On Optimization in Discourse Generation

Jason Mattausch
Universiteit van Amsterdam
November 2000
67911030@netmail.nl

Abstract

The purpose of this paper is to investigate generative strategies for maximizing coherence in discourse. We will outline a description of a generative procedure for anaphoric substitution using the Optimality Theory framework of Prince and Smolensky [P&S93] that is loosely based on earlier attempts by Hendriks and de Hoop [H&H00] and, in particular, Beaver [Beaver00] to apply that framework to anaphora resolution and generation, paying particular attention to recent proposals by Blutner et al. related to bidirectionality and the interdependence of linguistic interpretation and production. We will argue that the notion of bidirectionality ought to be modified to reflect an asymmetry in that interdependence as opposed to the symmetric, mutual reliance defended or assumed in contemporary definitions thereof. Using the same constraint-based framework, and exploiting the notion of discourse relations expounded in Asher [Asher93] and Asher and Lascarides [A&L93b] et al., as well as the linguistic and non-linguistic knowledge bases that are assumed to underlie a hearer's determination of those relations, we extend the account to a description of restrictions on textual order, basic syntactic operations such as conjunction and relativization, and the distributional behavior of tense constructions that will, again, depend heavily on insights related to the interface of interpretational and generative constraints and to our own claims about interpretational precedence. Finally, we return briefly to the subject of anaphora and, armed with the aforementioned insights regarding the utility of non-linguistic information in interpretation, give an account of some cases that are recalcitrant for our original, syntactic account.

Contents

0 Introduction 2

1 Optimization and Anaphora 4

1.0 Background 4
1.1 Beaver's Program for Optimization with Constraints 7
1.2 Groundwork for an Alternative Approach 9
1.3 Bidirectionality and Generation 19
1.3.0 Generation, Interpretation, and Interdependence 20
1.3.1 Reversibility and Resolution 21
1.3.2 Beaver's SYMMETRY 25
1.3.3 An Alternative to Beaver's SYMMETRY: Blutner's Bidirectionality 28
1.3.4 Rethinking Superoptimality 32

2 Optimizing Discourse Coherence 39

2.0 Overview 39
2.1 SDRT and Discourse Relations 40
2.2 Restrictions on Sequence, Conjunction, and Relativization 43
2.2.1 Attachment 47
2.2.2 Conjunction 49
2.2.3 Relativization 50
2.2.4 Connection and Generation 55
2.3 Tense and Discourse: Preliminaries 57
2.3.0 Background 57
2.3.1 The Perfect 58
2.3.2 The Pluperfect 61
2.3.2a Background 62
2.3.2b A Detour: Definite Descriptions and Bridging 64
2.3.2c Be Informative! 67
2.4 A Generative Program for Tense Constructions 69

3 Loose Ends 75

3.1 Anaphora and the Lexicon 75
3.2 Loose Ends Left Untied 78

4 Conclusion 81

0 Introduction

There are two separate issues that we will address regarding the optimization of a discourse. On one hand, we wish to formulate a decision procedure for NP-to-anaphora transformations in the constituents of a discourse. On the other hand, we desire a procedure for determining the order of constituents in a discourse and the possibility for syntactic operations that constitute various types of connection (e.g., conjunction), as well as a description of the distributional allowances for compound grammatical tenses, namely the perfect, pluperfect, and future perfect. We intend to formulate both procedures in the framework of Optimality Theory, invented by Prince and Smolensky [P&S93]. We will address the former issue first for, as we will see, a good deal of the literature regarding strategies for anaphoric substitution and anaphora resolution has already employed the Optimality Theory framework, and we will find it a simpler task to introduce the mechanics of that theory in the context of existing approaches.

Unfortunately, we will be sacrificing convenience in a different way by choosing to present the two issues in this order, as much of the current literature from which we will draw in our discussion of the maximization of the rhetorical and temporal coherence of a discourse involves reference to the interplay between different types of information, in particular information of a purely linguistic nature and non linguistic information, so-called "world-knowledge", and we will, at times, argue that intuitions about this interplay may also be used to fund a procedure for NP-to-anaphora transformation. Thus, in presenting the first issue, we will occasionally engage in some foreshadowing of what we plan to present in our discussion of the second matter.

In section 1, we propose a procedure for generation of anaphora that uses the work of Beaver [Beaver00] as a baseline. We will discuss Optimality Theory, a framework that is well represented in the current literature involving sets of ranked, violable constraints which serve as successive filters for linguistic input in order to generate output deemed 'optimal.' The strategy for the generation of anaphora will be set in that framework, and its potential for reversibility will be explored for the purpose of discussing a relatively recent idea related to Optimality Theory generation, the bidirectionality issue – the interdependence of generative optimality and interpretational optimality – explored first by Blutner and later Jäger, et al. We will show that Beaver's means of incorporating bidirectionality into his system of constraints fails to capture the results that motivate that notion and we will propose a simple means of correcting that oversight so that Blutner's statement of *strong bidirectionality* may be defined as a constraint placed inside an optimal theoretic evaluation procedure as opposed to being defined in terms of evaluation-external results. Finally, we will propose to re-examine the definition of *weak* bidirectionality or *superoptimality* and evaluate that notion's potential to serve as a system-internal constraint. Ultimately, we will argue that a different version of that definition ought to be adopted and we will show how such a definition is useful for solving the problems that initially motivated the weaker version of bidirectionality as well as how it avoids some of the problems that will motivate our alteration of that definition. Our notion of discourse coherence will draw heavily from the work of Asher and Lascarides, who use the notion of *discourse relations*, an idea first due to Mann and Thompson [M&T87] – relations between sentences in a discourse that describe how or why the state or event described in one sentence is relevant to a state or event described in another – to formulate constraints on what kinds of discourses are acceptable and how discourses

are interpreted. In section 2 we will adopt the distinctions between various categories of discourse relations proposed in these works and attempt to identify what kinds of restrictions, if any, these relations impose on discourse generation, in particular the use of tenses in discourse as well as the conjunction and relativization of constituents, and on sequential ordering. With these observations, we will propose a generative strategy that will draw from our discussion in section 1 regarding the bidirectionality issue. We will attempt to show that, with bidirectionality installed in the generative evaluation procedure, we may mold a generative strategy that is largely governed by the interpretational strategy for which the generative output is meant to serve as input.

Finally, in section 3, we will return briefly to the generation of anaphora and suggest how the interpretational constraints discussed in section 2 that rely on world-knowledge and that restrict inferences related to discourse relations may be used to provide a fine-tuned extension of a generative strategy for anaphora that will, again, be based on the view that, contrary to contemporary ideas about bidirectional strategies for interpretation and generation, the interplay between the two enterprises is not a symmetrical relationship but, rather, the mechanics of the interpretation procedure of a hearer is what motivates speakers to behave the way they do in terms of linguistic generation.

1 Optimization and Anaphora

The present section is dedicated to formulating a procedure for the optimization of discourse in terms of the distributional behavior of pronouns and definite and indefinite descriptions. We will propose a means of determining which elements in a discourse are replaced with anaphoric pronouns and which pronominal constituents are endowed with intonational focus. The formulation of the strategy will depend primarily on the insights of Beaver as a starting point. We begin with a brief overview of the recent literature related to NP-to-anaphora transformation in discourses. In section 1.1 we introduce Beaver's program for the optimization of anaphora resolution and generation, which – using the Optimality Theory framework of Prince and Smolensky [P&S93] – employs a set of constraints based on syntactic features of a discourse, and point out some weaknesses of that approach. In section 1.2 we suggest our own syntactically based strategy, intended to be an improvement on Beaver's program. In section 1.3, we discuss a challenge for both approaches. We outline Beaver's solution to that challenge, which relies on the work of Blutner [Blutner00] et al., which in turn draws from the work of Atlas and Levinson et al. related to the so-called bidirectionality of interpretation and generation. We will point out some oversights in Beaver's solution and propose an alternative – one that will involve a critique of Blutner's formulation of the bidirectionality condition – which will both harvest more desirable results and keep the insight behind Beaver's original solution intact.

1.0 Background

Recent work, including but not limited to that of Hendriks and de Hoop [H&H00], and Beaver [Beaver00], has employed the Optimality Theory of Prince and Smolensky [P&S93] – a framework originally proposed as a descriptive mechanism for procedures in generative phonology – to the interpretation of natural language, in particular the resolution procedures whereby anaphora are interpreted. Beaver in particular, in his OT-style reformulation of the Centering Theory of Grosz, Joshi, and Weinstein [G&J&W83] and [G&J&W95] – a theory designed to make predictions about anaphoric resolution and the interpretational coherence of discourses – attempts to show his declaratively stated model to be a reversible one, suitable for generative purposes. Following these lines, we propose to treat the decision procedure for selecting which NP-constituents of sentences in a discourse undergo anaphorization and which do not as an optimal theoretiprocedure. The recent proposals of Blutner et al. have added a new dimension to the OT framework, one in which two OT evaluation procedures for two distinct enterprises – namely generation and interpretation – may be seen as interdependent, and another sort of optimality – optimality with respect to *both* evaluation procedures – may be defined. We will look at two different versions of the 'new optimality' called *bidirectional optimality* and *superoptimality* and explore their utility for our purposes as well as the potential for internalizing the notion of these varieties of optimality into the two evaluation procedures which they are normally seen as operating above.

In OT, a piece of linguistic input is subjected to a series of constraints, which are ordered with respect to their relative degree of violability, in order to determine the output. Various candidates for the ultimate output are evaluated on the basis of which constraints they violate, the relative violability (i.e., ranking) of these

constraints, and the number of violations committed. The results of the evaluation procedure corresponding to a particular input are traditionally represented in a *tableau*, wherein the output candidates are listed in a vertical axis, the constraints on a horizontal axis, and each violation resulting from the cross-referencing of a candidate and a constraint is tallied by a " * " in the cell corresponding to the intersection of the two axes. A fatal violation – one which effectively disqualifies a candidate – is noted as " *! ".

In the work of Beaver and of Hendriks and de Hoop, the constraints governing the interpretation of anaphoric elements crucially depends on the notion of a *topic*. In both, some constraint invoking the notion of topic is proposed to affect the resolution strategy of the interpreter.

[H&H00]	TOPICALITY:	As an antecedent for an anaphor, choose a topic.
[Beaver00]	PRO-TOP:	The (unique) topic of a sentence is pronominalized.

The notion of topic used in Hendriks and de Hoop is primarily a *semantic* or, perhaps more accurately, a *pragmatic* one, related to the so-called 'aboutness' of a discourse, defended in, e.g., Reinhart [Reinhrt82], Vallduví [Val90], Aissen [Aissen99], and Dekker and Hendriks [Dek&Hen95].[1] In contrast, Beaver's notion of topic is one which is primarily a *syntactic* notion: for every sentence there is exactly one topic; the topic is the "most salient discourse entity" in a sentence; the most salient entity in a discourse is the one appearing in the least oblique argument position; only entities from a previous sentence are salient.[2] In effect: the topic of a sentence is any entity that was referred to in the previous sentence. If there is more than one such entity, then the tie is broken by comparing the elements in terms of their respective canonical positions in the previous sentence. If there is no such entity, then the topic is the subject of the current sentence.

There are advantages and disadvantages to each approach. A semantic/pragmatic definition of topic is difficult to pin down; giving a formal definition of what exactly a discourse is about would be difficult if not impossible. Certainly if a hearer were to know ahead of time, given a discourse like *John fought Bill He won*, which character the discourse could reasonably be said to be about, he would have a helpful tool with which to determine to which individual the pronoun *He* actually referred. However, it is not entirely clear how one would come to possess such a tool; that is, it may very well be the case that the entity that is the discourse topic is the individual the discourse in question is primarily about, but it seems that, in at least some cases, determining what a discourse is about and resolving a particular pronoun are one and the same problem.

---

[1] The relation of the notion of topic to a notion of 'aboutness' under discussion here is quite different from the view of Asher [Asher83] that we will introduce in section 2 of this manuscript. For the former, the topic of a sentence is necessarily a linguistic constituent of a sentence, usually an NP. Certain accounts (e.g., Büring [Büring99]) allow for topics to be adjectives and determiners as well.

[2] The four maxims stated here are just Beaver's constraints UNIQUETOPIC, SALIENTTOPIC, ARGUMENTSALIENCE, and ONESENTENCEWINDOW, in that order. Beaver uses these four constraints to replace a preliminary definition given earlier on in [Beaver00]. "The topic of a sentence is the entity that is referred to in both the current sentence and the previous sentence, such that the relevant referring expression in the previous sentence was minimally oblique. If there is no such entity, the topic can be anything." (*Ibid.* p30) To be sure, the only difference between the original definition and the effect of these four constraints is that the constraints mold a stronger definition; due to SALIENTTOPIC and ARGUMENTSALIENCE, if there are no elements in the current sentence that corefer with elements in the previous one, then the subject of the current sentence must be the topic (and can no longer "be anything"), as it is the most salient entity in terms of the 'upcoming sentence.' Other constraints are tentatively proposed later which do constrain the notion of topic in a way that neither matches nor reinforces the original definition.

On the other hand, a syntactic formulation of the notion of topic faces difficulty as well. Firstly and most obviously, a function is present in most languages whereby one may take virtually any sentence with a two or three argument verb and produce a passivized version of that sentence. Given that Beaver's notion of topic relies so heavily on the canonical positions of the elements in a discourse, a function that makes possible the optional transposition of the canonical order of the discourse elements of any constituent has the potential to severely disrupt his account. To be sure, it has been argued in the literature (cf. Bollinger [Bol77]) that passive constructions may exhibit semantic differences compared to their active counterparts. Furthermore, strong arguments have been made (cf. Aissen [Aissen99]) that the decision to cast information in a passive construction is not at all an arbitrary one but is dependent on the features (e.g., animacy versus non-animacy) of entities in question. It is a bit beyond our scope here to consider passive constructions and the constraints which govern their inclusion in a discourse or their effects on a syntactically based theory of topic and thus, in the present discussion, we will leave consideration of that matter aside.

A second challenge for a syntactic notion of topic, and one which we will not leave aside, may be illustrated by the following sequences.

(1.1) John pushed Bill. He fell.
(1.2) Mary gave Jane a dollar. She spent it on candy.
(1.3) A raindrop hit a book. It got wet.

Beaver's account, and any account that employs a notion of topic based on minimally oblique canonical position and uses such a notion to facilitate resolution procedures for anaphora, will fail to get results for the above three discourses that are the intuitively correct ones. Under such accounts, the pronouns in the second sentence of each of the sequences above are predicted to be coindexed with the NPs in the subject position of the sentences that respectively precede them. These examples serve to show a point that is argued for extensively in the work of Asher and Lascarides, which we will discuss extensively in the next section: world-knowledge must be take into account when formulation strategies for interpretation, for such knowledge may override the usual decision procedure governing how discourses are to be understood. We will suggest a solution for this challenge to syntactically based approaches to anaphoric substitution based on the work of those authors, however, it will be helpful to suspend discussion of that issue until we have had an opportunity to introduce their work in a proper way; that opportunity will not present itself until the next section and so we choose to first lay the groundwork for a syntactic analysis of anaphora generation and then, after we have how the ideas of Asher and Lascarides related to the semantic coherence of discourses may fund a strategy for discursive generation, return briefly to the anaphora question so that we may borrow from the ideas introduced in that section and show how world-knowledge and linguistic knowledge will at times override the syntactic approach we propose. In the discussion that immediately follows, we will examine Beaver's analysis with a bit more care, adopt, as he does, a syntactic notion of topic that will be the nucleus of the default optimization strategy we intend to advocate, and discuss how that approach may be turned into a bidirectional procedure, whereby it is inexorably linked to interpretational strategies.

1.1 Beavers Program for Optimization with Constraints

Two constraints that Beaver introduces into his program for resolution will not be immediately necessary for our purposes; these are ALIGN and COHERE.

COHERE: The topic of the previous sentence is the topic of the current sentence.

ALIGN: The topic is in the subject position.

The constraints COHERE and ALIGN will be of no use to us, as we will not assume ay mechanism in our generation procedure which could effect a change in canonical positions of the arguments of a sentence; we will assume that the canonical positions in the output will correspond to directly to the configurations of the verbal arguments in the input representation.[3] Six constraints remain that directly concern the NP-to-anaphor decision procedure.

AGREE: An anaphor must agree with its antecedent in number and gender.

DISJOINT: Co-arguments of a predicate are disjoint.

PRO-TOP: The topic of the sentence is pronominalized.

FAMDEF: Each definite NP is familiar. "This means that both the referent is familiar, and that no new information is provided by the definite."

*FOCUS: Do not intonationally stress a constituent.[4]

SYMMETRY: If M (a meaning) is an input to a generator and F (a form) is an output, then F is a unique optimal realization of M if and only if M is a unique optimal interpretation for F.

We will borrow the constraint AGREE directly from Beaver, unmodified, this will guarantee that we generate only those pronouns which bear the appropriate gender and features. We will assume to have a slightly modified version of the constraint DISJOINT at our disposal such that it will effect the generation of reflexive pronouns just in case the arguments of a single relation fail to be disjoint, but we do not bother to restate or rename that constraint. We will suppose that each of these each of these is a hard constraint, i.e., one such that every violation is a fatal one. The constraint *FOCUS is fairly straightforward, and we will propose a constraint that will have the same effect in the repertoire of constraints that we ultimately advocate, though we will be

[3] An utterly awkward two-sentence discourse lie *A ball landed at John's feet It was picked up by him* illustrates that any optimization strategy that incorporates a constraint like COHERE must rank it below some sort of constraint demanding that an NP referring to an inanimate or non-human entity not be forced to the minimally oblique canonical position of the current sentence simply because it was the topic (i.e., the subject) of the previous one.

[4] The constraint is originally due to Schwarzschild [Schwar99].

looking at a very narrow range of elements that qualify for intonational focus, as we will have nothing to say about such focus that relates to anything other than pronouns. We will have a good many things to say about SYMMETRY below, which is related to the idea that interpretation and generation are interdependent, but we will suspend discussion of that constraint until section 1.3. PRO-TOP is a constraint for which we will also propose a similar counterpart. One issue that is immediately pressing is some confusion about the generative function of FAMDEF.

In Beaver's analysis, "the class of definites is taken to include pronouns, definite descriptions, and proper names." (*Ibid.* p16) This is will have two effects with regard to the use of proper names in a discourse. Firstly, the first use of every name will be a FAMDEF violation.[5] Secondly, when a proper name is used twice, from a resolution standpoint, the second use of that name (and the third, and the fourth, etc.) will be interpreted as referring to the same individual, i.e., for a discourse like $John_i$ *loves* $Mary_j$ $Bill_k$ *loves* $Sally_l$ $John_m$ *likes* $Carol_n$, the resolution procedure governed by the constraints will record the information that $i=m$. From a generative point of view, if we were to generate the same discourse in a circumstance where $i=m$ did *not* hold, then the occurrence of $John_m$ would effect a violation of the FAMDEF constraint (as would all the other uses of the names in that discourse.) However, in his discussion of the reversibility of his program and its potential to serve as a generative tool, this is *not* how FAMDEF violations are registered. In fact Beaver seems to adopt an entirely new definition of FAMDEF without warning once the constraint is being used in a generative enterprise. The following tableau is adopted from Beaver. (*Ibid.* pp36/7) We have omitted consideration of the constraints and COHERE and ALIGN, which are related to the passive versus non-passive issue. In addition, the constraints DISJOINT and AGREE (as well as the candidates that violate them) are not considered. Beaver proposes the constraints PRO-TOP, FAMDEF and *FOCUS to be ranked as follows. (In the tableaux we will represent rankings with the presence of a double line.)

PRO-TOP >> FAMDEF >> *FOCUS

The input */$Fred_j$ amused $Jane_i$/* is being evaluated in the context of the preceding discourse $Jane_i$ *is happy* $Fred_j$ *gave her a present*$_k$. Beaver's tally of the violations looks like this.

[5] Thinking of proper names as definite elements that require antecedents is not nearly as unintuitive an idea as it might initially seem to be, for a speaker who wished to communicate successfully would hardly use a name like *Bill Clinton* in a conversation with an interlocutor who had no idea to whom the name referred and we may assume that a name, like a definite, must either have an antecedent that is contextually or explicitly supplied.

$Jane_i$ is happy $Fred_j$ gave her a $present_k$ /$Fred_j$ amused $Jane_i$/	PRO-TOP	FAMDEF	*FOCUS
[Fred amused Jane]	*!	**	
[He amused Jane]		*!	
[HE amused Jane]		*!	*
[Fred amused her]	*!	*	
[Fred amused HER]	*!	*	*
☞ [He amused her]			
[HE amused her]			*!
[He amused HER]			*!
[HE amused HER]			*!*

Our question then, is this: Why are any of these candidates being said to violate FAMDEF? FAMDEF states that no pronoun, definite description, or proper name may appear without an antecedent nor may it add to the content of that antecedent.[6] None of the above candidates do so; all NPs in the sentence *Fred amused Jane* have antecedents. Beaver is treating this constraint, when applied to semantic input for the purpose of syntactic output, as one which demands pronominalization of non-topic elements, but this is simply not what FAMDEF says. The tableau above, given the literal reading of FAMDEF should look like the following.

$Jane_i$ is happy $Fred_j$ gave her a $present_k$ /$Fred_j$ amused $Jane_i$/	PRO-TOP	FAMDEF	*FOCUS
[Fred amused Jane]	*!	**	
☞ [He amused Jane]			
[HE amused Jane]			*!
[Fred amused her]	*!	*	
[Fred amused HER]	*!	*	*
☞ [He amused her]			
[HE amused her]			*!
[He amused HER]			*!
[HE amused HER]			*!*

We take these results to be undesirable on the grounds that the candidate [*He amused Jane*] is suboptimal and ought not to be judged a winning candidate given the input at hand. We require a constraint that deals with NP constituents in a discourse which, under Beaver's definition, are not topics, and must address the question of when they may be appropriately transformed into anaphora. Before going further, let us sketch what such an analysis could look like.

[6] By constraining expressions from "adding content to the antecedent" it is simply meant that definites like *the black donkey* do not qualify as being familiar when only the indefinite *a donkey* (or *a happy donkey*) has been introduced.

1.2 Groundwork for an Alternative Approach

First we introduce a constraint, call it ECON, assuming it to be a violable constraint that will disallow NPs that have salient antecedents in the discourse (salience is a notion we will have to define) from appearing in a marked form. We will say that a marked form is one that is either not pronominalized or that is pronominalized but is endowed with intonational focus. We will assume that ECON is *scalar* with regard to its evaluation of an input. That is to say that the evaluation procedure registers a violation of ECON for every discourse element that has a salient antecedent, but is marked. In addition, we propose a constraint that will serve to restrict the distribution of indefinite noun phrases, *REPINDEF, another hard constraint.

Definition 1:

Salience – A discourse element X in a constituent A is *salient* with respect to a discourse element Y in a constituent B if and only if the discourse referents of X and Y are non-disjoint and A immediately precedes B in a discourse.[7]

Definition 2:

Markedness – A discourse element is *marked* if and only if it is not pronominalized or is an intonationally focused pronoun.

ECON: If X is a discourse element with a salient antecedent, then X must be unmarked.

*REPINDEF: No discourse entity may be associated with more than one indefinite phrase unless the phrase appears in an identity statement.[8]

We may now see how the constraint ECON fares with the input from the tableau above.

[7] This definition of salience simply mirrors the ONESENTENCEWINDOW constraint of Beaver. Clearly much further progress could be made with the definition. For example, there seem to be certain discourse relations which are identifiable as being more or less *salience conductors*, under the right circumstances, e.g., the relation *background*, discussed briefly in the next section: *John entered a room It was pitch dark The curtains were drawn There were no lamps He could not see a thing*. For a discussion on referential chains in discourse, see Benz [Benz00].

[8] Here we are simply reversing Heim's Familiarity Condition [Heim82], which bars two indefinites from being interpreted as coreferential. We believe that the condition is indeed too strong, as sentences like *John is a rich farmer* and *John is a successful farmer* are obviously not to be interpreted as referring to two Johns, but, rather, to the same individual.

$Jane_i$ is happy $Fred_j$ gave her a present$_k$ /$Fred_j$ amused $Jane_i$/	ECON
[Fred amused Jane]	*!*
[He amused Jane]	*!
[HE amused Jane]	*!*
[Fred amused her]	*!
[Fred amused HER]	*!*
☞ [He amused her]	
[HE amused her]	*!
[He amused HER]	*!
[HE amused HER]	*!*

This is a desirable result and, as we have witnessed, one which Beaver's constraints do not capture.

It will become obvious that there is more to an account of discursive anaphora than a universal principle that demands that all elements with salient antecedents be pronominalized. Based on what we judge to be the acceptability of a sequence like *John kissed Mary Mary slapped him*, we believe that a discourse wherein a discourse element is in the minimally oblique canonical position of a sentence, but is not a topic, the pronominalization of that element is more or less optional in most cases. We would like to incorporate a constraint into the system whose results will reflect this. To accomplish this, we define the notion of topic as below and formulate a constraint PRON⇔TOP.

Definition 3:

Topic – A discourse element X is a *topic* of constituent B if and only if A is the sentence immediately preceding B and the antecedent of X is in the minimally oblique canonical position of A.

PRON⇔TOP: Pronominalize a discourse element X if and only if X is a topic.[9]

The constraints ECON and PRON⇔TOP interact and indeed will in some cases be in direct conflict with one another; for a constituent that contains one or more elements that are not topics, if those elements are pronominalized, that constituent will spare itself an ECON violation, but will incur a violation of PRON⇔TOP as a result. Likewise, in a case where a constituent that contains one or more elements that are not topics, then for each of those elements that are not pronominalized, that constituent will avoid a PRON⇔TOP violation, but will violate ECON one time for each such avoidance. Of course, with respect to discourse elements that *are* topics, ECON and PRON⇔TOP do not compete with each other but rather overlap or reinforce one another, since where an ECON violation occurs due to a topic element occurring in its *full form*, i.e., where it is not pronominalized, the constituent containing that element will violate both ECON and PRON⇔TOP. We will

[9] The constraint is nothing more than a variation of Bresnan's REDUCED⇔TOP, proposed in [Bresnan99], although we have not adopted the same notion of topic.

suppose these constraints to be equally ranked and it will follow directly from this fact that, given two candidates, each which commits *n* violations of one of these two constraints and no other constraint, the candidates will be tied, as the violations offset each other. With these constraints in place, we get the results illustrated below.

John$_i$ kissed Mary /John$_i$ smiled/	ECON	PRON⇔TOP
[John smiled]	*!	*
☞ [He smiled]		
[HE smiled]	*!	

John$_i$ kissed Mary$_j$ /Mary$_j$ slapped John$_i$/	ECON	PRON⇔TOP
[Mary slapped John]	**!	*
[She slapped John]	*	*!*
[SHE slapped John]	**!	**
☞ [Mary slapped him]	*	
[Mary slapped HIM]	**!	
☞ [She slapped him]		*
[SHE slapped him]	*	*!
[She slapped HIM]	*	*!
[SHE slapped HIM]	**!	*

These are, we feel, desirable results. However, these two constraints do not yield the correct predictions for discourses which do not share the canonical configurations with the ones above. Consider the results illustrated in the tableaux below. (We omit the focused pronouns here; it may be checked that all candidates containing them will be disqualified, as they will all commit more violations of ECON than their unfocused counterparts.)

John$_i$ dates Mary$_j$ /John$_i$ loves Mary$_j$/	ECON	PRON⇔TOP
[John loves Mary]	**!	*
☞ [He loves Mary]	*	
[John loves her]	*	*!*
☞ [He loves her]		*

John$_i$ caught a fish$_k$ for Mary$_j$ /Mary$_j$ ate a fish$_k$/	ECON	PRON⇔TOP
☞ [Mary ate the fish]	**	
☞ [She ate the fish]	*	*
☞ [Mary ate it]	*	*
☞ [She ate it]	**	

These outcomes are clearly incorrect. Note that if we had used Beaver's PRO-TOP as opposed to our PRON⇔TOP, we would get only the outputs [*He loves her*] and [*She ate it*], for the above tableaux, as ECON would rule out the others, and these are the predictions we are aiming for. However, as we stated above, we judge *John kissed Mary Mary slapped him* to be an acceptable discourse, so PRO-TOP will not get us the results we want, for nothing would compete with ECON as to guarantee the optionality we desire with respect to the pronominalization of the discourse element *Mary*. We think that the reason that candidates such as [*John dates Mary He loves Mary*] and [*John caught a fish for Mary Mary ate the fish*] are suboptimal is due to the fact that the discourse elements *Mary* and *a fish* have not undergone a shift in canonical position from one sentence to the next, i.e., in the example */John dates Mary He loves Mary/*, *Mary* is in the object position of the first sentence, and in the second. The same is true of the phrase *a fish* for the second example. We propose a constraint that will demand that an element – even one that lacks topic status – remains unmarked in cases where a salient antecedent is available for that element which sits in the same canonical position in the previous sentence as the element occupies in the current sentence. What is more, we will make the constraint a biconditional and it will require that all elements that switch canonical positions from one constituent to another appear in a marked form. The biconditional effect will harvest unintuitive results at first, but in the discussion that follows we will see how it will be helpful.

MARK⇔SHIFT: Where a discourse element X has a salient antecedent Y, mark X if and only if X is in a different canonical position in the current sentence than the one Y occupies in the previous sentence.

Ranking MARK⇔SHIFT equally with ECON and PRON⇔TOP would effect the results we want for the data above. However, for reasons that will become clear later, we propose to rank MARK⇔SHIFT above the other soft constraints. With the addition of MARK⇔SHIFT, the result for the input */John dates Mary John loves Mary/* looks as follows.

John$_i$ dates Mary$_j$ /John$_i$ loves Mary$_j$/	MARK⇔SHIFT	ECON	PRON⇔TOP
[John loves Mary]	*!*	**	
[He loves Mary]	*!	*	
[HE loves Mary]	*!*	**	
[John loves her]	*!	*	**
[John loves HER]	*!*	**	**
☞ [He loves her]			*
[HE loves her]	*!	*	*
[He loves HER]	*!	*	*
[HE loves HER]	*!*	**	*

These results are, we feel, perfect predictions, however, the unfortunate effects of the biconditional status of the constraint is made clear by the following tableau. (We again omit candidates with focused pronouns; all will fatally violate MARK⇔SHIFT or ECON + PRON⇔TOP as opposed to only PRON⇔TOP.)

$John_i$ caught a $fish_k$ for $Mary_j$ /$Mary_j$ ate a $fish_k$/	MARK⇔SHIFT	ECON	PRON⇔TOP
[Mary ate the fish]	*!	**	
[She ate the fish]	*!	*	*
☞ [Mary ate it]		*	*
[She ate it]	*!		**

These results are obviously not what we are after. Nevertheless, we will discover benefits to this approach both when we explore the reversibility of the constraint MARK⇔SHIFT as well as its interaction with a constraint we plan to introduce next. We move on to this constraint presently.

Note that in the tableau above for the input (*$John_i$ kissed $Mary_j$*) /*$Mary_j$ slapped $John_i$*/, the candidate [*SHE slapped him*] is disqualified due to its violation of both PRON⇔TOP and ECON, which results from the fact that the pronoun in that candidate bears intonational focus. There are certain circumstances for which we will need to require that discourse elements bear this type of focus, as sentences in these circumstances will sound unnatural if the intonational stress is absent. As an example of the types of cases for which we would prefer to generate intonationally endowed output, consider the inputs (*$John_i$ loves $Mary_j$*) /*$Mary_j$ does not love $John_i$*/. We believe that in a case like this, the outputs [*Mary does not love John*], [*SHE does not love HIM*], and [*Mary does not love HIM*] are superior compared to the candidate [*Mary does not love him*] or to [*She does not love him*], both of which would be declared winners under the repertoire of constraints currently in place. We aim to provide evidence that the need for intonational focus in certain outputs is related to the discourse relation *parallel*, and propose to add a constraint to the evaluation procedure which makes reference to this relation in order to effect more desirable outputs for inputs like (*$John_i$ loves $Mary_j$*) /*$Mary_j$ does not love $John_i$*/.

It is necessary to do a bit of foreshadowing here. We will discuss the notion of discourse relations in section 2 of this manuscript. In our brief discussion of the relation *parallel*, we will treat it as a relation between two constituents that bear some structural symmetry to one another, where by "structural symmetry" we mean that a verb or a predicate present in one constituent was present in another, for example *John gave Mary a rose He gave Sally a tulip*. We believe that a discourse like *John loves Mary She does not love him* warrants intonationally focused anaphora specifically because there is a symmetry between the verbal elements in the two sentences.[10] We also judge a preference for intonationally focused elements in cases where the *parallel* relation is slightly more subtle than for pairs of constituents with identical verbs, e.g., *John caught a fish for Mary SHE gave it to Bill* but not *John caught a fish for Mary #SHE cooked it for Bill.* Given this evidence, we will propose to think of the relation *parallel* as a semantic relation between constituents, namely a relation such that where V^A is the verb in A and V^B is the verb in B, then ($V^A \rightsquigarrow V^B$) (we will use the '$\rightsquigarrow$' repeatedly throughout this paper to indicate non-monotonic entailment, which may be read *if … then, normally …*) The result of this with respect to our two examples is that a *parallel* relation exits between the sentence *John caught a fish for Mary* and the sentence

[10] It is worth noting that, by concentrating on the *parallel* relation alone, there is more than one type of intonational focus that we will not be able to explain. A discourse like *John loves Mary She despises him* indeed typically involves some type of stress. However, that stress is normally manifested by way of some complex intonational contour imposed over the entire second sentence of the discourse, most of the stress being placed on the verb: SHE DESPISES HIM. It is beyond our scope here to consider these types of sentential contours and thus we must remain satisfied to ignore them. For an analysis of contrastive focus, cf., e.g., Büring [Büring99].

SHE gave it to Bill, where as no *parallel* relation exists between the constituent *John caught a fish for Mary* and the constituent *She cooked it for Bill*. This is due to the fact that, while *x* catching a fish for *y* non-monotonically implies that *x* gave or will give the fish to *y*, *x* catching a fish to *y* does not imply anything about cooking.

MARK⇔PAR: For two constituents A and B, where A immediately precedes B, if X appears in B and an antecedent of X appears in A, then mark X if and only if A and B are such that *parallel*(A, B).

Now obviously it is not the case that intonational focus shows up wherever a *parallel* relation is present between two constituents. (The pronoun in a discourse like *John loves Mary He loves Sally* does not warrant intonational focus.) However, we submit that when there is a *parallel* relation between two constituents and one or more discourse elements in the second constituent appears in a canonical position distinct from the one in which it appeared in the first constituent, there is a need for that constituent to be marked. In the example *John loves Mary SHE does not love HIM*, this is exactly what is going on. Similarly for a discourse like *John gave a rose to Mary SHE gave it to Bill*. The constraint MARK⇔PAR does *not* say that where the *parallel* relation is present between two constituents and one or more discourse elements in the second constituent appears in a canonical position distinct from the one in which it appeared in the first constituent, then each such element must be marked; it does not need to say this, for we already have the far-too-strong constraint MARK⇔SHIFT to do this work for us. MARK⇔PAR simply says that all elements in a constituent that bears a *parallel* relation to the sentence preceding it must be marked. What we are aiming to accomplish by this is to allow for optionality – which we believe to be desirable – for two discourses like (1.4) and (1.5), below.

(1.4) John gave Mary a rose. SHE gave it to Bill.
(1.5) John gave Mary a rose. SHE gave the rose to Bill.

By ranking MARK⇔PAR and MARK⇔SHIFT equally, we will see that these results are effected, and also that the disturbing results above are alleviated.

John$_i$ caught a fish$_k$ for Mary$_j$ /Mary$_j$ ate a fish$_k$/	MARK⇔PAR	MARK⇔SHIFT	ECON	PRON⇔TOP
[Mary ate the fish]	**!	*	**	
[She ate the fish]	*	*!	*	*
☞ [Mary ate it]	*		*	*
☞ [She ate it]		*		**

We assume that there is no *parallel* relation between the two constituents in the input above. (Catching *x* for *y* does not non-monotonically imply anything about eating.) Thus, [*Mary ate the fish*] violates MARK⇔PAR twice. The candidate [*She ate the fish*] is disqualified because *She* is unmarked, though it has shifted canonical positions with respect to the previous sentence and *the fish* is marked even though there is no *parallel* relation present and that phrase has *not* shifted canonical positions. The other two candidates survive the pair of higher ranked

constraints because each violates one but not the other. Furthermore, they are tied with respect to the lower ranked constraints, and therefore both are winning candidates.

Secondly, we provide an illustration of how the constraints fare with the input (*John$_i$ loves Mary$_j$*) */Mary$_j$ does not love John$_i$/* .

John$_i$ loves Mary$_j$ /Mary$_j$ does not love John$_i$/	MARK⇔PAR	MARK⇔SHIFT	ECON	PRON⇔TOP
[Mary does not love John]			**	*!
[She does not love John]	*!	*	*	**
[SHE does not love John]			**	*!*
[Mary does not love him]	*!	*	*	
☞ [Mary does not love HIM]			**	
[She does not love him]	*!*	**		*
[SHE does not love him]	*!	*	*	*
[She does not love HIM]	*!	*	*	*
[SHE does not love HIM]			**	*!

First we note that in the presence of a *parallel* relation between two constituents with transitive verbs whose arguments have swapped canonical positions from one sentence to the next, the constraints MARK⇔PAR and MARK⇔SHIFT turn out to have no effect independent of one another; they mirror each other exactly. Secondly, it is our feeling that the results above are far too strong, for we believe that, for example, [*John loves Mary SHE does not love HIM*] is an optimal output for the relevant input and ought to be tied with the winner in the tableau above. One way to achieve this effect is by demanding that, where pairs of elements in a have swapped canonical positions from one sentence to the next are marked, they must be marked in the *same way*, i.e., either both must be intonationally focused or both must appear in full form. If we encode this demand into a constraint that is equally ranked with PRON⇔TOP and ECON, it will result in the evaluation procedure being more liberal with regard to the candidates that we would like to keep.

SYMMARK: Where A and B are constituents such that A immediately precedes B and two discourse elements X and Y are such that the canonical position of B in which the antecedent of X stood in A is filled by Y, and the canonical position of B in which the antecedent of Y stood in A is filled by X, then, if X and Y are both marked, then X may be intonationally focused if and only if Y is intonationally focused and X may be a full form if and only if Y is a full form.

With the addition of SYMMARK (an abbreviation for 'symmetrical marking'), we have:

John$_i$ loves Mary$_j$ /Mary$_j$ does not love John$_i$/	MARK⇔PAR	MARK⇔SHIFT	ECON	PRON⇔TOP	SYMMARK
☞ [Mary does not love John]			**	*	
[She does not love John]	*!	*	*	**	
[SHE does not love John]			**	**!	*
[Mary does not love him]	*!	*	*		
☞ [Mary does not love HIM]			**		*
[She does not love him]	*!*	**		*	
[SHE does not love him]	*!	*	*	*	
[She does not love HIM]	*!	*	*	*	
☞ [SHE does not love HIM]			**	*	

The two tableaux below serve to illustrate the effect of the constraints on input with ditransitive verbs.

John$_i$ caught a fish$_k$ for Mary$_j$ /Mary$_j$ cooked a fish$_k$ for John$_i$/	MARK⇔PAR	MARK⇔SHIFT	ECON	PRON⇔TOP	SYMMARK
[Mary cooked the fish for John]	**!	*	**	*	
[She cooked the fish for John]	**	*!	**	**	
[SHE cooked the fish for John]	**!	*	**	**	*
[Mary cooked it for John]	**		**	*!	
[Mary cooked IT for John]	**!	*	**	**	
[Mary cooked the fish for him]	**	*!	**		
[Mary cooked the fish for HIM]	**!	*	**		*
[She cooked it for John]	*	*	*	**!	
[SHE cooked it for John]	**		**	**!	*
[She cooked IT for John]	**	*!	**	***	
[SHE cooked IT for John]	**!	*	**	***	
[She cooked the fish for him]	*	**!	*	*	
[SHE cooked the fish for him]	**	*!	**	*	
[She cooked the fish for HIM]	**	*!	**	*	
[SHE cooked the fish for HIM]	**!	*	**	*	
☞ [Mary cooked it for him]	*	*	*	*	
[Mary cooked IT for him]	**	*!	**	*	
[Mary cooked it for HIM]	**		**	*!	*
[Mary cooked IT for HIM]	**!	*	**	*	*
☞ [She cooked it for him]		**		**	
[SHE cooked it for him]	*	**	*	**!	
[She cooked IT for him]	*	**!	*	**	
[She cooked it for HIM]	*	*	*	**!	
[SHE cooked IT for him]	**	*!	**	**	
[SHE cooked it for HIM]	**		**	**!	
[She cooked IT for HIM]	**	*!	**	**	
[SHE cooked IT for HIM]	**!	*	**	**	

John$_i$ gave a book$_k$ to Mary$_j$ /Mary$_j$ had given a book$_k$ to John$_i$/	MARK⇔PAR	MARK⇔SHIFT	ECON	PRON⇔TOP	SYMMARK
☞ [Mary had given the book to John]		*	***	*	
[She had given the book to John]	*	*!*	**	**	
[SHE had given the book to John]		*	***	**!	*
☞ [Mary had given it to John]	*		**	**	
[Mary had given IT to John]		*	***	**!	
[Mary had given the book to him]	*	*!*	**		
☞ [Mary had given the book to HIM]		*	***		*
[She had given it to John]	*	*!	*	***	
[SHE had given it to John]	*		**	**!	*
[She had given IT to John]	*	*!*	**	***	
[SHE had given IT to John]		*	***	**!*	
[She had given the book to him]	**!	***	*	*	
[SHE had given the book to him]	*	*!*	**	*	
[She had given the book to HIM]	*	*!*	**	*	
☞ [SHE had given the book to HIM]		*	***	*	
[Mary had given it to him]	**!	*	*	*	
[Mary had given IT to him]	*	*!*	**	*	
☞ [Mary had given it to HIM]	*		**	*	*
[Mary had given IT to HIM]		*	***	*	*!
[She had given it to him]	**!*	**		**	
[SHE had given it to him]	**!	**	*	**	
[She had given IT to him]	**!	***	*	**	
[She had given it to HIM]	**!	*	*	**	
[SHE had given IT to him]	*	*!*	**	**	
☞ [SHE had given it to HIM]	*		**	**	
[She had given IT to HIM]	*	*!*	**	**	
[SHE had given IT to HIM]		*	***	**!	

Finally, we note a difference in the behavior of two types of anaphora which we have so far left unaddressed. Consider.

(1.6a) A woman was in the audience. She screamed.
(1.6b) A woman was in the audience. #One screamed.

We believe that the discrepancy between (1.6a) and (1.6b) is due to the fact that, where no *parallel* relation exists between constituents, one-anaphora like the one exhibited in (1.6b) are reserved for partitive expressions, i.e., where there is no *parallel* relation present, a one-anaphor may only refer to a proper subset of its antecedent.

(1.7a) A shark attacked a swimmer yesterday. One attacked a lifeguard last week.
(1.7b) A shark attacked a swimmer yesterday. #John saw one at the aquarium last week.

(1.8a) John owns a house. Mary bought one yesterday.
(1.8b) John owns a house. ??Mary painted one yesterday.

We may propose the following constraint to reflect this observation, supposing it to be highly ranked.

1 ⇒ PAR: Use (non-partitive) one anaphora only if there is a parallel relation holding between the constituent containing the one-anaphor and the previous constituent.

The existence of a parallel relation does not seem to be all there is to the story regarding where one-anaphora are licensed, however. Consider.

(1.9a) John bit a donkey. IT bit Bill.
(1.9b) John bit a donkey. ??ONE bit Bill.

Here, the fact that the NP *a donkey* appears in object position of the first sentence of (1.8b) while the one-anaphor which goes proxy for that phrase in the second sentence of that discourse is in the subject position seems to be what renders it so unnatural. We could suppose that there was yet another highly ranked constraint that conspired with 1 ⇒ PAR to block continuations like the second sentence of (18b), one that demanded that focused one-anaphora were also reserved for partitive readings.

FOCUS1⇒PART: Endow a one-anaphor with intonational focus only if it is partitive.

This would guarantee that a discourse like (18b) would always contain a full form, since, if there is a one anaphor there that is unfocussed, it will violate both MARK⇔SHIFT and MARK⇔PAR, whereas the full form *a donkey* would satisfy both of these constraints.

Admittedly, a sequence like *John bit a donkey A donkey bit Mary* could hardly be called optimal, though, given the constraints we are using, there is little choice in the matter. We might choose to think of *another* as a focus operator which does the work if intonational stress when such stress is banned from use by the constraint FOCUS1⇒PART, and this would give us the expression *another donkey*, which seems the optimal alternative. However, we will leave consideration of the issue, and consideration of the constraints related to it, aside.

1.3 Bidirectionality and Generation

In the present section we will discuss the notion of bidirectionality, an idea most thoroughly explored in Blutner [Blutner00] and Jäger [Jäger00] related to the dependence of a speaker's generative behavior on a hearer's interpretational strategy, and, in turn, the hearer's interpretational strategy on a speaker's generative behavior. The work of these authors has proven to be a quite elegant way of representing Horn's idea [Horn84] of the existence of a "division of pragmatic labour" between speaker and hearer. Beaver introduces a constraint which is intended to import bidirectionality into the evaluation procedure of both the generative and interpretational programs. That is to say, the constraint is there to 'judge' whether a certain form (on the generative side) or meaning (on the interpretational side) is congenial to the needs of the other procedure – whether that form will be interpretable in light of the interpretational constraints, and whether the interpretation being evaluated is one for which the form under consideration is optimal. We will discuss Beaver's method of capturing bidirectionality in his program, and introduce evidence for why that method is ultimately unsuccessful. Secondly, we will return to the source – to Blutner's statement of bidirectional optimality – and argue that this definition itself does not capture what we feel is a proper description of the interdependence between the two relevant procedures. We will propose our own definition and, following Beaver, incorporate that definition into the two evaluation procedures by proposing a separate constraint for each.

1.3.0 Generation, Interpretation, and Interdependence

The constraints we introduced in section 1.2 still do not make accurate predictions, since, as they stand, they will yield the following tableau.

John$_i$ fought Bill$_j$ /Bill$_j$ won/	MARK⇔PAR	MARK⇔SHIFT	ECON	PRON⇔TOP
☞ [Bill won]	*		*	
☞ [He won]		*		*
[HE won]	*		*	*!

We take these results to be undesirable, as we believe that the only legitimate winner in the above tableau ought to be [*Bill won*]. We would like to say that the reason the pronoun *He* should not occur is that, given the average hearer, it will be interpreted as being coindexed with *John*. Being that we are ostensibly designing a generator whose output may serve as the input for the interpretational procedure of some hypothetical listener, we would like the output to be as congenial as possible to the resolution strategies of that listener and see (*John fought Bill*) [*He won*] barred altogether as output for the input in the tableau above.

The program of Beaver we discussed above suggests how this issue may be solved; he finds his solution in *bidirectional* evaluation, proposed by Smolensky [Smol98][11] and explored in detail by Blutner [Blutner00] and Jäger [Jäger00] et al. The idea behind bidirectionality in generation is that a candidate form ought only to be judged truly optimal if the meaning it is intended to represent is also an optimal meaning for that form, lest another meaning be derived from that form and the form be misinterpreted. (NB: Given the mechanics of OT, if a certain meaning is not optimal for a certain form, *then some other meaning is*.) Beaver's way of incorporating this idea into his strategy is to propose the constraint SYMMETRY. We repeat our statement of that constraint below.

SYMMETRY: If M (a meaning) is an input to a generator and F (a form) is an output,
then F is a unique optimal output for M if and only if
M is a unique optimal interpretation for F.

In plain English this says that a form is uniquely optimal given some meaning if and only if that meaning is the unique meaning that will be derived from that form. As Beaver points out, the constraint SYMMETRY makes reference to the output of the evaluation procedure of which it is a part. Wishing to avoid circularity in defining the constraint, the definition is given as "[A] meaning should be optimally realized as a certain form using all the constraints except SYMMETRY if and only if that form is optimally interpreted as having that meaning, using all of the constraints except SYMMETRY." ([Beaver00] p44) Taking A▷B to mean that "given input A, there is a unique optimal output B." (*Ibid.*) – uniquely optimal that is, according to set of constraints, minus SYMMETRY – the constraint SYMMETRY is thus defined as below.

SYMMETRY: M▷F⟺F▷M

We wish to show that there are some problems with the way this constraint is formulated. In order to see how SYMMETRY works when incorporated into our repertoire of constraints, we need to *reverse* each constraint, creating a resolution program out of our generative enterprise. The following subsection is dedicated to this end.

1.3.1 Reversibility and Resolution

Below we propose the reversed counterparts of each constraint so far introduced.

DISJOINT: Interpret a discourse element as coreferential with an element with which it is a co-argument of a predicate just in case one of the arguments is a reflexive pronoun.

AGREE: Interpret a pronoun X as coreferential to a discourse element Y only if
X agrees with Y in terms of number and gender.

*REPINDEF: Interpret all discourse elements that are indefinites as referring to distinct entities unless they appear in an identity statement.

[11] The source mentioned here is credited in [Beaver00] and our own citation of it in this manuscript is pure hearsay.

ECON: If a discourse element appears in full form,
interpret it as referring to a new discourse entity.

PRON⇔TOP: Interpret X as a topic if and only if X is pronominalized.

MARK⇔SHIFT: Where A and B are adjacent constituents, A preceding B, then if a discourse element X is focused, interpret X as coreferential with an element Y such that Y is in a different canonical position in A than the one X occupies in B; if a discourse element X is unmarked, interpret it as coreferential with an element Y such that Y sits in the same canonical position in A that X occupies in B.

So that may give credit where it is due. The constraint *REPINDEF is merely a modified version of Heim's Familiarity Condition [Heim82]. PRON⇔TOP, as we mentioned earlier, is a variation of Bresnan's REDUCED⇔TOP [Bresnan99].

These constraints are the only ones we need to incorporate into the resolution program we are building. The constraint SYMMARK is not reversible in any obvious (or useful) way and the constraint MARK⇔PAR, used as an interpretational aid, would do only two things: (i) incline a hearer to do exactly what MARK⇔SHIFT directs him to do if and only if a *parallel* relation holds between the constituents under evaluation and (ii) incline a hearer to infer a *parallel* relation holding between constituents that contained marked elements that were either topics or reflexives, for example, given a discourse like *John despises Bill Bill abhors HIMSELF*, or *John despises Bill Bill abhors HIM*, a hearer who was unfamiliar with the word *abhor* would be inclined to interpret it as a synonym for *despise* due to the fact that, were there is no *parallel* relation present between the relevant constituents, *HIMSELF* and *HIM* should not be marked (the element *HIMSELF* occupies the same canonical position in the current sentence as the element to which it corefers occupies in the previous sentence, thus would not be marked by virtue of MARK⇔SHIFT and, in the *HIM* case, this element should not be marked in the absence of a *parallel* relation due to the fact that in such a case MARK⇔SHIFT and MARK⇔PAR would offset each other.)[12] We think that this is a correct prediction, but it will not aid our investigation of anaphora in any way, so we leave it aside. We now construct a tableau whose direction is the opposite of the one we have we have worked with so far. We assume that the ranking of the reversed constraints is analogous to the ranking of their original counterparts.

DISJOINT = AGREE = *REPINDEF >> MARK⇔SHIFT >> ECON = PRON ⇔TOP

[12] Technically, as it stands, the reversal of MARK⇔PAR would force a hearer to infer a *parallel* relation whenever that hearer encountered stressed pronouns that he did not interpret as coreferential with elements that had switched canonical positions from one sentence to the next. To avoid this, we must assume that there is some highly ranked constraint FAITH, whereby a hearer will interpret words to mean what they mean, assuming that he does know what they mean, and not interpret them as being synonymous with lexemes to which they bear no synonymy relation.

John fought Bill [He won]	MARK⇔SHIFT	PRON⇔TOP
/he = John/ ☜		
/he = Bill/	*!	*

The results of this tableau are predictable; the candidate */he = Bill/* is disqualified because the unfocused pronoun *He* is to be interpreted as a topic in the first canonical position of the previous sentence and *John* is the topic, not *Bill*, and both elements maintain their canonical positions from the first sentence to the next. The constraint ECON does not apply, as the second sentence of the discourse contains no full forms, and no focused pronouns.

John fought Bill [HE won]	MARK⇔SHIFT	ECON	PRON⇔TOP
/HE = John/	*!	*	
/HE = Bill/ ☜		*	*

In this tableau, */HE = John/* is disqualified by virtue of the fact that MARK⇔SHIFT outranks PRON⇔TOP.

We note one interesting result of reversing our constraints and that is that it is necessary for us to adopt something like Beaver's FAMDEF – a constraint that demands that pronouns, definite descriptions, and proper names refer to antecedent elements in the discourse – if we wish to avoid a result like the one displayed in the tableau below.

John fought $Bill_i$ [$Bill_j$ won]	ECON
/$Bill_i$ = $Bill_j$/	*!
/$Bill_i$ ≠ $Bill_j$/ ☜	

A constraint like Beaver's FAMDEF could result in */Bill = $Bill_i$/* being tied with the candidate */Bill ≠ $Bill_i$/* or being declared the outright winner here, depending no how we were to rank that constraint. Obviously the latter alternative is a more intuitive one. We propose to rank FAMDEF above MARK⇔SHIFT. Note that this will do us no harm whatsoever when FAMDEF shows its hand in the generative strategy, for as we showed in our discussion of that constraint above, FAMDEF is a very weak generative constraint: it will not be violated by discourses that contain full forms or focused pronouns, so long as those discourse elements have antecedent elements in the discourse; FAMDEF will be violated only when names, definite descriptions, or pronouns are used that lack antecedents. (As for what the optimal form for the */Bill ≠ $Bill_i$/* case would be, we would guess something like *Another Bill*, or perhaps the addition of a surname, if it were known.)

We now turn to cases where more than one pronominal element must be resolved. We will omit ECON as a habit, as it should be clear that, due to the fact that it is ranked below FAMDEF, an ECON violation will never affect the interpretation of a pronoun. The results are displayed below.

Jane knows Mary [She loves her]	DISJOINT	MARK⇔SHIFT	PRON⇔TOP
/She = Jane, her = Mary/ ☜			*
/She = Mary, her = Jane/		*!*	*
/She = Jane, her = Jane/	*!	*	
/She = Mary, her = Mary/	*!	*	**

Jane knows Mary [SHE loves her]	DISJOINT	MARK⇔SHIFT	PRON⇔TOP
/SHE = Jane, her = Mary/ ☜		*	*
/SHE = Mary, her = Jane/ ☜		*	*
/SHE = Jane, her = Jane/	*!	**	
/SHE = Mary, her = Mary/	*!		**

Jane knows Mary [She loves HER]	DISJOINT	MARK⇔SHIFT	PRON⇔TOP
/She = Jane, HER = Mary/ ☜		*	*
/She = Mary, HER = Jane/ ☜		*	*
/She = Jane, HER = Jane/	*!		
/She = Mary, HER = Mary/	*!	**	**

Jane knows Mary [SHE loves HER]	DISJOINT	MARK⇔SHIFT	PRON⇔TOP
/SHE = Jane, HER = Mary/		*!*	*
/SHE = Mary, HER = Jane/ ☜			*
/SHE = Jane, HER = Jane/	*!		
/SHE = Mary, HER = Mary/	*!	*	**

Jane$_i$ knows Mary [She loves Jane$_j$]	DISJOINT	FAMDEF	MARK⇔SHIFT	PRON⇔TOP
/She = Jane, Jane$_i$ = Jane$_j$/	*!			*
/She = Mary, Jane$_i$ ≠ Jane$_j$/		*!	*	*
/She = Jane, Jane$_i$ ≠ Jane$_j$/		*!		
/She = Mary, Jane$_i$ = Jane$_j$/ ☜			*	**

Jane$_i$ knows Mary [SHE loves Jane$_j$]	DISJOINT	FAMDEF	MARK⇔SHIFT	PRON⇔TOP
/SHE = Jane, Jane$_i$ = Jane$_j$ / ☜				**
/SHE = Mary, Mary/		*!		*
/SHE = Jane, Mary ≠ Mary$_j$/		*!		*
/SHE = Mary, Jane$_i$ = Jane$_j$ /	*!			

Jane knows Mary$_i$ [She loves Mary$_j$]	DISJOINT	FAMDEF	MARK⇔SHIFT	PRON⇔TOP
/She = Jane, Mary = Mary$_j$/ ☜			*	
/She = Mary, Mary ≠ Mary$_j$/		*!	*	*
/She = Jane, Mary ≠ Mary$_j$/		*!		
/She = Mary, Mary = Mary$_j$/	*!		*	*

Jane knows Mary$_i$ [SHE loves Mary$_j$]	DISJOINT	FAMDEF	MARK⇔SHIFT	PRON⇔TOP
/SHE = Jane, Mary = Mary$_j$/ ☜			**	
/SHE = Mary, Mary ≠ Mary$_j$/		*!		*
/SHE = Jane, Mary ≠ Mary$_j$/		*!	*	
/SHE = Mary, Mary = Mary$_j$/	*!			

1.3.2 Beaver's SYMMETRY

With these results in hand, we may now see how the application of Beaver's SYMMETRY affects our generative predictions. From a generative perspective, a candidate violates SYMMETRY just in case the biconditional M▷F⟺F▷M fails to hold, i.e., if a candidate is the unique optimal form for the input, but the meaning corresponding to the input fails to be the unique optimal meaning for that form – as determined by the tableaux above – or if the input is a unique optimal meaning for that form but that form is not a unique optimal form for that meaning, as judged by all constraints but SYMMETRY. In terms of the symbols we are using, a SYMMETRY violation will be registered when a candidate is the only candidate to get a ☞ in the generative tableau but where the input meaning under consideration is not the exclusive bearer of a ☜ in the interpretational tableau for which that form served as input *or* when an input meaning under consideration is the sole holder of a ☜ in the interpretational tableau wherein that form served as input but the form either does not get a ☞ in the generative tableau, or is a tied winner in that tableau. Since we are using the ☞ symbol to indicate that a candidate is an optimal form as judged by the constraints without SYMMETRY, we need a new symbol to indicate that a candidate is a winner under the constraints including SYMMETRY. We'll use the ✌ symbol for this purpose. We wish to show two things: first we wish to show that the uniqueness condition that Beaver encodes into the SYMMETRY constraint is uncalled for, as tableaux with multiple winners are possible and do appear. Secondly, we wish to show that formulating that constraint as a conditional also forces the wrong results, since candidates which are not winners under the regimen of constraints without SYMMETRY may be unexpectedly promoted to optimal outputs when the original winners fall to a SYMMETRY violation, despite the fact that the losers-turned-winners do not fulfill the criterion of *either* side of the M▷F⟺F▷M condition (and thus *do* satisfy the biconditional itself.) We repeat the results of our generative tableaux to illustrate the results of the evaluation procedure without SYMMETRY.

John$_i$ fought Bill$_j$ /Bill$_j$ won/	MARK⟺PAR	MARK⟺SHIFT	ECON	PRON⟺TOP
☞ [Bill won]	*		*	
☞ [He won]		*		*
[HE won]	*		*	*!

John$_i$ fought Bill$_j$ /John$_i$ won/	MARK⟺PAR	MARK⟺SHIFT	ECON	PRON⟺TOP
[John won]	*!	*	*	*
☞ [He won]				
[HE won]	*!	*	*	

Now we add the results produced from the reversed tableaux, and evaluate the candidates with regard to SYMMETRY. The ☜ symbol is being used here to represent that the form is optimal for the meaning under consideration, but this is not what is being evaluated here, we are merely relying on the results above. In Beaver's analysis, we see "SYMMETRY ranked below AGREE and DISJOINT, but above everything else." (*Ibid.* p46) Let us assume that SYMMETRY is a constraint ranked higher than all the other soft constraints we have proposed.

	John fought $Bill_j$ /$Bill_j$ won/	SYMMETRY	MARK⇔PAR	MARK⇔SHIFT	ECON	PRON⇔TOP
	☞ [Bill won] ☜		*		*	
✌	☞ [He won]			*		*
	[HE won] ☜		*		*	*!

	$John_i$ fought $Bill_j$ /$John_i$ won/	SYMMETRY	MARK⇔PAR	MARK⇔SHIFT	ECON	PRON⇔TOP
	[John won] ☜		*!	*	*	*
✌	☞ [He won] ☜					
	[HE won]		*!	*	*	

The conclusion: three of the candidates in the tableaux above violate SYMMETRY. Because a candidate violates SYMMETRY if and only if that candidate either (a) is a unique optimal form for a meaning *and* that meaning is not the uniquely optimal meaning for that form (under all constraints sans SYMMETRY) or (b) the candidate's unique optimal meaning is the input meaning but it is not the uniquely optimal form for that meaning, the candidates in the above tableaux which are *not* uniquely optimal forms for the meaning under consideration *and* for which the input meaning in the relevant tableau is not a uniquely optimal interpretation of those candidates are not offenders of the SYMMETRY constraint, as SYMMETRY requires nothing of them. For SYMMETRY to be violated, one side of the M⊳F⇔F⊳M biconditional must hold, but not the other. For example, [*John fought Bill He won*] is an optimal form for the meaning /$John_i$ *fought* $Bill_j$ $Bill_j$ *won*/, under the constraints sans SYMMETRY, but it is not the *unique* optimal form, nor is that meaning optimally recoverable from that form. Thus, that candidate does not violate SYMMETRY, M⊳F⇔F⊳M *does* hold, for *both* sides of the biconditional are false.

In a case where there is more than one optimal form for a meaning, if one of those forms is not optimally interpretable as the meaning under consideration, SYMMETRY is not violated by that form, for neither side of the biconditional will hold for that form. On the other hand, in a case wherein an optimal form for a meaning is tied with others and the meaning under consideration *is* uniquely, optimally recoverable from that form, then that form will violate SYMMETRY, since F⊳M holds, but not M⊳F. Thus, in the first tableau above, the candidate [*John fought Bill Bill won*] is disqualified, while [*John fought Bill He won*] remains a winner for both inputs, even though we should hope that it would be disqualified from the top tableau by virtue of the fact that the optimal *interpretation* of that form does not correspond to the interpretation /*fought(j, b)* ∧ *won(b)*/. We think that this indicates an obvious flaw in the statement of SYMMETRY, for we believe that (even if our prediction that the *Mary/she* optionality for an input sequence like /$John_i$ *kissed* $Mary_j$ $Mary_j$ *slapped* him_i/ is based on an incorrect judgement[13]) we think that there are at least some cases where a candidate form corresponding to a meaning is optimal, though not uniquely so. If we were to find just one language for which there are two equally optimal forms for expressing one thought, our case would be made. But on Beaver's program, output forms that are tied winners in a tableau but are such that the meaning they are optimal for is not optimally recoverable from them will never be subject to the SYMMETRY constraint, and this will mean that those outputs will never be

[13] 'We' is a native speaker

judged in terms of whether or not the meaning they are intended to represent is actually recoverable from them and the bidirectionality that SYMMETRY is meant to import into the evaluation procedure will be absent.

A second problem with SYMMETRY reveals itself when we look that constraint's effect on the evaluation procedure working in the interpretational direction. For we may imagine a case in which M is a uniquely optimal form for F, but F is not the optimal output for M (under all constraints but SYMMETRY.) A case like this shows up with the discourse above: *Jane knows Mary Jane loves Mary*.

$Jane_i$ knows $Mary_j$ [$Jane_k$ loves $Mary_m$]	DISJOINT	FAMDEF	MARK⇔SHIFT	PRON⇔TOP
/$Jane_i = Jane_k$, $Mary_j = Mary_m$/ ☜			**	*
/$Jane_i \neq Jane_k$, $Mary_j = Mary_m$/		*!	*	
/$Jane_i = Jane_k$, $Mary_j \neq Mary_m$/		*!	*	*
/$Jane_i \neq Jane_k$, $Mary_j \neq Mary_m$/		*!*		

Now we add SYMMETRY. The results of this are below.

	$Jane_i$ knows $Mary_j$ [$Jane_k$ loves $Mary_m$]	DISJOINT	SYMMETRY	FAMDEF	MARK⇔SHIFT	PRON⇔TOP
	/$Jane_i = Jane_k$, $Mary_j = Mary_m$/ ☜		*!		**	
☹	/$Jane_i \neq Jane_k$, $Mary_j = Mary_m$/			*	*	
	/$Jane_i = Jane_k$, $Mary_j \neq Mary_m$/			*	*	*!
☞	/$Jane_i \neq Jane_k$, $Mary_j \neq Mary_m$/		*!	**		

Notice that the outcome is rather disastrous. For the optimal candidate under the constraints without SYMMETRY (the one with the ☜) is disqualified by virtue of the fact that the form in question is not the unique optimal form for the meaning to which the candidate corresponds. In fact, if we took the relatively safe assumption that the optimal form for the /$Jane_i \neq Jane_k$, $Mary_j \neq Mary_m$/ case would be [*Another Jane loves another Mary*] (or something along those lines), then the form in question would not be optimal for *any* meaning; in such a case, a candidate interpretation would violate SYMMETRY if and only if the interpretation were the uniquely optimal interpretation of that form! On the other hand, one of the candidates which was disqualified by virtue of the constraints without SYMMETRY is now resurrected – for it *does not violate* SYMMETRY because, again, neither side of the biconditional is fulfilled, so SYMMETRY places no conditions on it. We find it obviously wrong to guarantee that anytime a winning candidate in an interpretation tableau wherein a form is under consideration that is not the optimal form for that candidate violates SYMMETRY, it will wind up violating a constraint so highly ranked that it will demand that an alternate candidate – one that was a loser with respect to the evaluation procedure without SYMMETRY – be chosen.

1.3.3 An Alternative to Beaver's SYMMETRY: Blutner's Bidirectionality

Can we repair SYMMETRY? We pointed out two problems for that constraint. The first problem was that where two forms were optimal for one meaning, SYMMETRY would disqualify a candidate only if it *was* uniquely interpreted as corresponding to the input meaning under consideration. This problem was caused by the uniqueness condition in Beaver's definition of the '$\triangleright$' operator.

The second problem was that the SYMMETRY constraint, even without the uniqueness condition, still doesn't demand anything of candidates which satisfy neither side of the biconditional. And thus, as we saw, losing interpretation-candidates wind up in the winner's circle by virtue of the fact that they are *neither* optimal interpretations for a form *nor* optimally realizable via that form.

F	CON
M ☜	
M´	*!
M´´	**!

+

M´	CON
☞ F	*
F´	**!*
F´´	**!

=

	F	SYMMETRY	CON
	M ☜	*!	
	☞ M´	*!	*
✌	M´´		**

The first problem may be ameliorated if we simply strip the '$\triangleright$' operator of its uniqueness condition. We would need to decide whether we would like to formulate a constraint that demands that forms have unique optimal interpretations, or whether we will allow for tied winners on the interpretation side as well. We choose the latter. Our motivation for this is as follows. First of all, it is undeniable that ambiguity does exist in natural language and, at times, that ambiguity may result from the fact that one form is optimal for two meanings and that two meanings are optimal interpretations of a single form. Consider the two discourses below.

(1.10) Jane$_i$ asked a waitress$_j$ PRO$_i$ to speak to the manager. He told her to wait.
(1.11) Jane$_i$ asked a waitress$_j$ PRO$_j$ to speak with the manager. He told her to wait.

The sentences above contain a null element whose presence is widely argued for in the various traditions of generative grammar. Without defending the assumption, let us take for granted that in each of the discourses above the subject of the sentential complement (i.e., PRO$_i$ and PRO$_j$, respectively) is the topic of the constituent that precedes the sentence *He told her to wait*. Suppose too that PRON⇔TOP applies only to overt elements and that the appearance of PRO$_j$ in (1.11) is not a violation of that constraint. We get the following resolution data.

Jane asked a waitress PRO to speak with the manager [He told her to wait]	MARK⇔SHIFT	PRON⇔TOP
/PRO = Jane, her = Jane/ ☜	*	
/PRO = waitress, her = Jane/	**!	*
/PRO = Jane, her = waitress/	**!	*
/PRO = waitress, her = waitress/ ☜	*	

Here we see a case in which there are two optimal meanings for the same form. Were we to subject these outputs to a constraint that demanded that a form have a unique recoverable meaning, then the form [*Jane asked a waitress PRO to speak to the manager*] would violate that constraint for both meanings and potentially be disqualified for both, as it is a unique optimal form for both meanings (we assume), but neither meaning is *uniquely* recoverable from that form.

Let A⊵B mean that B is a (not necessarily unique) optimal output for A, given all constraints in the evaluation procedure except for a constraint we will call STRONGBI. The motivation for the name of this constraint will be discussed in a moment. Instead of defining STRONGBI as a conditional, we will simply state it as a conjunction; this will avoid the second problem we pointed out for Beaver's SYMMETRY.

STRONGBI: M⊵F & F⊵M

For any candidate, (whether it is winner or a loser given all constraints except STRONGBI) that candidate, whether it is a form F or a meaning M, will be required to be such that M⊵F & F⊵M. If this is not the case, that candidate violates STRONGBI. Of course, for each form F and meaning M that is a winner in a tableau given all constraints sans STRONGBI, one of the conjuncts will be superfluous; where F is an optimal form for M it will always satisfy the first conjunct, and where M is an optimal interpretation of F it will always satisfy the second. Let us compare the tableaux we evaluated before with the SYMMETRY constraint and check the performance STRONGBI.

	John fought Bill /Bill won/	STRONGBI	MARK⇔PAR	MARK⇔SHIFT	ECON	PRON⇔TOP
✌	☞ [Bill won] ☜		*		*	
	☞ [He won]	*!		*		*
	[HE won] ☜	*!	*		*	*

	John fought Bill /John won/	STRONGBI	MARK⇔PAR	MARK⇔SHIFT	ECON	PRON⇔TOP
	[John won] ☜	*!	*	*	*	*
✌	☞ [He won] ☜					
	[HE won]	*!	*	*	*	

	$Jane_i$ knows $Mary_j$ [$Jane_k$ loves $Mary_m$]	DISJOINT	STRONGBI	FAMDEF	MARK⇔SHIFT	PRON⇔TOP
✌	/$Jane_i$ = $Jane_k$, $Mary_j$ = $Mary_m$/ ☜		*		**	
	/$Jane_i$ ≠ $Jane_k$, $Mary_j$ = $Mary_m$/		*	*!	*	
	/$Jane_i$ = $Jane_k$, $Mary_j$ ≠ $Mary_m$/		*	*!	*	*
	☞ /$Jane_i$ ≠ $Jane_k$, $Mary_j$ ≠ $Mary_m$/		*	*!*		

Given this data, we could not hope for much better. As we see, on the generative side, for the first two tableaux, the candidate [*John fought Bill He won*] is barred as output for the input interpretation corresponding to */fought(j, b) ∧ won(b)/*; this is exactly what we wanted. Also, on the interpretational side, where there is no meaning such that that meaning is optimal for a form that is optimal for that meaning (given all the constraints except STRONGBI), all of the candidates violate STRONGBI, and the winning interpretation(s) is/are decided as usual, since the STRONGBI violations simply cancel each other out.

We can show that STRONGBI is an evaluation-procedure-internal version of what Blutner calls *bidirectional optimality* [Blutner00], sometimes called *strong bidirectional optimality*, the strong version being contrasted with a weaker version, which is shown to produce more desirable results, particularly in its ability to account for interpretational phenomenon related to partial blocking – where an expression generated by some productive process where a specific, simpler expression exists that is suitable for the same meaning, is not blocked completely (i.e., in contrast to a phrase like *yesterday night*, is not ungrammatical) but is rather simply interpreted in a different way. In our final remarks in the present subsection, we will look at why strong bidirectionality (and the constraint STRONGBI to which it corresponds) is inadequate. In the next subsection we will explore the consequences of replacing that constraint with a weaker one, which corresponds to the weaker version of bidirectionality. We can show with almost no effort that the constraint STRONGBI is equivalent to what Blutner's bidirectional optimality. Ultimately, we will attempt to show why neither the strong nor the weak version is sufficient.

Both the strong version and the weak version of bidirectionality are based on the so-called Q and I principles first due to Atlas and Levinson [At&Lev81] and Horn [Horn84], each an attempt to mirror somewhat the quantity and manner maxims of Grice [Grice75], related to the compromise between speaker-economy versus informativity and communicative accuracy.

I-principle:	Say as little as necessary… to produce your communicational ends (bearing the Q principle in mind)
Q-principle:	Say as much as you can (given I)

Blutner's first version of bidirectionality – the strong version of bidirectional OT – is as follows:

A form-meaning pair ⟨F, M⟩ is *bidirectionally optimal* if and only if:

(I) There is no other pair ⟨F′, M⟩, such that, given the input M to an evaluation procedure, the performance of F′ is superior to F.

(Q) There is no other pair ⟨F, M′⟩, such that, given the input F to an evaluation procedure, the performance of M′ is superior to M.

In lay terms, this says that form-meaning pair ⟨F, M⟩ is bidirectionally optimal just in case there is no other form that is better for the meaning than F and there is no better interpretation for the form F than the meaning M. This is, of course, precisely what the constraint STRONGBI evaluates when it looks at the output of the evaluation procedure, sans STRONGBI; a violation of STRONGBI is committed by any form or meaning that is not bidirectionally optimal, given all constraints, except STRONGBI.

It follows directly from Blutner's bidirectionality that a meaning is not optimal for a form unless the form is optimally interpreted as having that meaning. This is something we whole-heartedly agreed with above. However, it also follows directly from his definition that an *interpretation* of a form is not optimal unless the form is an optimal form for that meaning. It can be shown that this claim is false.

We can imagine a case in which one or more forms Fi, …, Fn are optimal realizations of some meaning M, but M is not an optimal interpretation for *any* of the forms Fi, …, Fn. To illustrate such a case, we use the following tableaux.

M′	CON
☞ F^1	
F^2	**!

F^1	CON
M	*!
M′ ☜	

M	CON
☞ F^1	*
F^2	**!

F^2	CON
M ☜	
M′	*!

Here, ⟨F^1, M′⟩ is a bidirectionally optimal pair. Furthermore, it is the only such pair. What is interesting to see is that F^2, whose optimal interpretation is M, will not be the realization of M, as F^2 is not the optimal form given M.

M′	STRONGBI	CON
☞ F^1	*!	
F^2		**!

F^1	STRONGBI	CON
M	*!	*
M′ ☜		

M	STRONGBI	CON
☞ F^1	*	*
F^2	*	**!

F^2	STRONGBI	CON
M ☜	*	
M′	*	*!

This would be a fantastically unintuitive result. We have a form F^2, that is optimally interpreted as a certain meaning M but, given that meaning, the generative constraints will direct a speaker to output a different form, F^1, which is not optimally interpreted as having that meaning, but rather one which is optimally interpreted as having *some other* meaning and, further, is an optimal form for that other meaning.

1.3.4 Rethinking Superoptimality

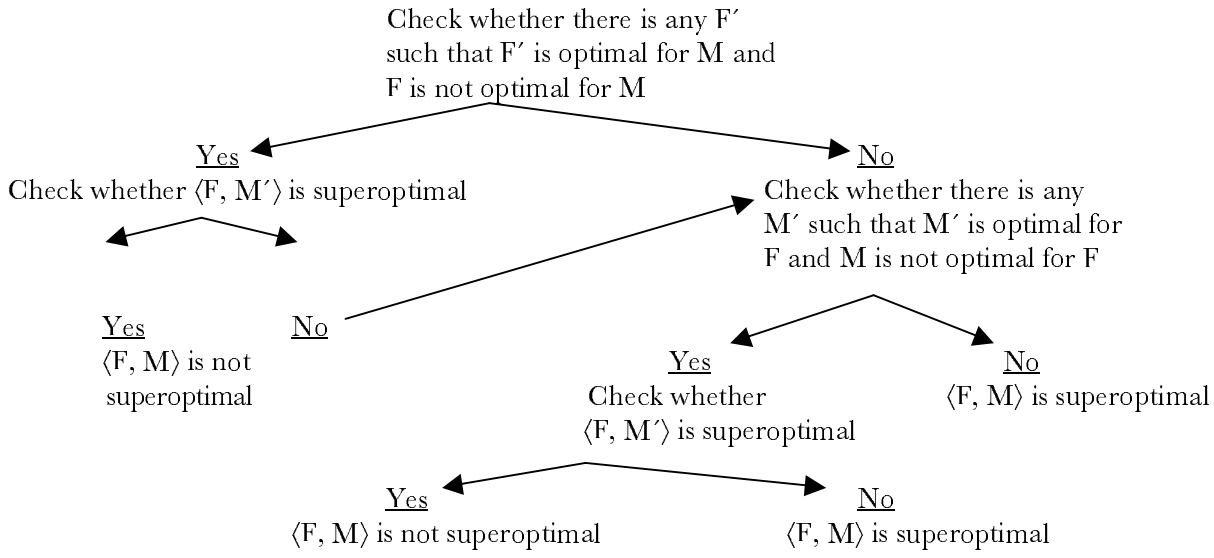
We may find alternative results in the weaker version of bidirectional optimality, Blutner's *superoptimality*. Superoptimality inexorably links the Q and I requirements above so that the evaluations that determine optimality for form-for-meaning and meaning-for-form are no longer completely independent of each other, but entirely interdependent. We wish to find out whether we may exploit Blutner's superoptimality for our purposes, formulating that idea into a constraint that will act as a proper part of the evaluation procedure. Our ultimate answer to that question will be negative and we will illustrate why this is the case and why we think that the formulation of superoptimality shows a flaw. Below is Blutner's definition of the conditions for superoptimality.

A form-meaning pair ⟨F, M⟩ is *superoptimal* if and only if:

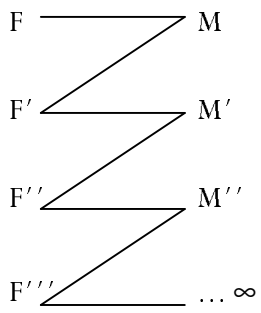
(I) There is no other pair ⟨F′, M⟩, such that, given the input M to an evaluation procedure, the performance of F′ is superior to F and ⟨F′, M⟩ satisfies (Q).

(Q) There is no other pair ⟨F, M′⟩, such that, given the input F to an evaluation procedure, the performance of M′ is superior to M and ⟨F, M′⟩ satisfies (I).

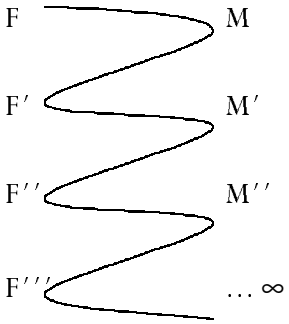
At first glance, this definition may seem a bit bewildering, for the definition for satisfaction of criteria in condition (Q) is included in the definition for satisfaction of criteria in condition (I), which is in turn is included in the in the definition for satisfaction of criteria in condition (Q). Jäger, who has explored the formal properties of superoptimal evaluation writes: "…this definition might seem circular … This is not a real problem however, since we may safely assume that [the relation of superior/inferior performance in an OT tableau] is well founded." In order to check whether a form-meaning pair ⟨F, M⟩ is superoptimal, one must follow the following procedure:



Jäger's nickname for this brand of optimality *is Z-optimality*, for the strategy adheres to the following zigzag pattern. (The following diagram is virtually identical to the figure appearing in [Jäger00], p5.)



Now, if we were to bend the lines a bit, we would see that, indeed, the procedure is not circular, but rather something like a *spiral*. Like the famous chicken and egg puzzle, one never comes back to the *same individual*. (Chickens do not lay the eggs from which they are hatched.)



The bottom line in superoptimality is that for a pair ⟨F, M⟩ to fail to be superoptimal, it is not enough that there be a pair ⟨F′, M⟩, or a pair ⟨F, M′⟩ such that F′ beats F in a tableau in which M is the input or M′ beats M where F is the input, rather, ⟨F, M⟩ only lacks status as a superoptimal pair only if there is such a pair ⟨F′, M⟩ or ⟨F, M′⟩ and that pair is itself a superoptimal pair. Now, if we wished to formulate a constraint that reflected the results of Blutner's superoptimality, the only obvious way to do so would be to postulate a constraint that actually did apply to its own output, or to postulate an infinite number of constraints that applied cyclically such that $\textsc{Con}^{n}$ applied to the output of $\textsc{Con}^{n-1}$, though we are speculating here, and will do so no further, as we have a grievance against superoptimality that will persuade us to avoid incorporating the idea into our analysis altogether.

We wish to show that the statement of superoptimality above does not harvest intuitive results for generative strategies in communication. And that, in fact, it can be shown that where a speaker and hearer differ with respect to the information they possess about the discourse entities being referred to, the superoptimal spiral actually *can* be turned into circle. Under the present circumstances, we believe that if the superoptimality of a form meaning pair ⟨F, M⟩ were a necessary condition for the output of that form F, given the meaning M, then a speaker whose generative procedure was governed by that principle would at times make the choice either to fail to successfully communicate or would not to attempt to communicate at all. Consider the following sequences.

(1.12) Marion was frustrated with Jo. She was pulling his hair out.

(1.13) Marion was frustrated with Jo. He was pulling her hair out.

Now, we are operating under the following assumptions: we suppose that a neutral hearer who had no acquaintance with either person mentioned in the discourse above would be quite likely to interpret the pronouns *She* and *his* as coindexed with *Marion* and *Jo* respectively, as most hearers would assume that names with those pronunciations would refer to a man, Joe, and a woman, Marianne. But suppose that this is not in fact the case, but instead, Marion is a man, Jo a woman. Suppose further that the speaker *knows* that the hearer is unaware that this is the case. We think that such circumstances are not rare in discursive situations, for if one wants to communicate a message, for example, about a (female) doctor and a (male) nurse, and the speaker is aware that the (perhaps slightly sexist) hearer is ignorant to the gender of the two individuals, but will make assumptions, he would be fool to use pronouns like *he* and *she* and expect to be understood. Try as he might, a speaker who wanted to get the correct message across could never do so if he refused to break his own economy principles. Thus, he may not simply stay in the superoptimal spiral; he is forced to make a choice: Which comes first, the Q-principle or the I-principle?

Now we may ask ourselves: is $\langle {}^{F}$*She was pulling his hair out*, ^{M}*pulling-hair-out(j, m)*$\rangle$ a superoptimal pair? Suppose the pairs are as below.

$\langle {}^{F}$*She was pulling his hair out*, ^{M}*pulling-hair-out(j, m)*$\rangle$

$\langle {}^{F}$*She was pulling his hair out*, $^{M'}$*pulling-hair-out(m, j)*$\rangle$

$\langle {}^{F'}$*He was pulling her hair out*, ^{M}*pulling-hair-out(j, m)*$\rangle$

$\langle {}^{F'}$*He was pulling her hair out*, $^{M'}$*pulling-hair-out(m, j)*$\rangle$

The procedure to required to check whether the pair $\langle {}^{F}$*She was pulling his hair out*, ^{M}*pulling-hair-out(j, m)*$\rangle$ is indeed superoptimal is followed below.

Is ⟨F, M⟩ a superoptimal pair?

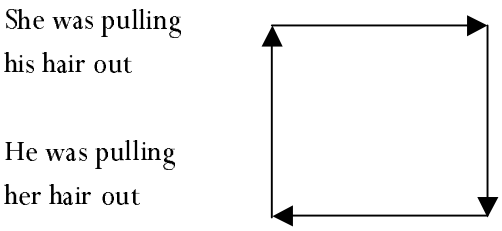
We check: Is there a pair ⟨F*, M⟩ such that F* is more economically realized than F, given M? The answer to this question is no, as the utterance of F is optimal with respect to speaker economy, given that meaning. Next we check: Is there a pair ⟨F, M*⟩ such that M* is an optimal interpretation of F where M is not? The answer is obviously yes, as the meaning $^{M'}$*pulling-hair-out(m, j)* is the one which will be interpreted under our assumptions about the hearer in this case. So ⟨F, M*⟩ = ⟨F, M′⟩. This means that ⟨F, M⟩ is a superoptimal pair if and only if ⟨F, M′⟩ is *not* a superoptimal pair.

Is ⟨F, M′⟩ a superoptimal pair?
We check: Is there a pair ⟨F*, M′⟩ such that F* is more economically realized than F, given M′? The answer is yes, since ^{F}*She was pulling his hair out* is not the speaker-optimal realization of M (such a form would violate the highly ranked AGREE constraint!), but rather $^{F'}$*He was pulling her hair out* is. So ⟨F*, M′⟩ = ⟨F′, M′⟩. Now we will need to check if ⟨F′, M′⟩ is a superoptimal pair, but first let us verify that there is no pair ⟨F, M*⟩ such that M* is superior to M′ insofar as the interpretation of F is concerned: indeed there is none, for the hearer will interpret ^{F}*She was pulling his hair out* as $^{M'}$*pulling-hair-out(m, j)*. Therefore: ⟨F, M′⟩ is a superoptimal pair if and only if ⟨F′, M′⟩ is *not* a superoptimal pair.

Is ⟨F′, M′⟩ a superoptimal pair?
Again we check: Is there a pair ⟨F*, M′⟩ such that F* more economically realized than F′, given M′. Answer: No, since $^{F'}$*He was pulling her hair out* is optimal with respect to speaker economy, given the meaning $^{M'}$*pulling-hair-out(m, j)*. Next we check: Is there a pair ⟨F′, M*⟩ such that M* is an optimal interpretation of F′ where M′ is not? The answer is yes, since the optimal interpretation of $^{F'}$*He was pulling her hair out* will be ^{M}*pulling-hair-out(j, m)*, thus ⟨F′, M*⟩=⟨F′, M⟩. Therefore, ⟨F′, M′⟩ will be a superoptimal pair if and only if ⟨F′, M⟩ is *not* a superoptimal pair.

Is ⟨F′, M⟩ a superoptimal pair? Check: Is there a pair ⟨F*, M⟩ such that F* more economically realized than F′, given M? Answer: Yes, since, again, $^{F'}$*He was pulling her hair out* is not speaker optimal, given the meaning ^{M}*pulling-hair-out(j, m)*, it violates AGREE. ⟨F*, M⟩ = ⟨F, M⟩. Now we will need to check if ⟨F, M⟩ is a superoptimal pair, but first let us verify that there is no pair ⟨F′, M*⟩ such that M* is superior to M insofar as the interpretation of F is concerned: indeed there is none since, as we have noted, ^{M}*pulling-hair-out(j, m)* is the optimal interpretation of $^{F'}$*He was pulling her hair out*. Therefore ⟨F′, M⟩ a superoptimal pair if and only if ⟨F, M⟩ is *not* a superoptimal pair.

Is ⟨F, M⟩ a superoptimal pair? … ∞



The direction of the up-down arrows corresponds to the top-bottom status of the forms that are optimal for the meanings which appear underneath the arrows. The left-right arrows operate analogously, indicating which meaning is optimal for the form that appears to the left of the arrow. It may be checked that the pair $\langle {}^{F+}$*Marion was pulling Jo's hair out*, ^{M}*pulling-hair-out(j, m)*$\rangle$ is just as indeterminate with regard to its superoptimal status as the pairs $\langle$F, M$\rangle$, $\langle$F′, M$\rangle$, $\langle$F, M′$\rangle$, and $\langle$F′, M′$\rangle$, as the pair $\langle$F+, M$\rangle$ is superoptimal if and only if the more speaker-economical pair $\langle$F, M$\rangle$ is not superoptimal, and we have shown that Blutner's definition leaves that question impossible to answer. But should this actually be the case? Says Jäger (*Ibid.* p6) " … the main objectives of the participants [in] a conversation should be successful communication, one should think. Economy considerations can only be taken into account if the main objective is granted." One *should* think! But, as we have shown, superoptimality does not guarantee that this is the way a speaker will behave. We think that a correct analysis is one which did make such a prediction, thus we look for an alternative.

We believe that we can encode satisfactory results into a constraint without having to resort to an evaluation-external definition of optimality. Further, we think that there is independent motivation for treating such a principle as something that exists inside the evaluation procedure itself as opposed to being external. We will, however, need to propose two constraints, one for the generative direction and the other for the interpretational direction. The demand of the generative constraint will be quite simple: it will demand that every form be optimally interpretable as the meaning it is intended to represent. (In this way we are automatically avoiding the undesirable results we saw in the case of Jo and Marion.) The interpretational constraint will not be so simple, though we believe it will be suitable for our purposes. Furthermore, in the next section, where we discuss the generation and interpretation of tense, we will see an application of the interpretational direction of our constraint that will effect similar results as those that were the motivation for superoptimality in the first place: an explanation of partial blocking. We state both constraints below.

$$\textsc{Bidirect}^{\textsc{gen}}: \quad F \trianglerighteq M$$

$$\textsc{Bidirect}^{\textsc{interp}}: \quad \neg\exists F^{*}\,(M \trianglerighteq F^{*} \wedge F^{*} \trianglerighteq M \wedge \neg M \trianglerighteq F)$$

In words $\textsc{Bidirect}^{\textsc{gen}}$ says that a candidate form F satisfies $\textsc{Bidirect}^{\textsc{gen}}$ with respect to an input meaning M just in case M is an optimal interpretation for F, given all constraints except $\textsc{Bidirect}^{\textsc{interp}}$. On the other hand, a meaning M violates the constraint $\textsc{Bidirect}^{\textsc{interp}}$ for a form F just in case F is not an optimal output given the meaning M (under all constraints except $\textsc{Bidirect}^{\textsc{gen}}$) *and* there is form F^{*} such that F^{*} is an optimal output

given M (under all constraints except BIDIRECT^{GEN}) and M is an optimal interpretation of that form (under all constraints except BIDIRECT^{INTERP}.)

The constraint BIDIRECT^{INTERP} is meant to ensure that, given a form F, a meaning M′ won't be the optimal meaning for F if M′ is the optimal interpretation of some other form F′ which is more economically realized than F and which is an optimal form given M′.

M′	CON
F	*!
☞ F′	

F′	CON
M	*!
M′ ☜	

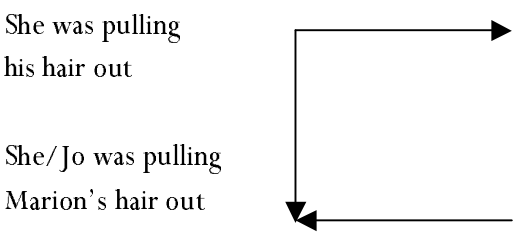
	F	BIDIRECT^{INTERP}	CON
✌	☞ M		*
	M′ ☜	*!	

What we are seeing here is a case where M, a suboptimal interpretation of F without BIDIRECT^{INTERP}, is coming out a winner due to the fact that the pair ⟨F′, M′⟩ is such that F′⊵M′ and M′⊵F′ and F′ is more economically realized than F, given M′. M′ violates BIDIRECT^{INTERP} because it is a member of such a pair and because F is not an optimal form given M′.

Now, for BIDIRECT^{GEN}, the evaluation is easy, F cannot be an optimal candidate for M unless M is the optimal interpretation of F.

	M	BIDIRECT^{GEN}	CON
	☞ Fi	*!	
	☞ Fj	*!	
	☞ Fk	*!	
✌	Fm ☜		***

The diagram below illustrates the results that would be effected for the case of Jo and Marion, after the application of the constraint BIDIRECT^{GEN}. The form *She was pulling Marion's hair out* (or *Jo was pulling Marion's hair out*) is now an optimal form, for it is the only form which is not guaranteed to be misinterpreted.



pulling-hair-out(j, m) pulling-hair-out(m, j)

Our answer to the question "which comes first?" is clear: it is the Q principle. After all, if a speaker were forced to choose between the lesser of two evils, one being the violation of a set of economy related principles, the other being a virtual guarantee that his utterance would be interpreted as meaning something other than the what he had hoped to express, which would he choose? We think that he should choose to be understood. Furthermore, we believe that this is what speakers *do* choose. For, by making the other choice, would he really be observing his own economic interests anyway? Is there anything economical about outputting an expression that will be interpreted as meaning something else?

We believe that this is what is attractive about Beaver's original idea of incorporating the notion of bidirectionality into the evaluation procedure itself. In the spirit of what we said above, we feel that a speaker's first goal – before aiming to minimize his effort – is to be understood, for an utterance that will be uninterpretable or misinterpreted is a *wasted* utterance and is thus the worst offense against his economy related aims that one could think of. Bidirectionality is the highest ranked economy constraint a speaker could have, and one which he will avoid violating at any cost.[14]

[14] Well...not quite. The notorious *rad/rat* problem has been widely discussed in the literature. The pronunciation of the German word "rat" (= council) and the word "rad" (= wheel) are identical, as the phonology of German demands that all syllable final plosives be devoiced. If BIDIRECT^{GEN} were actually the highest ranked generative constraint, then the string /Rat/ would only be generated for the word "rat" and never for "rad." It seems likely to us that there are many phonological constraints which a speaker will not violate, even at the cost of a BIDIRECT^{GEN} violation, i.e., that are ranked higher than BIDIRECT^{GEN}. Such facts actually help our case rather than hurt it however, for this seems to be yet another reason for thinking of an interpretation-related generative constraint as a proper part of the evaluation procedure, rather than something *super*optimal, which operates over and above the theater of constraints, as we may propose to rank all phonological constraints above BIDIRECT^{GEN}.

Note also that we have not predicted that a speaker will utter *He was pulling her hair out* in an attempt to express *pull-hair-out(j, m)*. This would suggest that AGREE is ranked higher than BIDIRECT. We actually think that there is no need for AGREE on the generative side (in most cases BIDIRECT^{GEN} will do the work of that constraint, though not so obviously in the Marion/Jo case.) Instead, we think that a speaker would not use pronouns that disagree with the gender of the entities to whom he wishes to refer on the grounds that one way of being misinterpreted is to force a hearer to infer information that is inconsistent with the information that one is intending to express, i.e., uttering *He was pulling her hair out* in an attempt to express *pull-hair-out(j, m)* would be nothing more than a lie about the gender of the two characters in the discourse, so, in fact, it *would* be violating BIDIRECT^{GEN}.

2 Optimizing Discourse Coherence

2.0 Overview

The section that follows is concerned with the optimization of discourse coherence. By "discourse coherence" we mean the faithfulness with which a sequence of expressions presents its description of events or situations with respect to the temporal order and interrelatedness of those events or situations. A discourse may be said to be incoherent if a typical hearer is unable to determine what the speaker is talking about or if he cannot determine why two sentences were uttered in a sequence, as the two pieces of information they express appear to have nothing to do with one another. Not every discourse that is coherent may be called an optimal one. For there are circumstances wherein a hearer may determine (i.e., *infer)* that certain pieces of information bear some relevance to one another, but has made this inference for the wrong reasons. To optimize the coherence of a discourse is to organize the pieces of that discourse in such a way as to coerce accurate inferences from a hearer about the temporal relations between the situations and events described in that discourse as well as any other relations that may hold between them.

An attempt to categorize the various *discourse relations* in which one sentence could stand to another and to formally describe how the presence of these relations affects the organization of a discourse and how they demarcate the boundaries of discourse coherence was first made by Mann and Thompson [M&T87]. Much effort has been made in the last decade and a half by Asher [Asher83] and Asher and Lascarides [A&L93b] and [A&L96] et al. to extend and improve upon that account. We will introduce and borrow from the regimen of discourse relations advocated by the latter, though we will not wholly adopt their views on the restrictive criteria they propose for some of these relations. Their program will be essential for the view we intend to advocate regarding the allowances for discursive order and the dependency of such allowances on the contents of what are called by Asher and Lascarides, *knowledge bases* – vessels of data, some which are default-related, others indefeasible – that are argued to govern a hearer's linguistic comprehension by way of facilitating inferences about temporal relations between events described in a discourse and the rhetorical motivation of utterances. Asher and Lascarides exploit the idea of a linguistic knowledge base and a world-knowledge base for the purpose of describing how certain inferences are made in the presence of certain types of discourses, arguing that these inferences are very often what allow some discourses to be interpreted as coherent even though they exhibit various types of freedom with respect to textual order and the inclusion of discursive cues (e.g., *because* or *while*), while others – those which do not coerce powerful enough inferences – are allotted no such freedom.

The analysis with which we concern ourselves presently will be dedicated to two basic issues. Firstly, we seek to give a description of the restrictions on discursive order – the order of two sentences appearing in a discourse – given the temporal relation between the eventualities they describe and the discourse relation holding between them as well as an account of the allowances and prohibitions that exist regarding other syntactic possibilities for connecting two sentences in a discourse, namely conjunction and relativization. Secondly, we will discuss the distributional behavior of compound grammatical tenses, stating conditions – again, based on discourse relations and temporal facts about the discursive content – on where such tense constructions are licensed. As in section

1, we intend to present an optimal theoretic account of these phenomenon, arguing that the principle BIDIRECT, and the motivation behind that principle, is almost exclusively responsible for the restrictions related to textual order, syntactic restrictions, and restrictions on tense constructions, as constraints related to speaker economy appear fairly marginal with respect to these issues.

2.1 SDRT and Discourse Relations

The Segmented Discourse Representation Theory (SDRT) of Asher proposes to explain the coherence and incoherence of discourses based on facts about sequential organization, grammatical tense, the rhetorical motivation of the utterances which constitute those discourses, and on temporal facts about the eventualities these utterances describe. SDRT represents a discourse in terms of a variety of rhetorical connections which hold between propositions introduced by segments of a discourse. An accompanying theory of *discourse attachment* called DICE (Discourse in Commonsense Entailment), serves to calculate – on the basis of the hearer's background information – exactly which rhetorical relations are inferred (by the hearer) to hold between which constituents. A formal system for specifying a hearer's lexical knowledge base, LKB, is also employed.

What follows is a summary of the nine discourse relations proposed by Asher and Lascarides.

Narration: For a constituent β to stand in the *narration* relation to a constituent α[15] in a discourse, three conditions must hold.

- Both α and β must represent events.
- The event described in β must temporally follow the event described in α.
- α and β must have a "distinct, common topic."

(2.1) Max stood up. John greeted him.

The first two conditions here are fairly straightforward. As for the, third, for A&L 'topic' is nothing like the notion with the same moniker that we discussed in section 1. Rather, it is an intuitive notion which does not necessarily correspond to any phrase or constituent of a discourse but is rather the general theme or umbrella of 'aboutness' that stands above the discourse. For example, in a pair of segments exemplary of the *narration* relation like (2.1) say A&L, "the topic could be John's introduction to Max." ([A&L93b] p22) By claiming that a narrative topic must be both "distinct" and "common" it is meant that for two constituents α and β, the two share a topic, but α is not the topic of β, nor β of α. In SDRT, it is stipulated that the *narration* relation will, as a default, be inferred by a hearer to hold between constituents that describe events.

[15] Throughout the A&L literature, the notation corresponding to "β is a *narration* of α" is Narration(α, β). This can be extremely confusing, as the order of the arguments is reversed in their discussion of other, non-discursive, relations. For example, their *Axiom on Explanation* is written $\Box$(Explanation(α, β) $\rightarrow$ cause(e^{β}, e^{α})) and read "Necessarily, if β explains α, then the event β describes causes the event α describes." We will make no adjustment to that notation here.

Background: For a constituent β to stand in the *background* relation to a constituent α in a discourse, four conditions must hold.

- β represents a state.
- α represents an event.
- The state described in β is temporally overlapped with the event described in α.
- The state described in β is the circumstantial backdrop for the event in α.

(2.2) John entered a room. It was dark.

As with *narration* A&L treat *background* as a default relation holding between a state and an event which that state overlap.

Result: For a constituent β to stand in the *result* relation to a constituent α in a discourse the eventuality represented in α must cause the one represented in β.

(2.3) John pushed Bill. Bill fell.

Explanation: For a constituent β to stand in the *explanation* relation to a constituent α in a discourse, the event described in β must cause the one in α.[16]

(2.4) Bill fell. John pushed him.

Elaboration: For a constituent β to stand in the *elaboration* relation to a constituent α in a discourse, two conditions must hold.

- The eventuality described in β must be part of the eventuality α describes.
- The eventuality described in α must be the topic of β.

The claim that one state could be a substate of another is uncontroversial. The idea that one event can be a part of another is facilitated by the assumption of the "tripartate structure of events" argued for in Moens and Steedman [M&S88], which includes a preparatory phase, a culminative phase, and a consequential phase. Blackburn and Lascarides [B&L92] provide a formal treatment of these ideas based on the monotonic intervalic logic of Halpern and Shoham [H&S86]. An elaborative constituent is seen as being part of the preparatory or culminative phase of another event.

[16] We note that one version of A&L's *Axiom on Explanation* is $\Box(\text{Explanation}(\alpha, \beta) \rightarrow \text{cause}(e^{\beta}, e^{\alpha}))$, and this is reflected in the criterion stated above. In various other places in the A&L literature, this requirement is relaxed so that an actual causal relationship need not hold between the relevant events, but rather only that "the event described in β explains why α's event happened (perhaps by causing it)" ([A&L93b] p3). For the most part, this will not matter to us, although in section 2.4 we will observe a case in which a distinction like this shows its face in a hearer's inference patterns.

(2.5) John built a house. An architect drew a blueprint.

(2.6) John attacked Mary. He pulled her hair.

Evidence: For a constituent β to stand in the *evidence* relation to a constituent α in a discourse, β must represent an eventuality that is an instance or manifestation of the eventuality described in α.

(2.7) The council has been decisive lately. It concluded the meeting before 8:00.

Contrast: For a constituent β to stand in the *contrast* relation to a constituent α in a discourse, there must be a discrepancy between α and β.

(2.8) John was ill. He did not take any medicine.

It is appropriate here to make a remark about our adoption of A&L's repertoire of discourse relations. It is consistently claimed in the A&L literature that the relations *result, explanation, elaboration*, and at times *contrast* may only hold between events. The idea is plainly absurd. The state of having a fever may cause a state of delirium and certainly a state of sadness could be explained by an event, say a divorce or the death of a loved one. A sequence that is illustrative of the *contrast* relation (and one used by A&L as an example of this relation) is *John was ill He did not take medicine*. The eventuality described by the first sentence is a state. Further, A&L claim that the only evidentiary statements may only be made about states. This claim too, is one we find groundless; Mary having a bruise could be evidence that someone struck her. Here, a state is evidence for an event. What is more, we think that descriptions of events may be evidence for other events; the sequence *John hit Mary I saw him* is an evidentiary statement, and both the sentences in that discourse describe events.

Parallel: We introduced the *parallel* relation earlier, where we proposed criteria for intonationally focused pronouns in section 1. The relation *parallel* receives little attention in the A&L literature, though the semantics for that relation are discussed in Asher [Asher83]. For our purposes, we will take the relation *parallel* to hold wherever there is some structural symmetry between two constituents α and β, where by "structural symmetry" we mean that a predicate attributed to one entity in a segment α of a discourse is attributed to a second individual in a segment β or that the verb or predicate used in α typically entails the one in β.

(2.9) John gave Mary rose. He gave Sally a tulip.

Commentary: For a constituent β to stand in the commentary relation to a constituent α in a discourse, β must be an evaluative statement about the eventuality described in α.

(2.10) John hit Bill. It was terrible.

In the section that follows we will discuss various constraints on the interpretation of discourses pertaining to when the relations described above may be inferred in the presence of a specific syntactic configuration. Given

what we have observed in the previous section about the strong link between interpretation and generation, we will, in the final part of this subsection, use the observations we make about interpretational possibilities to subsidize a generative program.

2.2 Restrictions on Sequence, Conjunction, and Relativization

What follows are observations about the restrictions on discursive constituents with respect to their order in a discourse as well as on the potential for two constituents to be conjoined or relativized based on the temporal properties of the eventualities they describe and the discourse relations in which they stand to one another. We will advocate the view that these generative restrictions are almost totally based on interpretational considerations. Much of the discussion in the A&L literature is dedicated to exploring how and under what circumstances a hearer can infer temporal information about a discourse. In some circumstances, inferring a discourse relation between the segments, for example *explanation* or *elaboration*, will force a hearer to infer a temporal structure that differs from the discursive structure. In other circumstances, for instance, *narrations*, it is predicted that a hearer will infer that the structure of events is analogous to the order of the sentences that represent them.

We will suppose the existence of three syntactic functions '&', 'ρ^1' and 'ρ^2', as well as one we have already more or less assumed to have at our disposal – the function τ – the *attachment* function, which allows one sentence to follow another. We will investigate the potential for the attachment, conjunction and relativization of two segments, given some discourse relation. We will use the term *connection* as an umbrella expression for all four functions.

We will use the notation $\langle \tau, \alpha, \beta \rangle$ to represent the possibility of *attaching* β to α, i.e., the possibility that β immediately follows α in a discourse. The notation $\langle \&, \alpha, \beta \rangle$ represents the possibility conjoining the two segments, α being the first conjunct, β the second. We write $\langle \rho^1, \alpha, \beta \rangle$ to represent the possibility of connecting the constituents via relativization in such a way that a single discourse element (it must be a common noun) appears in the first canonical position of both α and β, the predicate in α is transformed into a relative clause, and the content of β is predicated of the entity to which that element refers, e.g., for *A dog hunts A dog whimpers*, we get *A dog that hunts whimpers*. We write $\langle \rho^2, \alpha, \beta \rangle$ to represent the possibility of relative clause formation whereby the segment α (it must be a transitive or ditransitive construction) 'absorbs' a segment β whose content is relativized. For example, from *John loves a donkey It brays*, we get *John loves a donkey that brays* and from *John loves a donkey He owns it*, we would get *John loves a donkey that he owns*.

We will occasionally wish to indicate a connection of β to α, which we will write $\langle +, \alpha, \beta \rangle$, which will be shorthand for $\langle \tau, \alpha, \beta \rangle \vee \langle \&, \alpha, \beta \rangle \vee \langle \rho^1, \alpha, \beta \rangle \vee \langle \rho^2, \alpha, \beta \rangle$.[17]

[17] At various points in this section, we will stipulate the existence of certain defeasible laws in a hearer's knowledge base which facilitate the inference of a certain discourse relation given the connection of two segments with specific content. We will use the notation $\langle +, \alpha, \beta \rangle$ to indicate this connection, even though the bulk of this section is dedicated to what types of connection possibilities block the inference of which types of discourse relations. We will assume that the restrictions on the connection possibilities are

We will propose constraints that will facilitate generation of discourses which will be sympathetic to an interpreter's abilities to draw conclusions about the temporal order of eventualities on the basis of the sequential organization of the sentences that describe them and the various laws in his linguistic and non-linguistic knowledge bases.

Our goal then, is to organize the constraints on the generative procedure so that they will force sequences to be generated in such a way that where there is a discourse relation holding between two constituents, we may ensure that that particular discourse relation, and the temporal criteria that accompanies that relation, will be inferred by a hearer upon interpreting that output. There are two sides to this task.

Firstly, we need to make sure that where there is information in the input representation that a relation holds between two eventualities, and that relation is something other than what would correspond to one of the default discourse relations, *narration* and *background*, there are sufficient cues in the output segments to guarantee that a hearer will not infer the existence of a default relation, but rather the existence of the relation that is actually present. In some cases, this will require no adjustment to the usual output at all, for example, in a discourse like *John pushed Bill Bill fell*, where there is a causal connection between event of John's pushing Bill and the event of Bill's falling, we may simply output the sequence *John pushed Bill Bill fell*, or, as we will see, even *Bill fell John pushed him* and assume that the discourse will be interpreted in the appropriate way; the assumption is afforded to us by A&L's postulate that the world-knowledge base of a hearer is endowed with a defeasible *Push Causal Law* whereby a hearer may non-monotonically infer the existence of a causal relation between a pushing event and a falling event whenever two segments that describe such events are connected to one another in a discourse and, in turn, with the aid of the *Causes Precede Effects Law*, also assumed to be present in a hearer's world-knowledge base as an indefeasible axiom, monotonically infer the temporal order of these events.

$$\text{Push Causal Law: } \mathrm{push}(x, y)_e^{\alpha} \wedge \mathrm{fell}(y)_e^{\beta} \wedge (\langle +, \alpha, \beta\rangle \vee \langle +, \beta, \alpha\rangle) \rightsquigarrow \mathrm{cause}(e^{\alpha}, e^{\beta})$$

$$\text{Causes Precede Effects Law}^{18}\text{: } \Box(\mathrm{cause}(e^{\alpha}, e^{\beta}) \rightarrow \neg(e^{\beta} \prec e^{\alpha}))$$

We will make similar assumptions about the existence of other defeasible laws whereby a hearer will infer a certain discourse relation, which – when the time comes to design a generative strategy based on the interpretational data – will grant us freedom with respect to the textual order of these types of constituents by virtue of the fact that the discourse relation presumed to be inferable will necessarily force an inference about

---

stronger than the options afforded by the disjunction that $\langle +, \alpha, \beta\rangle$ represents, and may block some of those options without necessarily being inconsistent with the law itself. In a way, this is careless, on the other hand, were we to write $\langle +, \alpha, \beta\rangle \vee \langle \tau, \beta, \alpha\rangle \vee \langle \rho^1, \beta, \alpha\rangle$ instead of $\langle +, \alpha, \beta\rangle \vee \langle +, \beta, \alpha\rangle$ for a certain law to indicate under which syntactic circumstances a specific discourse relation could be inferred, this would amount not only to giving away the ending, but to stipulating a restriction which we had not yet defended.

[18] Given the tripartate structure of events assume in the later A&L literature, and the content of the axiom itself, a more apt name would be the *Effects Do Not Precede Causes Law*, as the consequent $\neg(e^2 \prec e^1)$ in that axiom allows for, e.g., a fall in stock prices and the loss of wealth caused by such a fall to occur simultaneously.

the temporal order of the events standing in that relation, and thus the hearer will not need discursive order as a cue.

We note however, that, unlike the push/fall case, some of these defeasible laws will not allow flexibility with respect to the order of segments in a discourse but will merely preclude the need to add explicit cues in the output to the effect that the relevant discourse relation exists. For example, there are events between which a causal relation will typically be inferred if the segments that describe them are ordered in a way that mirrors the temporal order of those events, but not otherwise.

(2.11) A man saw Bill. He started running.
(2.12) A man started running. He saw Bill.

In other words, we will assume that there are defeasible laws in the knowledge base of a typical hearer that are – unlike the *Push Causal Law* – sensitive to the order of the attached constituents.

Flight Law: $\text{saw}(x, y)_e^{\alpha} \wedge \text{start-running}(x)_e^{\beta} \wedge \langle +, \alpha, \beta \rangle \rightsquigarrow \text{cause}(e^{\alpha}, e^{\beta})$

For the *Flight Law* above, we note that $(x \text{ see } y)_e^{\alpha} \wedge (x \text{ start-running})_e^{\beta} \langle +, \beta, \alpha \rangle \rightsquigarrow (\text{cause } e^{\alpha}, e^{\beta})$ does *not* hold. In fact, we see evidence in which, given two events e^{α} and e^{β}, if the constituents associated with them are connected in a discourse (i.e., if either $\langle +, \alpha, \beta \rangle$ or $\langle +, \beta, \alpha \rangle$), then a causal relation will typically be inferred between them, but whether it is inferred that e^{α} caused e^{β} or e^{β} caused e^{α} depends solely on the order of the segments.

(2.13) Mary got angry. John left
(2.14) John left. Mary got angry

We think that for (2.13), a typical hearer will infer that John left *because* Mary got angry. Likewise, for (2.14), a hearer will normally draw the inference that Mary got angry because John left.

Avoid Conflict Law: $\text{got-angry}(x)_e^{\alpha} \wedge \text{left}(y)_e^{\beta} \wedge \langle +, \alpha, \beta \rangle \rightsquigarrow \text{cause}(e^{\alpha}, e^{\beta})$

Anger Law: $X_e^{\alpha} \wedge \text{got-angry}(x)_e^{\beta} \wedge \langle +, \alpha, \beta \rangle \rightsquigarrow \text{cause}(e^{\alpha}, e^{\beta})$

With the constraint BIDIRECT, we are, in a sense, granting the generative procedure access to these inference patterns so that at anytime a hearer will draw an inference in accordance with a law in his knowledge base, the generative procedure will be able to detect which inference he is making, if the interpretational procedure is determinate. In taking this step, we can allow the generative procedure to tailor its output with these inference patterns 'in mind' for, as we noted earlier, the large majority of the generative work being done with respect to discursive organization is done solely for the interpreter's sake.

There will of course be the possibility that for two segments, information exists in the input representation to the effect that some relation, e.g., *cause*, holds between two eventualities and yet, regardless of what order those segments appear in, the typical hearer will infer no discourse relation other than the default relation. Where we encounter these cases we would like to see to it that the generative strategy provides cues in the output to ensure that the appropriate discourse relation is inferred. We will see that in some cases, this requires only a special type of conjunction, e.g., *because* or *so*, in other cases, the types of linguistic cues that would normally be necessary are those that our strategy will simply not be able to supply without assuming that a speaker would be willing to violate any economy-related principle that might exist in order to generate a full sentence indicating the presence of the relation to which he wished to draw a hearer's attention. In attempting to take care that wherever a non-default discourse relation holds, we provide cues in the output to ensure that that discourse relation is inferred by a hearer when such an inference would not typically have been drawn in the absence of such a cue, we are taking one step toward making a discourse – to borrow half of a phrase coined by Lascarides and Oberlander [Las&Ob92] – *precise*.[19]

A second step toward maximizing discursive precision is to block the potential for the inference of non-default discourse relations when a default relation is actually the only one that holds. Suppose, for example, that we have an input representation that involves information about a pushing event and a falling event where there is *no* causal relation between the events – perhaps a case in which John pushed Bill when Bill was on the ground, after he had slipped on the ice. We do not want a situation like this to license an output like *John fell Bill pushed him*, as we are operating under the assumption that there is a *Push Causal Law* present in the knowledge base of our hypothetical audience, we may expect that a causal relation will indeed be inferred. Where we find our procedure in a situation where it needs to generate linguistic output related to the description of a sequence of events that is unusual in the sense that, in one way or another, it goes against the grain of convention established by the network of defeasible laws presumed to exist in a hearer's knowledge base, we need to take care to produce an output that will curtail any potential inference of a relation which does not in fact exist. At times, we will be able to suggest a simple strategy whereby this can be accomplished; other times, we will simply have to resign ourselves to the fact that linguistic backtracking (e.g., a tedious addition to the discourse like *...But the former did not cause the latter.*") is necessary to curtail the unnecessary inference, though, at the risk of being unthorough, we leave formalizations of these types of operations to the reader.

As we have mentioned repeatedly, the following discussion will be geared toward restrictions on the *interpretations* of sequences which exhibit the various forms of syntactic configurations mentioned above. Subsequent to making these observations, we will show how the BIDIRECT constraint whose motivations were discussed at length in section 1 may be used to fund a generative strategy by exploiting the interpretational results.

[19] The full phrase is *temporally precise*. "A text is *temporally precise* if wherever a reader infers that one of a proper subset of [discourse relations] holds between the eventualities described in the sentences, then she is also able to infer *which*." [Las&Ob92] p4) However, using the phrase *temporally precise* to indicate precision with respect to the inference of discourse relations seems incorrect, as there is much more to a discourse relation than the temporal structure it imposes on the interpretation of eventualities.

2.2.1 Attachment

First we consider the interpretational restrictions with regard to segments that appear adjacent to one another in a sequence.

(2.15) John greeted Bill. Bill stood up.

The narrative sequence in (2.15), would be interpreted as a greeting event followed by a standing event. This is something that we would wholly expect given the indefeasible axiom in A&L's DICE regarding *narration* whereby given the attachment of two constituents, *narration* is non-monotonically inferred to be the relation holding between them and thus the events described therein may be monotonically inferred to have occurred in the order in which they were presented.

Axiom on Narration: $\Box(\text{Narration}(\alpha, \beta) \rightarrow e^{\alpha} \prec e^{\beta})$

Narration Default Law: $\langle \tau, \alpha, \beta \rangle \rightsquigarrow \text{Narration}(\alpha, \beta)$

We will follow A&L in their treatment of *narration* as a default link between two segments that represent events and, given that their *Axiom on Narration* demands that where, β is a *narration* of α, β temporally follows α, we would expect a reversal of discursive order to foster an interpretation of the reverse temporal order. To duplicate the effect of the defeasible default law regarding *narration*, we will introduce the following violable constraint.

τ-TEMP: Where two constituents α and β represent events and $\langle \tau, \alpha, \beta \rangle$, interpret the temporal order of the events as $e^{\alpha} \prec e^{\beta}$.

Note that we are really only reproducing the effect of *half* of the *narration* criteria, since *narration* involves both a fixed temporal order *and* the existence of a common discursive topic[20]; for now, we will remain silent about the latter, but it will become important and be discussed later.

With this constraint in place, the following results are effected.

[John greeted Bill Bill stood up]	τ-TEMP
$\text{greeted}(j, b)_e^{\alpha} \wedge \text{stood-up}(b)_e^{\beta} \wedge e^{\alpha} \prec e^{\beta}$ ☜	
$\text{stood-up}(b)_e^{\beta} \wedge \text{greeted}(j, b)_e^{\alpha} \wedge e^{\beta} \prec e^{\alpha}$	*!

We have mentioned more than once above that much of A&L's description of the strategies a listener employs for the purpose of discourse interpretation relies not only on the idea that a hearer's knowledge base is stocked

[20] For A&L, the criterion that *narration* must involve two constituents for which a topic is common to both is expressed by way of an *indefeasible* law [A&L98] p80. We believe that this is too strong a criterion and will assume that that criterion is in fact a defeasible requirement.

with defeasible laws like the *Narration Default Law* which are of a purely linguistic nature, but also with laws which are patently non-linguistic and are instead related to facts about the world. One such law that we mentioned earlier is *Push Causal Law*, another example – one which is a slight variation of a law proposed by A&L – will license the inference not of causation but of *elaboration*.

Blueprint Law:
$\exists x \exists y\, \text{built}(y, x)_e^{\alpha} \wedge \exists z \exists v\, \text{blueprint}(v) \wedge \text{drew}(z, v)_e^{\beta} \wedge \langle +, \alpha, \beta \rangle \vee \langle +, \alpha, \beta \rangle \rightsquigarrow \text{elaboration}(\alpha, \beta) \wedge e^{\beta} \prec e^{\alpha}$

Axiom on Elaboration: $\Box(\text{elaboration}(\alpha, \beta) \rightarrow (\, e^{\beta} \subseteq e^{\alpha} \vee e^{\beta} \prec e^{\alpha})$

This law's existence in a hearer's knowledge base, along with an indefeasible axiom that an *elaboration* may not follow the event it elaborates and the so-called *Penguin Principle*[21], which will allows laws like the *Blueprint Law* and the *Push Causal Law* to override the *Default Narration Law*, coercing a hearer to interpret a discourse like *An architect built a house John drew a blueprint* as a description of a preparatory event followed by a building event, despite the mismatch of discursive order of the segments with the events that they represent.

We will assume that there is an interpretational constraint whereby a hearer will interpret a sequence as being consistent with default information in the world-knowledge base whenever such an interpretation is possible.

CONSISTENT: An interpretation must not conflict with defeasible laws in the world-knowledge base.

In addition, in preparation for what is to come, we will introduce a hard constraint (i.e., a filter on interpretational output) that will prohibit interpretations that are inconsistent with *indefeasible* laws in the world-knowledge base.

COHERENT: An interpretation must not conflict with indefeasible laws in the world-knowledge base.

To get the effect we want, we need to assign the following ranking to the existing constraints.
Below, soft constraints are separated from the hard constraints by a double line.

COHERENT || CONSISTENT >> τ-TEMP

[21] $\phi \rightarrow \psi, \phi \rightsquigarrow \neg\zeta, \psi \rightsquigarrow \zeta, \phi \mid\!\approx \neg\zeta$, where $\mid\!\approx$ is non-monotonic entailment. Intuitively: if there are conflicting default rules in the system and both rules apply, the rule with the most specific antecedent is non-monotonically inferred.

[John pushed Bill Bill fell]	CONSISTENT	τ-TEMP
$push(j, b)_e^{\alpha} \wedge fall(b)_e^{\beta} \wedge e^{\alpha} \prec e^{\beta} \wedge result(\alpha, \beta)$ ☜		
$fall(b)_e^{\beta} \wedge push(j, b)_e^{\alpha} \wedge e^{\alpha} \prec e^{\beta}$	*!	
$fall(b)_e^{\beta} \wedge push(j, b)_e^{\alpha} \wedge e^{\beta} \prec e^{\alpha}$	*!	*

[Bill fell John pushed him]	CONSISTENT	τ-TEMP
$push(j, b)_e^{\alpha} \wedge fall(b)_e^{\beta} \wedge e^{\alpha} \prec e^{\beta} \wedge explanation(\alpha, \beta)$ ☜		*
$fall(b)_e^{\beta} \wedge push(j, b)_e^{\alpha} \wedge e^{\beta} \prec e^{\alpha}$	*!	

[Bill built a house John drew a blueprint]	CONSISTENT	τ-TEMP
$\exists x\, house(x) \wedge built(b, x)_e^{\alpha} \wedge \exists v\, blueprint(v) \wedge drew(j, v)_e^{\beta} \wedge e^{\beta} \prec e^{\alpha} \wedge elaboration(\alpha, \beta)$ ☜		*
$\exists x\, house(x) \wedge built(b, x)_e^{\alpha} \wedge \exists v\, blueprint(v) \wedge drew(j, v)_e^{\beta} \wedge e^{\beta} \prec e^{\alpha}$	*!	

2.2.2 Conjunction

Upon consideration of the evidence below, one would conclude that significant restrictions exist on the interpretation of conjunctive discourses. In this subsection we aim to describe them. Assume that the discourse relations *explanation*, *elaboration* and *evidence* are intended to be present between the constituents below, as appropriate.

(2.16) #Bill fell and John pushed him.
(2.17) #John built a house and an architect drew plans
(2.18) #John pulled Mary's hair and he attacked her
(2.19) #The council is decisive and it concluded the meeting before 8:00.

We will propose the existence of a hard constraint – one that is inviolable and thus will operate as a filter on interpretational possibilities – that will demand that the textual order of conjoined segments not be interpreted as mismatched with the temporal order of the eventualities the segments describe.

&-TEMP: Where two constituents α and β represent events and $\langle \&, \alpha, \beta \rangle$, interpret the temporal order of the events as $e^{\alpha} \prec e^{\beta}$.

[Bill fell and John pushed him]	&-TEMP	CONSISTENT
$push(j, b)_e^{\alpha} \wedge fall(b)_e^{\beta} \wedge e^{\alpha} \prec e^{\beta} \wedge explanation(\alpha, \beta)$	*!	
$fall(b)_e^{\beta} \wedge push(j, b)_e^{\alpha} \wedge e^{\beta} \prec e^{\alpha}$ ☜		*

The constraint &-TEMP bars any interpretation whereby two sentences α and β describing events are interpreted as occurring in an order which mismatches the order in which those segments were presented to the hearer. As a consequence, a hearer will be prohibited from interpreting a segment that is the second conjunct of a discursive conjunction as the description of an elaborative event describing preparation, or an explanation – preparatory or explanatory events necessarily being precedent to the events which they explain or elaborate.

The result of such a constraint will be that – due to the complicit pressure of the other hard constraint, COHERENT – there will simply be no interpretation for some discourses, as some sequences will be such that each of their candidate interpretations violates a hard constraint. An example of something like this appears below.[22]

[John died and he had a heart attack]	COHERENT	&-TEMP
$\text{died(j)}_e^{\alpha} \wedge \text{had-a-heart-attack(j)}_e^{\beta} \wedge e^{\alpha} \prec e$	*!	
$\text{had-a-heart-attack(j)}_e^{\beta} \wedge \text{died(j)}_e^{\alpha} \wedge e^{\beta} \prec e^{\alpha} \wedge \text{explanation}(\alpha, \beta)$		*!

One issue we have not dealt with is the markedness of (2.19). That sequence is not unacceptable by itself, however there seems to be a conspicuous forfeiture of the evidential relation between the second segment and the first as a result of conjoining the two. A sentence like *John is lucky and he won the lottery* is not an evidentiary statement, rather, the sequence has a distinctly explanatory flavor to it. We will see that the same results show up when we consider relativization, so we will suspend the introduction of a rule meant to describe this fact until later so that we may propose one unified rule as opposed to three separate ones.

2.2.3 Relativization

Finally we turn to an examination of the two types of relativization we described above, ρ^1 and ρ^2. Interpretational restrictions on both varieties will require a constraint which makes reference to the discourse relations we summarized above. We address the first type presently. Suppose the following three laws to be in the knowledge base of a hearer.

Heart Attack Law:
$\exists x\ \text{had-a-heart-attack}(x)_e^{\alpha} \wedge \text{died}(x)_e^{\beta} \wedge \langle +, \alpha, \beta\rangle \vee \langle +, \beta, \alpha\rangle \rightsquigarrow \text{cause}(e^{\alpha}, e^{\beta})$

Hair Pulling Law:
$\exists x \exists y\ \text{attacked}(x, y)_e^{\alpha} \wedge \text{pulled-hair-of}(x, y)_e^{\beta} \wedge \langle \tau, \alpha, \beta\rangle \rightsquigarrow \text{elaboration}(\alpha, \beta) \wedge e^{\beta} \subseteq e^{\alpha}$

Informal Axiom on Death:
$\Box \exists x\ \text{died}(x)_e^{\alpha} \rightarrow [(\text{arrived}(x)_e^{\beta} \vee \ldots \vee \text{yelled}(x)_e^{\beta} \wedge \langle +, \alpha, \beta\rangle \vee \langle +, \beta, \alpha\rangle) \rightarrow e^{\beta} \prec e^{\alpha})]$

[22] Note that we are not assuming that where A and B are competitors in a tableau and both violate a hard constraint *n* times, A and B are tied winners. As we hinted before, we are thinking of a hard constraint as a *filter* and, if we were being proper, would leave these filters out of the OT tableaux altogether, as, on this picture, there is a significant difference between being hard constraint and being the highest ranked soft constraint.

(2.20) A man who greeted John stood up.
(2.21) #A man who pulled Mary's hair attacked her.
(2.22) #An architect who built a house drew a blueprint for it.
(2.23) #A man who died had a heart attack.

Assuming that (2.21) and (2.22) are intended to represent elaborations whereby, respectively, a hair-pulling event was a part of an attack and the blueprint-drawing event was a preparatory measure for a house-building event, we judge (2.21) and (2.22) to be unacceptable, for we believe that, e.g., (2.21) will be interpreted as meaning that a man who had pulled Mary's hair at some time in the past later attacked her. Similarly, for (2.23), we infer no causal relationship between the two events but rather think that the sentence simply makes no sense. Given the unacceptability of (2.23), it appears that even in the face of indefeasible world knowledge (e.g. that people cannot have heart attacks *after* they have perished), a hearer could not interpret a sequence in a manner in which the temporal order of events mismatched the order of the segments that described them. We might imagine that there is a hard constraint at work here that bars the interpretation of a discourse whose form is $\langle \rho^1, \alpha, \beta \rangle$ as a description of an event sequence such that $e^{\beta} \prec e^{\alpha}$ or $e^{\beta} \subseteq e^{\alpha}$. However, we judge (2.24), below, to be a perfectly acceptable sequence.

(2.24) A man who visited us arrived in a limousine.

We will see recalcitrant cases like this for the other variety of relativization as well. Thus, before we propose an analysis of what is going on in a case like (2.24), let us look at the data for that variety

Consider the following.

(2.25) #Mary fought a man who pulled her hair.
(2.26) #An architect drew a blueprint for a house that he built.
(2.27) #John pushed a man who fell.
(2.28) A man had a heart attack that killed him.

Assuming as we have been, that (2.25) and (2.26) are intended to be elaborations and (2.27) is intended to express a cause-effect sequence, we judge all three to be unacceptable. In the sequences above, the content of one constituent is relativized and absorbed by the one preceding it. Where such relativization occurs, the relativized content is typically interpreted as being temporally *precedent* to the first segment; evidence for this is provided by narrative sequences below.

(2.29a) John lost a pen that he found.
(2.29b) *John caught a fish that he ate.

We judge the most natural interpretation of (2.29a) to be that John found a pen, then subsequently lost it, and not that John found a pen that he had previously lost. The discourse (2.29b) is incoherent. Further, we are fairly convinced of the unacceptability of (2.27) as a description of a situation where a pushing event caused a

falling event, though (2.28) is clearly acceptable. This evidence might persuade us to propose a constraint that disallowed the interpretation of a discourse whose form is $\langle \rho^2, \alpha, \beta \rangle$ as a description of an event sequence such that $e^{\alpha} \prec e^{\beta}$ or $e^{\alpha} \subseteq e^{\beta}$ and rank it above CONSISTENT, but still allow it to be a soft constraint as to allow for sequences like (2.28).

There are problems with this strategy, though. Consider:

(2.30) Mary heard a song that made her cry.
(2.31) John ate a sandwich that nauseated him.
(2.32) John saw a movie that he liked.

We are prepared to claim that the reason behind the unpalatability of (2.25), (2.26) and (2.27) as well as for (2.21) (2.22) and (2.23) is due to the fact that the descriptions of the events which appear out of the order expected for each each of the two types of relativization are events that *must* have taken place in order for the other event in the discourse to have occurred. We propose that there is a constraint at work that disallows the interpretation of a discourse whose form is $\langle \rho^1, \alpha, \beta \rangle$ as a description of an event sequence such that $e^{\beta} \prec e^{\alpha}$ and which also disallows the interpretation of a discourse of that configuration to be such that $e^{\beta} \subseteq e^{\alpha}$ *unless* there is an indefeasible law in the knowledge base that stipulates that the event described in β *must* have taken place in order for the event described in α to occur and must be such that $e^{\beta} \subseteq e^{\alpha}$.

Similarly, we think that the reason that, for example, (2.31) may be interpreted as an event sequence in which $e^{\alpha} \subseteq e^{\beta}$ is because (a) seeing a movie is a (preparatory) subevent of the event of the state of liking it and (b) It is impossible to like a movie unless you have seen it.[23]

Axiom on Visiting:	$\Box\exists x\exists y\ \text{visit}(x, y)_e^{\alpha} \rightarrow \text{arrived}(x)_e^{\beta} \wedge e^{\beta} \subseteq e^{\alpha}$
Heart Attack Axiom:	$\Box\exists x\exists y\ \text{heart-attack}(y) \wedge \text{cause-to-die}(y, x)_e^{\alpha} \rightarrow \text{had}(x, y)_e^{\beta} \wedge e^{\beta} \subseteq e^{\alpha}$
Movie Axiom:	$\Box\exists x\exists y\ \text{movie}(y) \wedge \text{like}(x, y)_e^{\alpha} \wedge \text{saw}(x, y)_e^{\beta} \rightarrow e^{\beta} \subseteq e^{\alpha}$
Sad Song Axiom:	$\Box\exists x\exists y\ \text{song}(y) \wedge \text{cause-to-cry}(y, x)_e^{\alpha} \rightarrow \text{heard}(x, y)_e^{\beta} \wedge e^{\beta} \subseteq e^{\alpha}$
Bad Food Axiom:	$\Box\exists x\exists y\ \text{food}(y) \wedge \text{cause-to-be-nauseous}(y, x)_e^{\alpha} \rightarrow \text{ate}(x, y)_e^{\beta} \wedge e^{\beta} \subseteq e^{\alpha}$

ρ-TEMP: (i) Where two constituents α and β are simple past constructions and α and β represent events and $\langle \rho^1, \alpha, \beta \rangle$, interpret the temporal order of the events as $e^{\alpha} \prec e^{\beta}$ unless there is an indefeasible law in the knowledge base such that $\Box(e^{\alpha} \Rightarrow (e^{\beta} \wedge e^{\beta} \subseteq e^{\alpha}))$.

[23] We are being slightly sloppy here, since obviously it is not the case that in order to visit, one must arrive *in a limousine*. But note: **The man who visited us arrived* is nonsense (see section 2.3.2 for our analysis, which, while dedicated to pluperfects, is just as applicable to that sentence.). The restriction ought to be read as to require only that the 'bare event'– sans prepositional or adverbial garnishings – must have occurred as a preparatory condition for the event that is the relativized predicate.

(ii) Where two constituents α and β are simple past constructions and α and β represent events and $\langle \rho^2, \alpha, \beta \rangle$, interpret the temporal order of the events as $e^{\beta} \prec e^{\alpha}$ unless there is an indefeasible law in the knowledge base such that $\Box(e^{\beta} \Rightarrow (e^{\alpha} \wedge e^{\alpha} \subseteq e^{\beta}))$.[24]

It is not impossible to fall and without having been pushed, to die without having a heart attack, to attack someone without pulling his or her hair, to eat a fish without having caught it, etc. Thus (2.27), (2.25) (2.23), (2.29b) are all violations of ρ-TEMP. We propose ρ-TEMP to be another hard constraint.

COHERENT ; &-TEMP; ρ-TEMP || CONSISTENT >> τ-TEMP

[A man who fell slipped]	ρ-TEMP	CONSISTENT
$\exists x\, fell(x)_e^{\alpha} \wedge slipped(x)_e^{\beta} \wedge e^{\alpha} \prec e^{\beta}$ ☜		*
$\exists x\, slipped(x)_e^{\beta} \wedge fell(x)_e^{\alpha} \wedge e^{\beta} \prec e^{\alpha} \wedge explanation(\alpha, \beta)$	*!	

[John lost a pen that he found]	ρ-TEMP
$\exists x\, pen(x) \wedge lost(j, x)_e^{\alpha} \wedge found(j, x)_e^{\beta} \wedge e^{\alpha} \prec e^{\beta}$	*!
$\exists x\, pen(x) \wedge found(j, x)_e^{\beta} \wedge lost(j, x)_e^{\alpha} \wedge e^{\beta} \prec e^{\alpha}$ ☜	

[John pushed a man who fell]	ρ-TEMP	CONSISTENT
$\exists x\, man(x) \wedge push(j, x)_e^{\alpha} \wedge fall(x)_e^{\beta} \wedge e^{\alpha} \prec e^{\beta} \wedge result(\alpha, \beta)$	*!	
$\exists x\, man(x) \wedge fall(x)_e^{\beta} \wedge push(j, x)_e^{\alpha} \wedge e^{\beta} \prec e^{\alpha}$ ☜		*

[A man who visited John arrived in a limousine]	COHERENT	ρ-TEMP
$\exists x\, man(x) \wedge visited(x, j)_e^{\alpha} \wedge arrived\text{-}in\text{-}a\text{-}limo(x)_e^{\beta} \wedge e^{\alpha} \prec e^{\beta}$	*!	
$\exists x\, man(x) \wedge visited(x, j)_e^{\alpha} \wedge arrived\text{-}in\text{-}a\text{-}limo(x)_e^{\beta} \wedge e^{\alpha} \prec e^{\beta}$ ☜		

[John caught a fish that he ate]	COHERENT	ρ-TEMP
$\exists x\, fish(x) \wedge caught(j, x)_e^{\alpha} \wedge ate(x)_e^{\beta} \wedge e^{\beta} \prec e^{\alpha}$	*!	
$\exists x\, fish(x) \wedge caught(j, x)_e^{\alpha} \wedge ate(x)_e^{\beta} \wedge e^{\alpha} \prec e^{\beta}$		*!

[A man who died had a heart attack]	COHERENT	ρ-TEMP
$\exists x\, died(x)_e^{\alpha} \wedge had\text{-}a\text{-}heart\text{-}attack(x)_e^{\beta} \wedge e^{\alpha} \prec e^{\beta}$	*!	
$\exists x\, died(x)_e^{\alpha} \wedge had\text{-}a\text{-}heart\text{-}attack(x)_e^{\beta} \wedge e^{\beta} \prec e^{\alpha}$		*!

[24] We add the proviso "are simple past constructions" here out of caution, as we will introduce other hard constraints in section 2.3 that will restrict the interpretation of compound constructions. The sentence *A man who fell had slipped* is quite obviously an acceptable utterance.

Finally, we must tie up some ends that we have left loose. Consider the following discourses and assume that a speaker's intention is to express evidentiary or elaborative statements, as appropriate.

(2.34) #The council has been decisive lately and it concluded the meeting before 8:00.
(2.35) #The council that has been decisive lately concluded the meeting before 8:00.
(2.36) #John is kind to a woman whom he showers with gifts.

We think that these data can be analyzed quite simply. We believe that segments (2.34) through (2.36) connected via any of the operations we have discussed, with the exception of attachment, may not be interpreted as evidentiary statements. We note that there are specialized cue phrases for which these types of segments may break the general rule we have stated; the conjunction *for* is an example of one which may be used to conjoin evidentiary statements, at times *because* is also appropriate.

CONSTRAINTONEVIDENCE:

$\langle \&, \alpha, \beta \rangle \vee \langle \rho^1, \alpha, \beta \rangle \vee \langle \rho^2, \alpha, \beta \rangle \Rightarrow \neg$ evidence$(\alpha, \beta) \wedge \neg$ evidence(β, α)

2.2.4 Connection and Generation

We have spent the last three subsections discussing constraints on the interpretation of discourses and how an interpretation strategy is restricted by constraints whose subjects are various syntactic connection possibilities. We have focused our effort on interpretation because, as we discussed at length in the previous section, we are committed to the idea that the primary consideration for any successful generative enterprise is how the output of that procedure is likely to be interpreted. Given what we have observed above about constraints on interpretation, we can state a fairly simple generative strategy that is based on these facts, as we think that, in essence, there *are no* economy principles related to the syntactic operations discussed above, save one: BIDIRECT. That is, we think that, given a certain meaning, as long as we can generate a form that will be optimally interpreted as having that meaning, any form will do.

	$\exists x$ woman(x) $\wedge$ push(j, x)$_e^{\alpha}$ $\wedge$ fall(x)$_e^{\beta}$ $\wedge$ $e^{\alpha} \prec e^{\beta}$ $\wedge$ cause(e^{α}, e^{β})	BIDIRECT
✌	☞ [John pushed a woman She fell] ☜	
✌	☞ [A woman fell John pushed her] ☜	
✌	☞ [John pushed a woman and she fell] ☜	
	☞ [A woman fell and John pushed her]	*!
	☞ [John pushed a woman who fell]	*!

One thing that we do wish to take care of that we have not overtly done anything about is the guarantee of discursive *precision* mentioned at the outset of this section. That is, we many imagine cases in which a speaker would like to report, e.g., a causal relationship between the two events, but it is not ensured by information in the relevant knowledge bases of a hearer that that relation will be inferred. To achieve this effect we don't need to do anything, for BIDIRECT will do the work for us. We will take cue words to be optional in cases where the

relevant discourse relation may be expected to be inferable without the aid of a cue word, so , for the tableau above, the winners would remain the same, and we would have two additional winning candidates:

	$\exists x\ \text{woman}(x) \wedge \text{push}(j, x)_e^{\alpha} \wedge \text{fall}(x)_e^{\beta} \wedge e^{\alpha} \prec e^{\beta} \wedge \text{cause}(e^{\alpha}, e^{\beta})$	BIDIRECT
✌	☞ [John pushed a woman so she fell] ☜	
✌	☞ [A woman fell because John pushed her] ☜	

On the other hand, for constituents between which the correct discourse relation may not be expected to be inferable, the use of cue words will be mandatory, as all those candidates which do not employ them will violate BIDIRECT.

	$\text{arrived-late}(j)_e^{\alpha} \wedge \text{smiled}(m)_e^{\beta} \wedge e^{\alpha} \prec e^{\beta} \wedge \text{cause}(e^{\alpha}, e^{\beta})$	BIDIRECT
	☞ [John arrived late Mary smiled]	*!
	☞ [Mary smiled John arrived late]	*!
	☞ [John arrived late and Mary smiled]	*!
	☞ [Mary smiled and John arrived late]	*!
✌	☞ [John arrived late so Mary smiled] ☜	
✌	☞ [Mary smiled because John arrived late] ☜	

This is all we will have to say about conjunction, relativization, and attachment, as we have hopefully shown that the restrictions on generation with respect to these operations is quite straightforward, when the idea of bidirectionalty and the dependence of a generative procedure on the interpretational strategies of its intended audience is taken into consideration. We turn next to a discussion of temporal interpretation and generation in discourse which will exhibit much of same type of interdependence between the two procedures.

2.3 Tense in Discourse: Preliminaries

We said above that one of the main claims made by A&L relates to the effect discourse relations have on the use of grammatical tenses. Part of this claim was discussed in the previous section and pertains to the permissibility of the textual order of simple past constructions where that order mismatches the temporal order of the events the constituents in a discourse describe. The A&L program also makes claims about restrictions on the employment and interpretation of compound grammatical tenses. We will focus on one of those claims, namely their proposal about criteria for the use and interpretation of the pluperfect, which they believe is related to the discourse relations summarized above, though we will say a little about the perfect tense as well, which A&L believe is a result of tampering with the status of the eventuality that a sentence represents. We will present their views on both, and ultimately argue against both, claiming that the distributional behavior of the perfect versus the simple past is decided by the presence or absence of an (often contextually supplied) temporal reference point in the discourse and arguing that, instead of discourse relations being a factor, the only relevant information in determining when a pluperfect can be used is the temporal order of eventualities.

2.3.0 Background

Much of the A&L's discussion of tense in discourse is aimed at improving on accounts inspired by the work of Reichenbach [Reich47]. In Reichenbach's analysis, each tense is represented through some possible ordering relation between three primitive temporal coordinates, these are an event time E, a speech time S and a reference time R. For example, the representation of the simple past is ER_S, indicating that E=R and both precede S; the present perfect is represented as E_RS, meaning R=S and E occurred before both. For the pluperfect, the representation is E_R_S, meaning that the time of the event is temporally prior to some other time, R, which is in turn precedent to the time S at which sentence is uttered. The future perfect is a conflation of three different tenses involving various relations between S and E (E_S_R, SE_R, and S_E_R). Reichenbach's use of the notion of a reference time is appealing in that it captures the intuition that the event described in a pluperfect construction is being described as occurring in the past with respect to some other time in the (more recent) past.

The details of Reichenbach's theory have been criticized successfully in the literature (cf., e.g., Vikner [Vikner85] and Hornstein [Hornst90]), though his notion of the need for reference times in semantic analyses have been widely adopted in modified versions, e.g., Kamp and Reyle [K&R93] adopt the idea and employ the notion of a temporal reference point in their analysis of the pluperfect when stating construction rules for their Discourse Representation Structures (DRSs) that represent interpretations of pluperfect constructions in Discourse Representation Theory. We will occasionally make reference to these representations where it is useful.

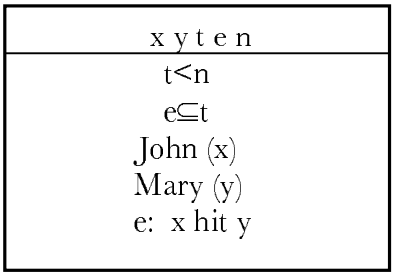
'Quasi-Reichenbachian' accounts of tense are attacked in the A&L literature, who argue that simple pasts and pluperfects are "*sententially* equivalent, although they play distinct discourse roles because of the different constraints they impose on a coherent discourse." ([A&L93a], p10) We will present the A&L view on perfect and pluperfect tenses in the subsections that follow. We will argue that the analysis they present makes incorrect predictions about discourse coherence, incorrect predictions about a hearer's inclination to infer information from a discourse, and lacks any independent motivation from an intuitive standpoint.

2.3.1 The Perfect

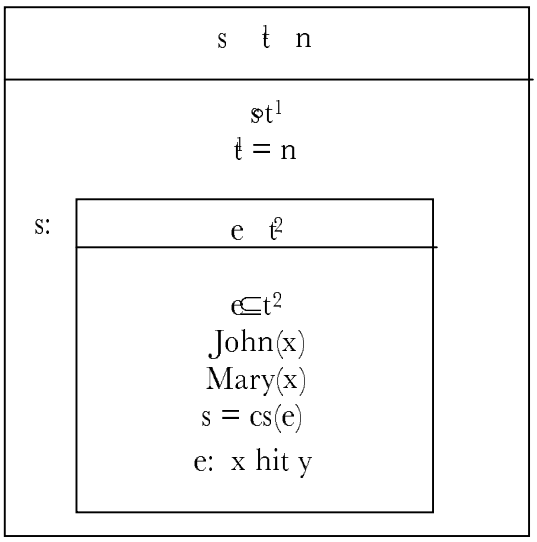
According to the construction rules for a DRS in Discourse Representation Theory (DRT) of Kamp and Reyle, the semantics for one sentence describing an event or state is the same whether that sentence is a perfect of a simple past.

(2.37) John hit Mary.
(2.38) John has hit Mary.

In the Discourse Representation Theory of Kamp and Reyle, both are assigned the DRS below.



A&L (who draw from the work of Moens and Steedman [M&S88]) treat the semantics of an event sentence framed in the perfect like (2.38) as a DRS containing an event that has been transformed into a state. Thus while the DRS for (2.37) remains as above, the DRS for (2.38) contains a condition which is a state that features the entire event DRS as its sole condition.



It is assumed both that every event yields a consequent state and that a DRS containing a consequent state represents a true statement if and only if the event from which that consequent state is derived holds at an earlier time, formally:

$$\Box\forall t'(e\subseteq t) \rightarrow \exists t(cs(e)\circ t \wedge t' \prec t)$$
$$\Box\forall t(cs(e)\circ t) \rightarrow \exists t'(e\subseteq t' \wedge t' \prec t).$$

At first blush, this would seem a constructive move given that sentences which employ perfect tense constructions do not combine with simple pasts the way the other simple pasts do (e.g., *#Bill fell John has pushed him*), and this suggests reason to believe that in fact present perfects describe states, not events. However, as we will see, A&L extend this analysis to perfect tenses in the past (i.e., pluperfects), which forces them to define a function *ev* that allows an event which has been turned into a state to remain available for attachment at the level of discourse relations so that these problems are avoided (e.g., for a discourse like *Max stood up John had greeted him* we cannot attach a state *cs(e)* to an event *e′* via *narration*, we will need the *e*, as *narration* is a relation that necessarily holds between events.)

A second feature of this move is that it demands, for a sentence such as *John has owned a donkey*, that the state of owning a donkey must first be turned into an event (corresponding, they say to "the inceptive reading of the state" ([A&L93a] p4) – the event of John beginning to own a donkey – then be turned *back* into a state in order to fit the program. We find this move rather odd, as it seems to lack any independent motivation. (It would predict that the sentences *John has owned a donkey* and *John has acquired a donkey* are in fact synonymous. In addition, it would not independently facilitate the prediction that a sentence like *John has owned a donkey* implies that John no longer owns a donkey, despite the fact that, intuitively, that sentence would indeed coerce the inference that John's status as a donkey owner was in the past and not the present.) Thus, while we will not say much about the generation of perfect tenses here, we will briefly give a different analysis of that tense – one which involves the Reichenbachian notion of a reference time – that we hope will, if only partially, justify our silence.

Partee [Partee73] observes that the truth conditions of sentences framed in the simple past may be heavily dependent on the context in which they are uttered.

(2.39) John did not turn off the stove.

The sentence in (2.39) would clearly not be uttered with the intended meaning "John, at at least one point in the past, failed to turn off the stove." Nor would it be used to convey the information that John has *never* turned off the relevant stove. Rather, John's failure to turn off the stove is being asserted to hold at some time in the past that is salient in the context in which the utterance is made. To put it differently, a contextually supplied reference point determines the location in time of the event or state (or lack thereof.) We propose that in at least some cases, the perfect is a way of indicating that no such reference point need be interpreted.[25]

(2.40) Mary has met the president.

A sentence like (2.40) is thus taken to assert that a meeting event between two individuals has taken place at at least one point before now. This, quite obviously, does not mean that the use of the perfect asserts that the event described did not occur at a certain point in time, only that that certain point in time is not relevant to the truth conditions of the sentence. Thus, whereas a sentence like (2.39) is the negation of a proposition claiming

[25] In recent work, for example, [Rooy99] and [Dekker00] it has been argued that indefinite expressions, such as in the sentence *John was bitten by a crocodile* are, while not properly referential expressions, are "...used with referential intentions." ([Dekker00], p53), i.e., they are used with the intention of a speaker to refer to a *specific* individual. The evidence cited for this is, among other things, the potential for anaphoric binding, even in cases where the content of the indefinite description is inconsistent with properties attributed to the entity referred to by the pronoun for which the description serves as an antecedent: *It wasn't a crocodile, it was an alligator*. From our perspective on the use of the perfect tense, we are tempted to wonder whether the so-called specificity of an indefinite is, rather than a property of the indefinite description itself, a symptom of the use of the simple past, as it seems that with other tenses, the claim that a specific individual is necessarily the intended referent of an indefinite is simply not true, as the ignorance expressed by the interlocutor in the following discourse is not surprising: *A man will deliver my package tomorrow. Will he be wearing a purple jogging suit? It depends on which courier they send*; we clearly see different conditions on anaphoric potential with the same indefinites used in the perfect tense: *One out of three cadets has killed a man with his bare hands. #Was he a big man?* This seems to be due to the fact that, unlike the simple past, which requires a (specific) contextually supplied temporal reference point for proper interpretation, there is no such specificity required for the use of a present perfect and thus the sentence *John has been bitten by a crocodile* is (on one reading) simply the denial of the claim that no crocodile has ever bitten John. No such reading is available for an analogous statement in the simple past.

that John turned off the stove at the contextually relevant time, the natural negation of (2.40) would be a claim that Mary has never met the president. This would explain why sentences in the perfect are incompatible with punctual temporal adverbials; such adverbials, which make explicit which temporal reference point is the salient one in the context of the utterance, cannot be used with a tense construction that is employed for the purpose of marking the absence of such a reference point. With other adverbials, the use of a perfect tense conveys a different meaning than a simple past counterpart.

(2.41) Mary met the president five minutes ago.
(2.42) *Mary has met the president five minutes ago.

(2.43) Mary met the president at 9:00am.
(2.44) Mary has met the president at 9:00am.

The sentence in (2.43) intuitively means that Mary met the president at 9:00am on some salient day – probably today, or some other day on which she was expected to meet the president. However, the sentence in (2.44) is just a denial of the claim that on no day in the past did Mary ever meet the president at 9:00am. We note that a use of present perfect indeed may involve a contextually given reference time.

(2.45) John has eaten lunch.

Surely (2.45) is not a claim that John has, at at least one point in his life, eaten lunch, and we believe that this is the case because of the presence of a contextually supplied *interval* (but not a *point* in time); indeed such a use is perfectly compatible with temporal adverbials such as *today* or *this week*, where the interval is simply being supplied explicitly.

We believe that this is the main difference between the simple past and the perfect, and, being that we do not wish to complicate matters by distinguishing between input representations that involve contextually supplied temporal reference points and those that do not, we will ignore the matter for our present purposes.

We will however propose one interpretational constraint on the simple past that will, when BIDIRECT shows its hand, coerce the use of the present perfect from the generative standpoint. Consider a sentence like (2.46), below.

(2.46) Most students saw a film.

We may draw two distinctions here; firstly, there is the classical *de re/de dicto* distinction: the sentence is ambiguous with regard to whether most students saw a *particular* film or just some film, not necessarily the same one. Secondly, it has been claimed that the sentence is ambiguous with regard to whether it describes a single event *e* which involved most students seeing a film together, or whether it involves – as it is called in DRT – a *collective event*, *E*, whereby most students saw a (particular) film, but not necessarily at the same time. With both of these distinctions in place, the sentence has three readings: (i) Most students saw one film together,

(ii) Most students saw one film, though not necessarily at the same time (iii) Most students saw some film, though not necessarily the same one. (Note that there is no fourth reading whereby most students saw different films together, as this situation, while not altogether impossible, would still not be thought of as a single viewing event, but a plurality thereof, and thus would have the same semantics as (iii).) It is our belief that the third reading will almost never be inferred by a neutral hearer in a neutral context, where, by "neutral context" we mean in the absence of a contextually or explicitly supplied interval, e.g., *over the weekend*. We introduce the following constraint to reflect that intuition.

CONSTRAINT
ONSIMPLEPAST: Where α is simple past representing an event e, and there is no interval ζ such that $\zeta \subseteq e$ is specified in α, interpret e as a single, non-collective event.

The constraint is in accordance with what we stated to be our belief before, that a simple past implies the presence of a salient reference time. The view is somewhat sympathetic to the analysis of Reichenbach (as well as his critics, e.g., Vikner [Vikner85], who has argued for that the R element is superfluous in perfect, and other, constructions.) We turn presently to the temporal construction upon which we wish to focus, the pluperfect.

2.3.2 The Pluperfect

In the present subsection, we wish to make some observations about the interpretation of pluperfect constructions. Much of the discussion will be for the purpose of setting the record straight about what we feel are some glaring errors in some of the attacks on Reichenbachian-inspired accounts of tense, in particular those of Asher and Lascarides [A&L93a] et al. and their claims regarding the analysis given by Kamp [Kamp91]. To be sure, A&L attack Kamp's quasi-Reichenbachian account of the pluperfect on three separate grounds, for lack of space, we will concentrate only on one, one which they deem the 'Relevance Problem.' Were we being proper, we would dedicate an equal amount of space to the close relative of the pluperfect, the future perfect, however, we feel that most of the observations we make about the pluperfect may be made about the future perfect as well and that the rules we state for one construction could easily be adopted for the other, therefore, we will dedicate our attention to only the past perfect, and have very little to say about its future tense counterpart.

2.3.2a Background

For A&L, the semantics for a pluperfect is much like the semantics for the perfect we saw above, only that the consequent state whose argument is an event is a state holding in the past, not the present. It is argued, in, for example, [A&L93a] and [A&L93b] that discourse relations partially govern the licensing of the use of the pluperfect tense. They cite the following examples as evidence.

(2.47) John entered the room. He poured himself a cup of coffee.

(2.48) #John poured himself a cup of coffee. He had entered the room.

A&L propose to "...think of the pluperfect as a *discourse marker* that indicates the range of possible connections that would make a clause 'contextually relevant'."([A&L93a] p2) in order to explain the incoherence of (2.48), in effect claiming that the discourse is incoherent because the second sentence in the discourse does not meet the relevance criteria which must be fulfilled in order to license a pluperfect construction.[26] A rule is introduced whose effect is to impose a restriction such that the "discourse relations permitted between a simple past and a pluperfect are exactly Elaboration, Explanation, Parallel, and Contrast." (*Ibid.* p5) The rule is meant to account for the discrepancy in acceptability between the two sequences (2.47) and (2.48), above. In [A&L93b], this rule is cast as the following indefeasible axiom called *Connections When Changing Tense*.

Connections When Changing Tense: $\Box\langle\tau, \alpha, \beta\rangle \wedge sp(\alpha) \wedge pp(\beta) \rightarrow Cpp(\alpha, \beta)$

In English: where a segment β attaches to a segment α and α is a simple past and β is a pluperfect, then the constraint *Cpp* holds for (α, β), where *Cpp* is the constraint that the consequent state described in the pluperfect must be derived from the eventuality described in the simple past and that the relation holding between that eventuality and the one to which it is attached must be either *elaboration*, *explanation*, *parallel* or *contrast*.

In [A&L96], a new, defeasible, version of this constraint (as above, sans $\Box$, with non-monotonic implication "$\rightarrow$" instead of "$\Rightarrow$"), called *Constraints when Changing Tense* (CCT) is given, to permit for exceptions. The exception cited by A&L is:

(2.49a) Max had left the house at 7am.

(2.49b) He had passed the station by 9:15am.

First, we note that the pluperfect in (2.49b) is used specifically because there is a temporal reference point in that sentence which the event of passing the station temporally precedes, namely 9:15am. Note that the eventuality described in (2.49b) is not one which temporally precedes the event described in (2.49a), as is normally the case for pluperfect constructions, and that there is simply no simple past expression which could be used to convey the same information as (2.49b).

(2.49c) ?He passed the station by 9:15am.

[26] The discussion in the passage cited here ([A&L93a], p.2) of what A&L call the *Relevance Problem* for Kamp's Reichenbachian account is one of the few places where the notion of relevance is mentioned in the A&L literature. The view being taken, similar to that of Caenepeel and Sandström [C&S92], seems to suggest that relevance must be thought of a *scalar* property, i.e., some things (e.g., elaborations) are more relevant than others (e.g., narrations) to a specific context. Our intuitions are unclear about how such a scale might be exhaustively described. (What would it mean for something to be, say, 100% relevant?) Though we will not defend the view here, we believe that, while there are a robust class of different *reasons* that a constituent may be relevant to a specific context (and, in fact, that these reasons might naively be said to be the things that demarcate the boundaries between one discourse relation and the others), we believe that, ultimately, a sentence is either relevant to a context, or it is not.

The sentence in (2.49c) does not seem to leave open the possibility that Max passed the station well before 9:15, perhaps at 7:30, rather, if the sentence is indeed grammatical at all, it is synonymous with *He passed the station <u>at</u> 9:15am*. Compare

(2.49d) ??By 9:15am he passed the station.

It can be, we think, rightly claimed that the pluperfect is (only and always) licensed for one-sentence discourses when a punctual temporal adverbial that precedes the eventuality described in that sentence is present. [27]

(2.50) #Max had passed the station.

Given these observations, we state the following generative constraint – another hard constraint – that will serve to restrict the restrict generation of pluperfects to sentences which either contain the type of temporal adverbial phrases described above or which, if pluperfects, describe an eventuality that is temporally prior to some other eventuality described in the in the discourse that is represented by a segment in the simple past or, if future perfects, describe an eventuality that is temporally prior to some other eventuality described in the in the discourse that is represented by a segment in the simple future tense. (We use *n* below to represent the temporal indexical *now*.)

FUT/PLUPPERFTEMP: A constituent α may be a future perfect or pluperfect construction only if

(i) α contains a temporal adverbial ζ denoting a time t, e^{α} is such that $e^{\alpha} \prec n$ or $n \prec e^{\alpha}$, and e^{α} is explicitly indicated in α as being such that $e^{\alpha} \prec_t \zeta$

or

(ii) α is connected to some segment β and $[e^{\alpha} \prec n \wedge e^{\beta} \prec n] \vee [n \prec e^{\alpha} \wedge n \prec e^{\beta}])$ and $e^{\alpha} \prec e^{\beta}$

Secondly, we reject the claim that *narrations* that fail to also be instances of *parallel* or *contrast*[28] are disallowed from being framed in the pluperfect and wish to argue that there is no relationship whatsoever between the allowance for the uses of tense in a discourse and the discourse relations holding between its constituents. We make this proposal on the grounds that there are many other exceptions to A&L's CCT, even those that do not involve the presence of temporal adverbials.

(2.51a) John poured himself a drink.
(2.51b) He had entered the room wearing a red scarf.

(2.52a) John poured himself a drink.
(2.52b) He had stumbled into the room.

[27] This is a fact that, apparently, A&L either dispute or ignore, as they give examples of 'stand alone' pluperfect, sans temporal adverbials, like *John had loved Mary*, claiming that this sentence is interpretable as *John started to love Mary*. ([A&L93a], p4)

[28] We omit "*elaboration* or *explanation*" here because *narrations*, by definition, can be neither.

(2.53a) John poured himself a drink.
(2.53b) He had entered the room again.

Firstly, while the above three discourses are acceptable, it is in no way clear to us how a stumbling event, or a state of wearing a red scarf would explain or elaborate a pouring-of-water event, nor is there any obvious *parallel* or *contrast* between the respective segments of these sequences. And certainly if John's entering the room was not "contextually relevant" enough to his pouring of water to license a pluperfect, his leaving the room and coming back would not be either. It would require a great deal of *ad hoc* stipulation about the interpretational procedure of a hearer to guarantee that when a stumbling event and a pouring-of-water event occurred in a discourse, a hearer could *infer* that there is a discourse relation like *explanation* or *elaboration* present, and thus there is clearly little justification for rules being postulated to exist in a hearer's knowledge base – defeasible or not – that would reflect the likelihood of such an inference.[29]

We will suggest a more commonsense explanation of the incoherence of (2.48), which will exploit a non-triviality restriction already in place in most update-style theories of semantics, as well as a notion of salience of definite descriptions that is not only already implicitly present in much of the current literature but which is also (almost) explicitly present in the work of A&L themselves, and may be inferred from that work if one is allowed to stipulate a minute extension the theory they present. To do so, we must say something about that theory; it is the theory of *Bridging*, in [A&L98].

2.3.2b A Detour: Definite Descriptions and Bridging

The theory of bridging defended in [A&L98] attempts to improve upon the work related to presupposition, including but in no way limited to that of Hobbs [Hobbs79], [Heim92], van der Sandt [Sandt92], and Chierchia [Chierchia95]. A great deal of that theory is related to the interpretation (i.e., the resolution) of definite descriptions. It is argued that inferences about discourse relations must necessarily be drawn in order to compute the value of underspecified relations which hold between a definite description and a (sometimes non-explicit) antecedent.

The story runs as follows. A definite description that lacks an antecedent in the discourse generates a presupposition that there is a unique and salient entity of the type described in the context.

(2.54a) I met two interesting people last night.
(2.54b) The woman was a lawyer.

In a sentence like (2.54b), there is a presupposition generated that there is exactly one salient woman. In addition, an implicature is generated that the woman referred to was one of the two interesting people that I met last night mentioned in (2.54a).

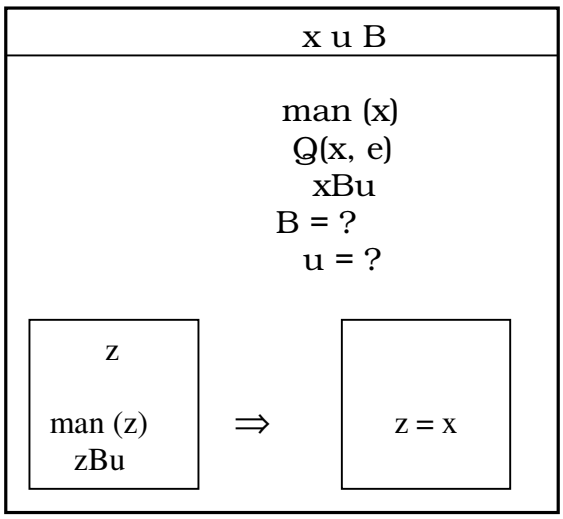
---

[29] An example of a law that the A&L analysis requires for its survival is their *Greeting Law*, which, while not (quite) as absurd as a *Stumbling/Pouring Law*, is equally *ad hoc*: $\langle \tau, \alpha, \beta \rangle \wedge \text{stand-up}((\text{ev}(e^{\alpha})) \wedge \text{greeting}(\text{ev}(e^{\beta})) \wedge \mathit{Cpp}(\alpha, \beta)) \rightarrow \text{explanation}(\alpha, \beta)$.

In A&L, bridging is called "a byproduct of discourse interpretation" ([A&L98] p2) and is done in order to compute rhetorical relations between constituents of a discourse. Bridging is seen as a "necessary precondition" for the interpretation of a discourse (*Ibid.* p3) Bridging inferences are made in order to aid the construction of a coherent discursive structure. Only subsequent to a coherent structure being in place is the discourse subjected to a model theoretic interpretation.

A&L propose a theory of how entities denoted by definite descriptions are related to individuals previously introduced in a discourse. Their proposal adopts Chierchia's treatment of definite descriptions involves a Russellian uniqueness condition which holds given a *domain restricting relation*, *B*. The representation for the definite description *the man* is as below.

λeλQ.



The key condition of the above DRS is the underspecified relation, *B*, which holds between *x* and *u*, *u* being the antecedent introduced by virtue of the presupposition triggered by the use of the definite description. The value of *B* needs to be computed. In the case of a definite description whose content is shared with exactly one indefinite description already present in the discourse, the resolution of the definite phrase is unproblematic. The relation *B* is merely the " = " relation and the definite description is interpreted as referring to the entity to which the previously introduced indefinite with the same content referred. (This feature of the theory is one which we have reversed and incorporated into our procedure for anaphora g eneration, as repeat occurrences indefinites that have a common discourse referent must be turned into definites once they have been introduced to a discourse, assuming they are not pronominalzed.)

(2.55a) Bill has a new watch and a new car.
(2.55b) The watch was a gift.

Thus, in (2.55b) the discourse referent corresponding to the definite description *the watch* is predicted be identical to the discourse referent corresponding to the indefinite phrase *a watch* in (2.55a).

It is a more challenging task to build a procedure for determining the value of the relation *B* in cases that involve an appearance of a definite description that lacks an explicit antecedent in the discourse, for, as we saw in (2.54a) and (2.54b), this relation is not always simply the identity relation, but may be the *subset* relation or, as shown in the example below, the *whole/part* relation.

(2.55a) John owns a car.
(2.55b) The engine is damaged.

A&L propose to compute the value of the underspecified relation holding between a discourse referent introduced by a definite description and the discourse referent that is the antecedent of that definite description (introduced by virtue of the presupposition triggered by the use definite phrase) using semantic information added to the context through the verification of coherence constraints imposed by the rhetorical relations that hold between constituents in a discourse.

World-knowledge and lexical knowledge are used to aid in the determination of exactly which discourse relations hold between which constituents. For example, the inference of a whole/part relation between the indefinite *a car* and the definite *the engine* is achieved based on the knowledge that an engine is a part of a car. In the pair below, the definite description is resolved with by virtue of the fact that the discourse relation *elaboration* may be inferred to hold between the segments.

(2.56a) John built a house.
(2.56b) An architect drew the blueprint.

Determination of discourse relations, then, can foster the specification of the values of relations that are underspecified, facilitating resolution of a definite description.

2.3.2c Be Informative!

We return now to the present task of stating what principle is at work that would disallow a mismatch of discursive and temporal order in some cases, but would, in other cases, allow an event e^{β} which stood in the *narration* relation to the segment describing e^{α} to appear before the segment describing e^{α} in the discourse, despite the fact that e^{β} occurred after e^{α}, and allow our generative strategy mirror that principle.

(2.48) #John poured himself a cup of coffee. He had entered the room.

As we noted above, A&L explain the incoherence of (2.48) in terms of a poverty of 'contextual relevance' possessed by the *narration* relation. In light of the counterexamples we have given, we instead opt for a different explanation for the awkwardness of (2.48), which we feel is not only more intuitive, but is more easily dealt with in generative terms.

We believe that the principle at work which disallows (2.48) is a generative constraint which guards a speakers economy interests by prohibiting to redundancy or triviality in his output.

INFORMATIVITY: Given a context C, a segment α is licensed in a discourse only if it effects a context-change in C.[30]

We believe that INFORMATIVITY is yet another hard constraint and that the incoherence of (2.48) is due to the fact that this discourse violates that constraint. Let us say why: Given what we have said about bridging, we think that, just as the salient engine in (2.55b) is the one which is a part of an entity mentioned in the previous sentence of a discourse, we believe that the salience of the room in the second sentence of (2.48) is determined by the previous sentence in that discourse. To be sure, the room is obviously not identical, nor a part of, nor a subset of anything mentioned in the first sentence of (2.48), but we believe that the underspecified relation in this case is one which holds between the room and – in the language of DRT – the discourse referent *e* which corresponds to the event of pouring a drink, the specific relation being something like "the environment in which *e* took place", for we think there is a strong tendency to interpret discourses this way.

(2.57) I was reading a book. The room suddenly went dark.

We believe that the second sentence in this sequence is inevitably interpreted as meaning that the room in which I was reading a book suddenly went dark. Thus, analogously, (2.48) may be taken to mean that John poured himself a drink; he had entered the room in which he was located when he poured himself a drink. This is redundant, as it is the case for things like rooms, offices, houses, etc. that to be in a state of being in one, one must have participated in an entering event beforehand (we assume this to be part of a hearer's world-knowledge though we will not bother to formalize this.) Note that whereas *John poured himself a drink* implies the fact that he had entered the (salient) room and thus, by INFORMATIVITY, the information that he entered the room may not be introduced to the discourse where information that implies that fact was presented earlier in the discourse, nothing bars introducing information to a discourse which will be implied by information introduced *later* in the discourse, hence the acceptability of *John entered the room. He poured himself a drink.*

Obviously, this procedure for computing salience may be overridden by explicit information in the discourse. Compare.

(2.59) John owns a car. The engine of his old car was damaged.
(2.60) John poured himself a drink, he had entered the room on the 3rd floor.
(2.61) John poured himself a drink, he had entered the room I was standing in.

Related to this, consider

[30] For lack of space, we will not bother defining contexts or information states, nor the formal criteria for what it means to update or 'effect context change' in such an entity. Any of the definitions for the update operation available in the literature (cf. e.g., Groenedijk, Stokhof, and Veltman [G&S&V96]) would do just fine for us. Intuitively, a sentence updates an information state/effects context change if and only if it adds information to the discourse that is not entailed by information that was already presented in that discourse or present in the common ground.

(2.62) John poured himself a drink. He had not entered the room.
(2.63) John poured himself a drink. He never entered the room.

Given what we have said about how the salience of *the room* is determined, we might, at first blush, expect (2.62) and (2.63) to be contradictory. However they are neither contradictory no incoherent for any other reason. Instead, we take it that the second sentences in (2.62) and (2.63), respectively simply indicate a shift in the default for salience (for perhaps John was in a room when he poured the drink, just not the salient one.) For both, in order to accommodate the discourse as a coherent one, we must assume that there is some other salient room (e.g., the one the speaker was in or the one John was *expected* to walk into) to which the definite description must refer.

In conclusion, we reject the claim that the pluperfect is a "discourse marker", for we believe that the use of the pluperfect construction is related to one and only one fact about a discourse: the temporal order of eventualities described in that discourse. Instead, we sympathize with straightforward Reichenbachian-inspired accounts of the pluperfect: that it indicates a past event, temporally precedent to some other temporal reference point in the past, where that reference point is established either by an event evoked in the discourse, or a punctual temporal adverbial.

2.4 A Generative Program for Tense Constructions

In the present section we outline a generative strategy for grammatical tense. The procedure will be largely based on the observations we made above regarding interpretational constraints on sequential organization and discourse relations. In addition, we will argue that the decision procedure for the use of compound constructions will rely on the notion of discourse topic, of which we will argue the use of compound grammatical tenses may be indicative. One group of compound tense constructions that we have yet to introduce are *would*-constructions which, like the pluperfect, utilize a temporal reference in the past, but which, unlike the pluperfect, describe an event as occurring after the relevant reference point, though still in the past. It will be useful to have this construction at our disposal and we introduce a rule for its employment that analogous to our rule for the pluperfect/future perfect. (Embarrassingly, we are ignorant to any other name for this construction and will resort to calling it a *would*-construction throughout the remainder of the manuscript.)

WOULD-TEMP: A constituent α may be a *would*-construction only if

(i) α contains a temporal adverbial ζ denoting a time t, e^{α} is such that $e^{\alpha} \prec n$, and e^{α} is explicitly indicated in α as being such that $t^{\zeta} \prec e^{\alpha}$

or

(ii) α is connected to some segment β and $[e^{\alpha} \prec n \wedge e^{\beta} \prec n]$ and $e^{\beta} \prec e^{\alpha}$.

Consider the following narrative sequences.

(2.64) John stood up. Bill greeted him.
(2.65) Bill greeted John. John had stood up.
(2.66) John had stood up. Bill greeted him.
(2.67) John stood up. Bill would greet him.

We remarked above that our interpretational constraint τ-TEMP, which was meant to capture the status of *narration* the relation which would be inferred as a default between two constituents only did half the job, since an inference of *narration* would also entail the inference of a what A&L call a "common topic." Below is a constraint which will do the other half of that job.

+-TOPIC: Where two constituents α and β are such that $\langle +, \alpha, \beta \rangle$,
interpret α and β as having a common topic.

It is our belief that of the discourses in (2.64) through (2.67), only one of these will be interpreted as having a common topic, namely (2.64). For we believe that, for example, a discourse like (2.67) will be interpreted as an expression in which the 'main point' is the standing-up event and that the greeting event described in that discourse is more or less being placed in the background (we are not using this term in the sense of a discourse relation here.) Similarly, we think that (2.65) and (2.66) both have the effect of marginalizing the standing-up event and that a speaker who uttered one of these discourses could be said to be focusing on a description of the greeting. We propose the following interpretational constraints along this line.

TOPICSHIFT: Where α and β are constituents and $\langle \tau, \alpha, \beta \rangle$ and $e^{\beta} \prec e^{\alpha}$,
interpret α as the discourse topic.

TOPICMARK: Where α and β are constituents and $\langle \tau, \alpha, \beta \rangle$ and $e^{\alpha} \prec e^{\beta}$, then,
if α uses a compound tense construction, interpret β as the discourse topic.
if β uses a compound tense construction, interpret α as the discourse topic.

Admittedly, these effects are perhaps least noticeable when one considers cases of *narration*, but we detect a strong partiality for two of the three sequences below and believe that two are optimal, while the other is suboptimal.

(2.68) John was struck by lightning. He died.
(2.69) John died. He was struck by lightning.
(2.70) John died. He had been struck by lightning.

We think that, if John's death is the topic of the discourse, then (2.69) and (2.70) are preferable to (2.68). Further, we could force the generation of these two, given the complicit power of +-TOPIC and BIDIRECT on the grounds that (2.68) will be interpreted as a discourse in which there is a common topic. Suppose the interpretational regimen (of soft constraints) looks as follows.

+-TOPIC = TOPICMARK = TOPICSHIFT >> CONSISTENT >> τ-TEMP

We rank TOPICMARK and TOPICSHIFT above CONSISTENT, as it is stipulated in the criteria for *elaboration* that to infer *elaboration*, one must infer that the elaborative segment is the topic of the segment it elaborates; we believe this inference may potentially be overridden.

The name of the constraint TOPICMARK is no accident for, on the generative side, following the line of Nilsenová [Nils00], we believe that economy considerations come into play in the decision of whether or not compound tenses are used and that, in some sense, a tense like the pluperfect is rightly seen as "...a marked form of expressing past." [*Ibid.* abstract] and that it is employed only at the cost of compromising speaker effort. We will present some convincing evidence for this shortly.

ECON: Do not use compound tenses

Where we write ^{T}[AB] we take this to mean that A and B have a common topic. Where we write [^{T}AB], we mean that A is the discourse topic and where we write [A ^{T}B], we mean that B is the discourse topic. Below is a tableau in which (2.67) is evaluated from an interpretational standpoint. We will omit candidates that violate hard constraints and leave out consideration of cue words for lack of space.

[John stood up Bill would greet him]	TOPICMARK	+-TOPIC
$^{T}[\text{greeted}(j, b)_e^{\alpha} \wedge \text{stood-up}(b)_e^{\beta}] \wedge e^{\alpha} \prec e^{\beta}$	*!	
$^{T}\text{greeted}(j, b)_e^{\alpha} \wedge \text{stood-up}(b)_e^{\beta} \wedge e^{\alpha} \prec e^{\beta}$	*!	*
$\text{greeted}(j, b)_e^{\alpha} \wedge {}^{T}\text{stood-up}(b)_e^{\beta} \wedge e^{\alpha} \prec e^{\beta}$ ☜		*

Given these results, we get the following outcome from a generative point of view.

	$\text{greeted}(j, b)_e^{\alpha} \wedge {}^{T}\text{stood-up}(b)_e^{\beta} \wedge e^{\alpha} \prec e^{\beta}$	BIDIRECT	ECON
	☞ [John greeted Bill Bill stood up]	*!	
	☞ [Bill stood up John greeted him]	*!	
✌	[John had greeted Bill Bill stood up] ☜		*
✌	[Bill stood up John had greeted him] ☜		*
	[John greeted Bill Bill would stand up]	*!	*

The first candidate violates BIDIRECT by virtue of the fact that the optimal interpretation for this sequence is one which involves a common topic. The second candidate violates BIDIRECT because the optimal interpretation for that discourse is one which involves a standing-up event followed by a greeting event. The final candidate violates BIDIRECT, as it will be interpreted as being such that the event $greeted(j, b)_e^{\alpha}$ is the discourse topic.

Next we consider a case other than *narration*.

	pushed(j, b)$_e^{\alpha}$ ∧ ^{T}fell(b)$_e^{\beta}$ ∧ e^{α} ∧ e^{β}	BIDIRECT	ECON
	☞ [John pushed Bill Bill fell]	*!	
✌	☞ [Bill fell John pushed him] ☜		
	[John had pushed Bill Bill fell] ☜		*!
	[Bill fell John had pushed him] ☜		*!
	[John pushed Bill Bill would fall]	*!	*
	[John had pushed Bill Bill would fall]	*!	**

The first, third, and final candidates all violate BIDIRECT for the same reasons their counterparts in the tableau for the *narration* case above did. However, it is no longer the case that the second candidate which exhibits a reversal of discursive order sans the employment of compound tenses may be expected to be misinterpreted; due to the force of the *Push Causal Law*, this sequence will get the correct temporal interpretation. The problem: these results are wrong, for we judge the candidate [*Bill fell John had pushed him*] to be acceptable. Before we go on to say what can be done about this, it will be helpful to consider the a similar type of case – a cause effect sequence for which the result is the discourse topic – for which we would actually want to get exactly the type of results we have above. From there, the sole difference between the two cases will give us the appropriate clues to eliminate the unwanted results above. Recall our semi-formal statement meant to represent an indefeasible law in the knowledge base of a hearer that dead individuals do not perform actions such as walking, sleeping, jumping, or having car accidents subsequent to their deaths.

Informal Axiom on Death:
$\exists x\ \text{died}(x)_e^{\alpha} \rightarrow [(\text{arrived}(x)_e^{\beta} \vee \ldots \vee \text{yelled}(x)_e^{\beta} \wedge \langle +, \alpha, \beta\rangle \vee \langle +, \beta, \alpha\rangle) \rightarrow e^{\beta} \prec e^{\alpha})]$

Further, suppose we have the following defeasible law at out disposal too.

Lightning Law: $\exists x\ \text{was-struck-by-lightning}(x)_e^{\alpha} \wedge \text{died}(x)_e^{\beta} \wedge (\langle +, \alpha, \beta\rangle \vee \langle +, \alpha, \beta\rangle) \rightarrow \text{cause}(e^{\alpha}, e^{\beta})$

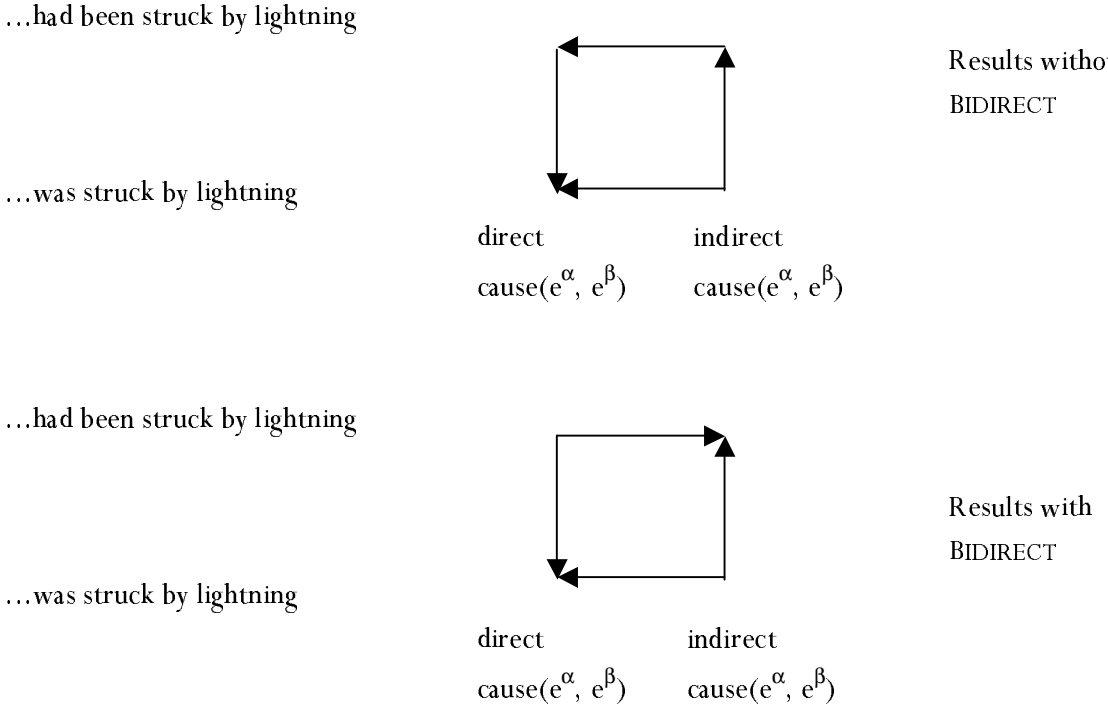
Consider the following tableau.

	pushed(j, b)$_e^{\alpha}$ ∧ ^{T}fell(b)$_e^{\beta}$ ∧ e^{α} ∧ e^{β}	BIDIRECT	ECON
	☞ [John was struck by lightning He died]	*!	
✌	[John died He was struck by lightning] ☜		
	[John had been struck by lightning He died] ☜		*!
	[John died He had been struck by lightning] ☜		*!
	[John was struck by lightning He would die]	*!	*
	[He had been struck by lightning He would die]	*!	**

We believe that these results are appropriate. Note also that the form [*John died He had been struck by lightning*] gives us rather nice example of the type of candidate that would effect a violation of BIDIRECT$^{\text{INTERP}}$:
$\neg\exists F^{*}\ (M \trianglerighteq F^{*} \wedge F^{*} \trianglerighteq M \wedge \neg M \trianglerighteq F)$.

	[John died He had been struck by lightning]	BIDIRECT	CONSISTENT
	was-struck-by-lightning(j)$_e^{\alpha}$ ∧ ^{T}died(j)$_e^{\beta}$ ∧ $e^{\alpha} \prec e^{\beta}$ ∧ direct-cause(e^{α}, e^{β}) ☜	*!	
✌	☞ was-struck-by-lightning(j)$_e^{\alpha}$ ∧ ^{T}died(j)$_e^{\beta}$ ∧ $e^{\alpha} \prec e^{\beta}$ ∧ indirect-cause(e^{α}, e^{β}) ☜		*

The form F under consideration is an optimal form – under all constraints except BIDIRECT – given the second candidate meaning M, furthermore, for the only other candidate meaning (call it M′) , there is another form F′ such that M′⊵F′ & F′⊵M′ and ¬M′⊵F. Thus, even if we suppose that the cause relation normally inferred by a hearer via the *Lightning Law* is a relation of *direct* cause – and that inferring an indirect cause is a violation of the constraint CONSISTENT – this form is not interpreted a describing a direct-cause/effect sequence. Rather, because the interpretational procedure detects, via BIDIRECT, that the form is suboptimally produced, another meaning is taken as optimal. This case is analogous to the classic kill/cause-to-die case, an instance of so-called *partial blocking* cited by Blutner [Blutner00] which inspired his formulation of superoptimality discussed at length in section 1.



We think that this result is intuitive since we believe that a form like */John died He had been struck by lightning/* is very unlikely to be interpreted as a case where John was struck by lightning and killed immediately after the being struck.

The only question left to ask is why there is a difference between the push/fall case and the car-accident/die case exists. We are again sympathetic with a line taken in Nilsenová, [Nils00] that the difference between defeasibility and indefeasibility in causal laws in the knowledge base plays a significant role in the licensing of compound tenses. We need to formulate a constraint that will reflect this, specifically, one which will compete with ECON and demand that, where discursive order has been reversed, a compound tense must be employed to explicitly indicate the temporal order of events described in the discourse. Such a constraint, if ranked equally

with ECON, will grant us the optionality we are looking for with regard to the push/fall example. We will call the constraint MARK⇔SWITCH.

MARK⇔SWITCH: Employ a pluperfect construction in β if and only if $\langle \tau, \alpha, \beta \rangle$ and $e^{\beta} \prec n$ and $e^{\alpha} \prec n$ and $e^{\alpha} \prec e^{\beta}$ and there is no indefeasible law such that $\Box \langle \tau, \alpha, \beta \rangle \neg e^{\alpha} \prec e^{\beta}$

Supposing: BIDIRECT >> MARK⇔SWITCH = ECON, we have:

	pushed(j, b)$_e^{\alpha}$ ∧ ^{T}fell(b)$_e^{\beta}$ ∧ $e^{\alpha} \prec e^{\beta}$	BIDIRECT	MARK⇔SWITCH	ECON
✌	[John pushed Bill Bill fell]	*!		
	☞ [Bill fell John pushed him] ☜		*	
	[John had pushed Bill Bill fell] ☜		*	*!
✌	☞ [Bill fell John had pushed him] ☜			*
	☞ [John pushed Bill Bill would fall]	*!		*

We believe that these are desirable results.

We note finally that there is no real trick involved in guaranteeing that the generative procedure will curtail inferences that do not belong. As we mentioned above, it is imaginable that pushing and falling events could occur that did not stand in a causal relationship with one another. We do not think it is necessary to represent in the form of a tableau that words like *unrelatedly* or *coincidentally* (we might call these *un*-cue words) could be used for these cases, as well as just about any other statement to the which cued a hearer to drop the inference he would normally draw. Where such action was not taken, the speaker would violate the BIDIRECT constraint.

3.0 Loose Ends

Before concluding, we wish to address a few final matters regarding the optimization strategies that have been the subject of our investigation so far. In the next subsection, we will address an issue that we left open in section 1, namely the ability for default information in the lexicon to override the default syntactic strategy we proposed for the resolution and generation of anaphora. We will propose a fairly straightforward way of incorporating the observations made in section 2 regarding the role of world-knowledge in interpretation into our constraint-based analysis of pronominal substitution. Finally, we reserve the latter half of the present section to make some remarks about some of the weaknesses present in the analysis we have outlined and to make a few remarks about approaches to the generation problem that we have not explored, some of which will be nothing more than our personal feelings about these approaches, which we will have to leave more or less undefended.

3.1 Anaphora and the Lexicon

In the introduction to section 1, we pointed out a challenge to any system, whether it is generative or related to resolution, that is based on syntactic circumstances of the discourse. We said that any theory whose notion of salience was defined directly or indirectly in terms of canonical configurations would most likely predict incorrect results for the discourses below.

(1.1) John pushed Bill. He fell
(1.2) Mary gave Jane a dollar. She spent it on candy.
(1.3) A raindrop hit a book. It got wet.

As is emphasized above, bases of world-knowledge and linguistic knowledge play crucial roles in A&L's theory of how discourse relations between constituents are computed. One postulate was the existence of a defeasible *Push Causal Law*, in the base of world-knowledge (roughly: where a pushing event occurs and a falling event subsequently occurs, the former normally causes the latter). We saw how such a postulate would allow the a hearer to infer that, in a sequence like *Bill fell John pushed him*, the temporal order of the events described in the two sentences that make up that discourse is the opposite of the order in which they are presented. We believe an intuition similar to this – perhaps a defeasible law in the world-knowledge base stating that where a pushing event takes place between a pusher and a pushee, and a falling event subsequently occurs, it may be non-monotonically inferred that not only did the pushing event cause the falling event, but also that the pushee is the one who did the falling – may be exploited for the purposes of funding a resolution procedure that will conclude that the pronoun *He* in (1.1) corefers with the name *Bill*, not *John*. Allowance for world-knowledge to override the default strategy based on the canonical position of nominal constituents is a feature that Beaver's analysis, and the analysis we have presented so far, lacks. We could easily postulate other maxims in the world-knowledge base of a hypothetical hearer such as a *raindrops-are-wet* rule as well as a linguistic information which, in effect, stated that objects that possess a property (e.g., wetness) cannot be said to acquire that property and that in order to spend something, one must possess that thing, and what one gives away, one no longer possesses, and this move would give us sufficient default information to ensure that there is only one resolution possibility for each of the other two discourses above.

As it stands, the generative results for (1.1) look as below.

	/John pushed Bill John fell/	BIDIRECT	MARK⇔ PAR	MARK⇔ SHIFT	ECON	PRON⇔ TOP
	[John pushed Bill John fell] ☜		*	*	*	*
✌	☞ [John pushed Bill He fell] ☜					
	[John pushed Bill HE fell]	*!	*	*	*	

	/John pushed Bill Bill fell/	BIDIRECT	MARK⇔ PAR	MARK⇔ SHIFT	ECON	PRON⇔ TOP
	[John pushed Bill Bill fell] ☜		*		*	
✌	☞ [John pushed Bill He fell]	*!		*		*
	[John pushed Bill HE fell] ☜		*		*	*!

We propose solve the problem by encoding more pieces of default information into certain elements in the lexicon. The default information can be information corresponding to world-knowledge about the denotation of the lexical item itself, for example, for the noun *raindrop*, we will stipulate indefeasible rules in the lexicon to the effect that anything that is raindrop is liquid, anything liquid is wet, and that anything that has a property cannot be said to acquire that property. Information possessed by a lexical item may also be related to potential discourse relations holding between the constituent containing that item and another constituent of a certain type. For example, we could extend the *Push Causal Law* to state that where a pushing event takes place between a pusher and a pushee, and a falling event subsequently occurs, it may be inferred that not only did the pushing event cause the falling event – an inference that is afforded to us by the current version of that law – but also that the *pushee* is the one who did the falling.[31]

Raindrop Axiom: $\Box\forall x(\text{raindrop}(x) \rightarrow \text{liquid}(x))$

Liquid Law: $\Box\forall x(\text{liquid}(x) \rightarrow \text{wet}(x))$

Condition on Acquisition: $\forall P\forall x(Px \rightarrow \neg\Diamond(x \text{ acquire } P))$

Pushees Fall Law: $\exists xyz([\text{push}(x, y)_e^{\alpha} \wedge \text{fell}(z)_e^{\beta} \wedge \langle +, \alpha, \beta\rangle \wedge \text{cause}(e^{\alpha}, e^{\beta})] \rightsquigarrow z = y)$

The default information we stipulate to be in the lexical knowledge base will in turn be the subject of the interpretational constraint, CONSISTENT, that we proposed above. It will demand that when a pronoun must be resolved, the resolution must be such that it is consistent with default information in the lexical knowledge base. In relation to the other constraints that applied to anaphora resolution, we will rank CONSISTENT between FAMDEF and BIDIRECT.

FAMDEF >> CONSISTENT >> BIDIRECT$^{\text{INTERP}}$ >> MARK⇔SHIFT >> PRON⇔TOP

[31] There are two versions of A&L's *Push Causal Law*. One states that where a pushing event precedes a falling event, the former normally caused the latter; the other states that where an x pushing y event preceded a y falling event, the former normally caused the latter. The defeasible law we are suggesting here is more or less a combination of those two laws, for we are taking one conjunct from the conjunctive antecedent of the more specific version (...and y fell) of the law and replacing it with a conjunct from the antecedent of the less specific version, (and someone fell), allowing the specific material that was taken out of the more specific antecedent to instead be inferred. This new law could be said to fall somewhere between A&L's *Push Causal Law* and the ideas used in the formulation of Dahlgren's probabilistic laws [Dahlgren88], whereby, roughly, pushings usually cause fallings. A&L argue against the latter type of law, calling them "far fetched" on the basis of the fact that "plenty of pushings don't cause fallings; and ...plenty of fallings ...cause pushings."(p4[A&L93b]) We note that our proposed defeasible law would not be overridden by a pushing event that did not cause a falling event, but only by those cases in which x pushing y was followed by x falling. It is our feeling that, in the absence of explicit information to the contrary, to 'fetch' the inference that where a pushing event is followed by a falling event, the one who was pushed is the one who fell, one would not have to travel very far at all.

[John pushed Bill He fell]	CONSISTENT	MARK⇔SHIFT	PRON⇔TOP
/he = John/	*!		
/he = Bill/ ☜		*	*

[John pushed Bill HE fell]	CONSISTENT	MARK⇔SHIFT	PRON⇔TOP
/he = John/	*!	*	
/he = Bill/ ☜			*

[John pushed Bill John fell]	FAMDEF	CONSISTENT	MARK⇔SHIFT	PRON⇔TOP
/John = John/ ☜		*	*	*
/John ≠ John/	*!			

Given the influence of CONSISTENT on the interpretation strategy, we will harvest different results from a generative standpoint, both when generating sequences that override default information in the lexical knowledge base (e.g., *John pushed Bill John fell*) and generating sequences that adhere to those laws (e.g., *John pushed Bill Bill fell*). The reason the interpretational constraint has an effect on the generative procedure is, of course, due to the generative constraint BIDIRECT. We have:

	/John pushed Bill John fell/	BIDIRECT	MARK⇔ PAR	MARK⇔ SHIFT	ECON	PRON⇔ TOP
✌	☞ [John pushed Bill John fell] ☜		*	*	*	*
	☞ [John pushed Bill He fell]	*!				
	[John pushed Bill HE fell]	*!	*	*	*	

	/John pushed Bill Bill fell/	BIDIRECT	MARK⇔ PAR	MARK⇔ SHIFT	ECON	PRON⇔ TOP
✌	☞ [John pushed Bill Bill fell] ☜		*		*	*
✌	☞ [John pushed Bill He fell] ☜			*		
	[John pushed Bill HE fell] ☜		*		*	*!

These are the results we are looking for. Hopefully it is clear that analogous results would be effected for the other two examples above (with the exception of the fact that the raindrop case would violate the interpretational constraint COHERENT, as opposed to CONSISTENT, though the results on the generative side would look the same.) The constraint BIDIRECT has does a good deal of work our generative procedure. The above is simply an extension of that account in that we allow facts about an interpreter's world-knowledge-governed tendencies to play a role in the generative procedure for anaphora in the same intuitive way that we did for the generative strategy related to discursive order, discursive connection, and tense.

3.2 Loose Ends Left Untied

The present subsection will serve no other purpose than to point out some shortcomings of the program above and to engage in some speculation about the general picture that surrounds that program.

(3.1) John knows a man. He is a doctor.
(3.2) A man knows John. He is a doctor.

According to both Beaver's account, and our own, the discourse (3.1), is predicted to provide information that John is a doctor. This is intuitively not the correct result, yet we cannot solve the problem by looking to world-knowledge or lexical knowledge and hoping that it will reverse the unfortunate result, as there is certainly no information that we would wish to speculate lies in the world-knowledge base or in the domain of lexical knowledge possessed by the average language user to the effect that people named John are not doctors. In fact, it seems to us that even if there were, one would have to choke quite hard on such a sentence before he could actually interpret it.

(3.3a) ??John knows a bachelor. He's married.
(3.3b) John knows a bachelor. HE's married.

Depending on who the speaker was in a case like this, we might be just as likely, if not more so, to believe the discourse in (3.3a) was a contradiction than to believe it was a statement about John's marital status. We see very little promise for the possibility that a syntactic solution could be provided for this puzzle, though, based on the evidence below, it would appear that the reason we cannot resolve the pronoun *He* in (3.3a) as referring to John is due to some fact about discursive coherence. Consider the following sequences.

(3.4) John knows a woman. She has red hair.
(3.5) A woman knows John. She has red hair.
(3.6) # John knows a woman. He has red hair.
(3.7) # A woman knows John. He has red hair.

We claim that the first two discourses are acceptable, i.e., coherent. And while neither A&L nor we have said what discourse relation it is that could be said to hold between their respective constituents, we believe such a relation is present. Further, we believe that such a relation (perhaps, naively, we could give it a name like "description") is conspicuously absent from the latter two sequences. We find this discrepancy odd. For there seems to be no more of a relation holding between the woman having red hair and John's knowing her (or her knowing him) than there is holding between the two individuals knowing each other and *him* having red hair. Asher's notion of "common topic" does not seem to get very far here, for we cannot imagine why an 'umbrella of aboutness' could be present above two of these discourse while the other two are left standing in the rain of incoherence, for if the first two discourses are respectively 'about' a woman John knows and about a woman who knows John, then why can latter two discourses not be about John? There is arguably some type of issue related to *relevance* that effects the discrepancies in these examples. Intuitively, one does not introduce a

quantified phrase to a discourse – especially one of which no other information is provided other than the fact that the entity denoted by the phrase stands in an acquaintance relation with something else – if he is not going to provide any more information about it later. The analysis we have presented above lacks any explanation for this and it is an area of further research whose results almost any conceivable program for anaphora resolution would need to necessarily have at its disposal if it hoped to meet any success both in terms of descriptive adequacy and in terms of its exploitability for an accompanying generative strategy.

Another serious challenge for the account we have given is that we have stipulated generative constraints – and religiously referred to these constraints as "economy-related" – that seem to have no relation at all to "speaker economy", e.g., MARK⇐⇒SHIFT. We would be hard-pressed to come up with an argument for why MARK⇐⇒SHIFT could be said to be in accordance with the so-called I-principle. After all, when a speaker utters a pair of sentences like *John kissed Mary Mary slapped him*, he seems to be going out of his way to say more than he needs to, even though – assuming that it is true that a speaker has some knowledge of an interpreter's resolution procedure and is aware that a hearer will never violate the AGREE constraint – he is certain that the pronoun *She*, appropriately employed, would never be misinterpreted. We have apparently not displayed much cleverness in our formulation of the constraint-regimen here and there is obviously a great difference between proposing a constraint-based account that is descriptively adequate for a set of data and proposing one that describes what is *really* going on. Our attempt in section 1 and the extension of that attempt in the current section, if we are charitable, has done the former, but certainly not the latter.

We have assumed without citing any justification – and the assumption is a popular one – that a pronoun is really a more economical form compared to, say, a proper name. Can we justify such an assumption? There is obviously one way that this assumption *cannot* be justified, and that would be an appeal related to the *articulatory* economy of the speaker. Names like *Bo* and *Mao* and mass nouns like *tea* are among the most economical utterances one could imagine in terms of articulation. Levinson [Lev85] has proposed to explain the preference for anaphoric reduction in terms of an informativity-related economy, and this is indeed in the spirit of the I-principle discussed above. We think that even this argument stands on shaky ground, for an utterance's informativity is determined by the information it adds to a discursive context. Therefore, if the – to use a popular term – *context change potential* of a pair of sentences like *John walks in the park He whistles* and a pair like *John walks in the park John whistles* is identical, then one pair is no more informative than the other, since the hearer will interpret *John* and *He* in the same way. (Current theories of semantic representation such as the Dynamic Predicate Logic of Groenedijk and Stokhof drive this point home, as they represent the *He* in the first pair as a *bound* variable.) Furthermore, it should be clear that arguments along the lines of Levinson's would be simply groundless as a means of explaining why *intrasentential* anaphora are used. To our knowledge not a language has been found that does not exhibit Binding Principles, which govern, for example, when reflexive pronouns may and must be used. One would imagine that such principles and the syntactic patterns that are effected by them showed up at some point in the evolution of linguistic behavior; they were not just there from the start. If we ask ourselves *why* such principles would come into being and why languages that do not have them are as common in the contemporary world as dinosaurs, it would seem absurd to claim that speaker economy is what motivated their genesis. A sentence like *Kay loves herself* is not only nowhere near as economical in terms of articulation as the sentence *Kay loves Kay*, but it is also not saving the speaker any degree

of informativeness – he is being as informative as he could possibly be. One would guess that the only answer left was that these principles came into being in the interest of communicative accuracy, i.e., for the hearer's sake. If we accept this, then the argument that transentential anaphora are used in the interest of economy seems odd. For why, once we crossed the sentence boundary, would the motivation for the employment of pronouns be *reversed*? We are left to wonder whether there is even such a thing as speaker economy and, if so, what resource these economic tendencies actually incline a speaker to conserve.

A proposal that speakers use pronouns for a *hearer's* sake, and not for their own would mesh well with the sentiments we have expressed above regarding the precedence of interpretational considerations to generative constraints. Furthermore, such a proposal would not be as far from the mainstream as it might seem. The interpretational constraint PRINCIPLEB of Hendriks and de Hoop, states that discourse entities that are co-arguments of a semantic relation which are not marked as being identical must be interpreted as being distinct. We could imagine that such a constraint could be universalized so that any two arguments that were not marked as identical would be interpreted as being distinct, of course this would be tempered by other constraints. The effect of a constraint like this on the generative side – given a constraint like our BIDIRECT – would have the same effect as (half of) our ECON, but it would be the *interpretational* constraint forcing the pronominalization, not a generative constraint. It is almost certainly the case that the constraints AGREE and DISJOINT that we heralded as reversible constraints above are in fact not generative constraints at all (certainly there is no *economy* to be found in saying *she* instead of *he* or *he* instead of *himself*) rather, we again are sympathetic to the idea that the reasons such generative decisions are made are related solely to the interests of the hearer, (This proposal is perfectly in agreement with what we have said above for, though we did not explore the possibility, we could easily have removed AGREE, DISJOINT, *REPINDEF, perhaps others from the generative program and gotten exactly the same generative results: all violations of the aforementioned constraints would wind up being violations of BIDIRECT.) The suggestion that a speaker would, in general, use pronouns not by virtue of any economy principle but rather *because he did not wish to be misinterpreted* – i.e., because pronouns help hearers to infer coreference – does not seem outlandish to us, for, while the necessity of resolving pronouns may burden a hearer somewhat, we see no reason why a sentence like *Mary drank tea and Bill spilled tea* would not burden him a great deal more. It is difficult to see which procedure is really making pronominalization necessary. If it were the hearer's interests, and not the speaker's, then the speaker's job would be to look opportunities to *avoid* pronominalization. We lack any strong arguments in one direction or the other, and thus must leave the question open, (though it is perhaps clear in which direction we lean) and our assumption above that economy related concerns have anything to do with the governance a speaker's inclinations to employ functional pronouns will remain undefended and is, perhaps, indefensible.

Conclusion

We have presented an account above of a generative program for discursive order, the use of tenses in discourse, configurations related to sentential connection, and anaphora. We would in no way care to commit ourselves to the proposal that the constraints which constitute that account have recognizable counterparts in human cognition related to linguistic production, rather we would prefer that they may be viewed as branches of descriptively motivated speculation growing out of more theoretically oriented roots. We hope to have made a case about where those roots – the roots of linguistic generation – are planted. The proposals of Horn, Atlas and Levinson, and Blutner et al., to the effect that interpretational and generative behavior are inexorably linked is a claim which we find indisputable. However, we believe that there is no justification for the claim that this link between linguistic production and linguistic comprehension manifests itself in the form of a *symmetrical* relationship between speaker and hearer. Rather, we believe that the interdependence of interpretational procedures and generative strategies is fundamentally *asymmetrical* and that the latter's reliance on the former is, in some sense, unbounded, while the former's reliance on the latter is, in many ways, incidental. While we are in agreement with the proposals of Horn et al. that a "division of pragmatic labour" exists between the participants in a conversational situation, we believe that this division is often patently unequal and that successful communication itself may not take place until the individual on the production end of that communication has done his share of that labor, a share which is often greater than that of his interlocutor. Assuming that the purpose of linguistic production is to convey information – and to do so accurately – linguistic output that is produced without honoring the interpretational needs of an interlocutor will never serve its purpose. The account we have given reflects this observation exactly, for on this account, an output that does not serve its sole purpose will, by definition, never be an optimal one.

Acknowledgements

The majority of this manuscript was prepared at Humboldt University in Berlin in November and December of 2000. Many thanks to Anton Benz and, in particular, Reinhard Blutner for their generosity in permitting me to use the facilities during my stay there. Special thanks to Reinhard for his helpful comments on some earlier versions of the paper.

I owe a tremendous debt of gratitude to my advisor, Henk Zeevat, not only for his guidance during the preparation of the thesis but also, along with Dejuan Wang, for selfless hospitality and kindness during my final months in Amsterdam in the autumn of this year.

Thanks to Susan Eldred, who has provided many forms of support over the last year.

Thanks to Dagmar and Reinhard Langhoff, and especially Volker Langhoff for their kindness and wonderful company in Berlin, and to Christine Maier for the same.

Thanks to Jim Levey, for having been the best friend a boy could have.

Thanks to Jo & Marjam & Khadisha for being the best friends a man could have.

References

[Aissen99] J. Aissen. *Markedness and Subject Choice in Optimality Theory*. Natural Language and Linguistic Theory, 17, pp 673-711, 1999.

[A&L98] N. Asher and A. Lascarides. *Bridging*. Journal of Semantics, 15.1, pp 83-113, Oxford University Press, 1998.

[A&L93a] N. Asher and A. Lascarides. *A Semantics and Pragmatics for the Pluperfect*, Proceedings of the European Chapter of the Association for Computational Linguistics (EACL93), pp 250-259, Utrecht, 1993.

[A&L93b] N. Asher and A. Lascarides. *Temporal Interpretation, Discourse Relations and Commonsense Entailment*. Linguistics and Philosophy, 16.5, pp 437-493, Kluwer Academic Publishers, Dordrecht, 1993.

[A&L96] N. Asher and A. Lascarides. *Lexical Disambiguation in a Discourse Context*. Lexical Semantics: The Problem of Polysemy, J. Pustejovsky and B. Boguraev (eds.), Clarendon, Oxford, 1996.

[Asher93] N. Asher. *Reference to Abstract Objects in English: A Philosophical Semantics for Natural Language Metaphysics*. Kluwer Academic Publishers, Dordrecht, 1993.

[At&Lev81] J. Atlas and S. Levinson. *It-Clefts, Informativeness and Logical Form*. Radical Pragmatics, P. Cole (ed.), New York, AP, 1981.

[B&L92] P. Blackburn and A. Lascarides. *Sorts and Operators for Temporal Semantics*. Proceedings of the Fourth Symposium on Logic and Language, Budapest, 1992.

[Benz00] A. Benz. *Chains and the Common Ground*. Forthcoming, Berlin, 2000.

[Beaver00] D. Beaver. *Centering and the Optimization of Discourse*. Manuscript, Stanford, 2000.

[Blutner00] R. Blutner. *Some Aspects of Optimality in Natural Language Interpretation*. Technical Report, Humboldt Universität, Berlin, 2000.

[Bresnan99] J. Bresnan. *The Emergence of the Unmarked Pronoun*. Optimality Theoretic Syntax, J. Grimshaw, G. Legendre, S. Vikner (eds.), MIT Press, 1999.

[Büring99] D. Büring. *Topic*. Focus: Linguistic, Cognitive, and Computational Perspectives, Bosch, Peter and Rob van der Sandt (eds.), Cambridge University Press, 1999.

[C&S92] M. Caenepeel and G. Sandström. *A Discourse-level Approach to the Past Perfect in the Narrative.* Proceedings of the Fourth International Workshop on the Semantics of Time, Space, and Movement in Temporal Reasoning, Toulouse, 1992.

[Chi95] G. Chierchia. *The Dynamics of Meaning: Anaphora, Presupposition, and the Theory of Grammar.* University of Chicago Press, 1995.

[Dahlgren88] K. Dahlgren. *Naive Semantics for Natural Language Understanding.* Kluwer Academic Publishers, Dordrecht, 1988.

[D&H95] P. Dekker and H. Hendriks. *Links without Locations: Information Packaging and Non-Monotone Anaphora.* Proceedings of the Tenth Amstedam Colloquium, pp 339-358, Universiteit van Amsterdam/ILLC, 1995.

[Dekker00] P. Dekker. *Meaning and Use of Indefinite Expressions.* Journal of Logic, Language and Information, 9, 2000.

[G&J&W83] B. Grosz, A. Joshi, and S. Weinstein. *Providing a Unified Account of Definite Noun Phrases in Discourse.* Proceedings of the 21st Annual Meeting of the Association for Computational Linguistics, pp 44-49, ACL, Cambridge, MA, 1983.

[G&J&W95] B. Grosz, A. Joshi, and S. Weinstein. *Centering: A Framework for Modeling the Local Coherence of Discourse.* Computational Linguistics, 21(2): pp 203-226, 1995.

[G&S91] J. Groenendijk and M. Stokhof. Dynamic Predicate Logic. Linguistics and Philosophy, 14, pp 39-100, 1991.

[G&S&V96] J. Groenendijk, M. Stokhof, and F. Veltman. *Coreference and Modality.* The Handbook of Contemporary Semantic Theory, S. Lappin (ed), pp 179-216, Blackwell, Oxford, 1996.

[Grice75] H. P. Grice. *Logic and Conversation.* In Syntax and Semantics, Volume 3: Speech Acts. P. Cole and J. L. Morgan, (eds), pp 41-58. New York Academic Press, 1975.

[H&H00] P. Hendriks and H. De Hoop. *Optimality Theoretic Semantics.* Linguistics and Philosophy, to appear.

[HLMMP92] E. Hovy, J. Lavid, E. Maier, V. Mittal, and C.Paris. *Employing Knowledge Resources in a New Text Planner Architecture.* Aspects of Automated Natural Language Generation R. Dale, E. Hovy, D. Rösner, O. Stock (eds), Springer Verlag Lecture Notes in AI no. 587 pp 57-72 Heidelberg, 1992.

[H&S86] J. Halpern and Y. Shoham. *A Propositional Modal Logic of Time Intervals*. Proceedings of the First IEEE Symposium on Logic and Computer Science, Cambridge MA, Computer Society Press, Washington, pp 279-292, 1986.

[Heim82] I. Heim. *The Semantics of Definite and Indefinite Noun Phrases*. PhD Dissertation, University of Massachusets, Amherst, 1982.

[Horn84] L. Horn. *Towards a New Taxonomy for Pragmatic Inference: Q-based and R-Based Implicatures*. Meaning, Form, and Use in Context, pp 11-42 (D. Schiffrin (ed), Georgetown University Press, Washington, 1984.

[Hornst90] N. Hornstein. *As Time Goes By*. MIT Press, Cambridge, Massachusetts, 1990.

[Jäger00] G. Jäger. *Some Notes on the Formal Properties of Bidirectional Optimality Theory*. Manuscript, ZAS, Berlin, 2000.

[K&R93] H. Kamp and U. Reyle. *From Discourse to Logic: Introduction to Model_theoretic Semantics of Natural Language, Formal Logic and Discourse Representation Theory*. Kluwer Academic Publishers Dordrecht, 1993.

[Kamp91] H. Kamp. *The Perfect and Other Tenses in French and English*. Tense and Aspect in English and French, H. Kamp (ed.), DYANA deliverable 2.3B, 1991.

[Las&Ob92] A. Lascarides and J. Oberlander. *Preventing False Temporal Implicatures: Interactive Defaults for Text Generation*. Proceedings of COLING92, pp 721-727, Nantes, 1992.

[Lev85] S. Levinson. *Minimization and Conversational Inference*. The Pragmatic Perspective: Selected Papers from the International Pragmatics Conference, M. Papi and J. Verscheuren (eds.), pp 61-129, John Benjamin, Amsterdam/Philadelphia, 1985.

[M&S88] M. Moens and M. Steedman. *Temporal Ontlogy and Temporal Reference*. Computational Linguistics, 14, pp 15-28, 1988.

[M&T87] W. Mann and S. Thompson. *Rhetorical Structure Theory: A Framework for the Analysis of Texts*. IPRA Papers in Pragmatics, 1, pp 79-105, 1987.

[M&T88] W. Mann and S. Thompson. *Rhetorical Structure Theory: Toward a Functional Theory of Text Organization*. Text 8(3), pp 243-281, 1988.

[Nils00] M. Nilsenová. *Optimal Interpretation of Tense in Discourse*. Conference on Optimal Interpretations of Words and Constituents, Utrecht, 2000.

[P&S93] A. Prince and P. Smolensky. *Optimalty Theory: Constraint Interaction in Generative Grammar*. Technical Report, Rutgers University Center for Cognitive Science, 1993.

[Partee73] B. Partee. *Some Strutural Analogies Between Tenses and Pronouns in English*. Journal of Philosophy 70, pp 601-609, 1973.

[Reich47] H. Reichenbach. *Elements of Symbolic Logic*. MacMillan, New York, 1947.

[Reinhrt82] T. Reinhart. *Pragmatics and Linguistics: An Analysis of Sentence Topics*. Philosophica, 27, pp 53-94, 1982.

[Rooy98] R. van Rooy. *The Specificity of Indefinites*. Budapest Workshop on Indefinites, Budapest, 1998.

[Schwar99] R. Schwarzschild. *Givenness, AvoidF and Other Constraints on the Placement of Accent*. Natural Language Semantics, 7(2), pp 141-177, 1999.

[Smol98] P. Smolensky. *Why Syntax Is Different (but not really). Ineffability, Violability, and Recoverability in Syntax and Phonology*. Stanford University Workshop. 1998.

[Val90] E. Vallduví. *The Informational Component*. PhD. Dissertation, University of Pennsylvania.

[Vikner85] S. Vikner. *Reichenbach Revisited: One, Two, or Three Temporal Relations?* Acta Linguistica Hafniensia, 19, pp 81-98, 1985.