlewine (2019) point out that it runs into an issue in reconciling long-distance movement and scope islands. Putting all the technical details aside, the crucial assumption for this theory is that pronominal anaphora is a scope phenomenon and as such it is predicted to abide by scope islands. However, as a matter of fact, pronominal anaphora is possible across a scope island, as in the following example.

(26) Every linguist^{i} thinks that her$_{i}$ research is useless.

Under the continuation theory of pronominal binding, the pronoun here has to take scope in the matrix clause, in order to enable the pronominal binding. As Leong & Erlewine (2019) point out, the theory can be amended to allow for such wide scope, but crucially it will undermine the explanation of CO effects in examples like the following.

(27) * Which student^{i} do you think that his$_{i}$ supervisor hates?

This issue might or might not be solvable, but crucially, we run into similar issues in the case of GCO effects with presuppositions. It can easily be demonstrated that presupposition satisfaction is oblivious to syntactic locality constraints. For instance, in the following example, the factive presupposition triggered by *realise* in a deeply embedded position can be satisfied by the subject quantifier *a simple glitch in the software* in the matrix clause.

(28) A simple glitch in the software made the team leader say that those who hadn't realised that there was a problem with the software needs to be made redundant.

Furthermore, GCO effects are observed across clausal boundaries. In the following example, the presupposition cannot be filtered, even when *a simple glitch in the software* receives a specific reading.

(29) The team leader who had realised that there was a problem with the software told everyone that those who couldn't spot a simple glitch in the software would be made redundant.

If one pursues the scope theory of presupposition satisfaction like Grove's (2019), then one needs a principled explanation for why certain scope takers like quantifiers are subject to scope constraints, while others like pronouns and presuppositions are not. Furthermore, the problem of reconciling such long-distance facts and scope islands for quantifiers discussed by Leong & Erlewine (2019) needs to be solved.

5 Conclusion

To summarise, we raised empirical evidence for the generalised version of the CO constraint:

(30) *Generalised Crossover (GCO)*
Projective phenomena (quantifier scope, presupposition projection) can feed *semantic dependencies* (pronominal anaphora, presupposition satisfaction), unless the semantically dependent expression precedes the trigger of the projection.

We discussed theoretical implications of our observations on recent theories of CO. Before closing, we will discuss further cases of GCO involving appositives as the project content.

Firstly, we observe the following generalisation regarding appositives and pronominal anaphora: Binding from an appositive is possible unless the pronoun precedes the appositive.

The following example demonstrates that indeed, pronominal binding is possible with an antecedent in an appositive clause preceding the pronoun.

(31) You shouldn't compare yourself to Chomsky, who wrote a book^{i} that started this whole field in his 20s, especially if you are influenced by it$_{i}$ so much.

Note that it is important that the appositive relative clause in this example is not semantically in the scope of negation. If it were, the pronominal anaphora should be disrupted, as in the following example of a non-appositive relative clause under the scope of negation.

(32) * You shouldn't compare yourself to any linguist who wrote an influential book^i in his 20s, especially if you are influenced by it$_i$ so much.

Now, consider the following example, where the pronoun precedes the appositive clause. We observe that the pronominal anaphora in this example is not licensed.

(33) * Its$_i$ readers shouldn't compare themselves to Chomsky, who wrote a book^i that started this whole field in his 20s.

Secondly, we observe similar GCO effects involving appositives with respect to presupposition satisfaction: An appositive can satisfy a presupposition unless the presupposition trigger precedes the appositive. Firstly, the following example demonstrates that the content of an appositive clause can feed presupposition satisfaction.

(34) You shouldn't refrain from mentioning our classmates, who can't help smoking whenever there is a chance, if someone is unaware that some people are really addicted to smoking.

A non-appositive relative clause in the scope of negation cannot satisfy a presupposition in a similar configuration, as demonstrated by the following example.

(35) You shouldn't mention anyone who can't help smoking whenever there is a chance, when someone is unaware that some people are really addicted to smoking.

We observe that when the presupposition trigger precedes the appositive clause, the presupposition cannot be satisfied.

(36) Someone that is unaware that some people are really addicted to smoking approached our classmates, who can't help smoking whenever there is a chance.

These observations are particularly challenging for a theory of appositives like Potts (2005), according to which appositive relative clauses are interpreted independently from the rest of the sentence. This view has to be amended to allow for pronominal dependencies in cases like (31) (cf. Nouwen 2007) as well as presupposition satisfaction in cases like (34). While these amendments can be made, e.g. by allowing appositive clauses to be interpreted before the rest of the sentence, one needs an account of the GCO effects observed in (33) and (36). If appositive clauses are simply interpreted first, such order effects with respect to the rest of the sentence will not be unaccounted for.

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