Temporal connectives in a discourse context

Citation for published version:
Lascarides, A & Oberlander, J 1993, Temporal connectives in a discourse context. in Proceedings of the sixth conference on European chapter of the Association for Computational Linguistics. Association for Computational Linguistics, Stroudsburg, PA, USA, pp. 260-268. https://doi.org/10.3115/976744.976775

Digital Object Identifier (DOI):
10.3115/976744.976775

Link:
Link to publication record in Edinburgh Research Explorer

Document Version:
Publisher's PDF, also known as Version of record

Published In:
Proceedings of the sixth conference on European chapter of the Association for Computational Linguistics

General rights
Copyright for the publications made accessible via the Edinburgh Research Explorer is retained by the author(s) and / or other copyright owners and it is a condition of accessing these publications that users recognise and abide by the legal requirements associated with these rights.

Take down policy
The University of Edinburgh has made every reasonable effort to ensure that Edinburgh Research Explorer content complies with UK legislation. If you believe that the public display of this file breaches copyright please contact openaccess@ed.ac.uk providing details, and we will remove access to the work immediately and investigate your claim.
Abstract

We examine the role of temporal connectives in multi-sentence discourse. In certain contexts, sentences containing temporal connectives that are equivalent in temporal structure can fail to be equivalent in terms of discourse coherence. We account for this by offering a novel, formal mechanism for accommodating the presuppositions in temporal subordinate clauses. This mechanism encompasses both accommodation by discourse attachment and accommodation by temporal addition. As such, it offers a precise and systematic model of interactions between presupposed material, discourse context, and the reader's background knowledge. We show how the results of accommodation help to determine a discourse's coherence.

1 Introduction

We focus on aspects of the discourse behaviour of the temporal connectives before, after and when. In particular, we note that discourse context can cause sentences which are equivalent in temporal structure to fail to be equivalent in terms of discourse coherence. We attempt to explain why context can have this effect. The explanation hinges on the differing presuppositions posted by the differing connectives, and on the novel mechanism whereby background knowledge determines how they are accommodated into the discourse structure during interpretation.

2 Temporal Equivalence and Discourse Incoherence

First, then, consider the following actual sequence of states and events: in the UK in November 1992, some right-wing Tory backbench MPs were objecting to government policy over the treaty of Maastricht, and threatened to vote against it; the Prime Minister, a Mr John Major, offered them a variety of concessions to win them back, in what the press termed a "charm offensive"; the MPs responded by voting with the government. Call this course of events $E_1$.

We can combine descriptions of the main eventualities in several ways, to reflect the right temporal structure, but only some of these seem pragmatically appropriate: consider in particular these possible descriptions of $E_1$ involving the connectives before, after and when:

1. The backbenchers were in revolt.
2. a. They were pacified after Major launched a charm offensive.
   b. ?Major launched a charm offensive before they were pacified.
   c. They were pacified when Major launched a charm offensive.
   d. ?Major launched a charm offensive when they were pacified.

There are at least two apparent anomalies, which require explanation. First, one might expect that (2a) and (2b) would be temporally equivalent, both describing $E_1$; why, then, does (2b) apparently lead to discourse incoherence? Secondly, it has been argued that A when B permits many possible temporal relationships between the eventualities denoted by A and B (cf. Moens and Steedman 1988); it's for this reason that (2c) can be interpreted as denoting $E_1$;
but given this permissiveness, why is (2d) not as ac-
ceptable as (2c)?

3 The basic explanation: temporal
presuppositions

The basic explanation for the inappropriateness of
(2b) and (2d) is actually quite simple. Sentences con-
taining temporal connectives are presuppositional: the
temporal clause introduces an eventuality that must be
presupposed to have occurred, for the sentence as a whole
to have a truth-value (cf. Heijmäki 1972; Kartunnen 1973).
If the presupposed eventu-
ality is not already in the reader’s model of the dis-
course context, she must add it: a process known as
accommodation (cf. Lewis 1979). Our view is that
the discourse behaviour of temporal connectives is
to be explained as follows. In the discourse context
where we are describing $E_1$, and have uttered (1),
the way presuppositions are accommodated depends
on the reader’s background knowledge; our inappro-
priate discourses are precisely those where accom-
modation ultimately leads to discourse incoherence.
In particular, the presupposed eventuality from they
were pacified cannot be accommodated in the previ-
ous context provided by (1), and must therefore be
given further treatment.

A presuppositional explanation stands in contrast
to the classical accounts of temporal structure built
upon Kamp’s (1981) Discourse Representation The-
ory (DRT) (cf. Partee 1984; Hinrichs 1986). On both
these accounts, subordinate clauses, such as those
introduced by temporal connectives, update the cur-
rent reference time, and the main clause is then in-
terpreted with respect to that reference time. How-
ever, no constraint is placed on the relationship be-
tween the current reference time, and the new refer-
tence time supplied by the subordinate clause. And
so no anomaly will be detected in (2b): a relation
of temporal progression between (1)’s reference time
and the new reference time for they were pacified will
be added to the DRS. Thus, the incoherence of (2b)
in the discourse context supplied by (1) remains un-
explained. This is only to be expected, since the
construction of discourse representation structures is
syntax-driven, and does not attempt to capture the
interactions with world knowledge which seem rele-
vant here.

So, although it promises to go further, the ba-
sic presuppositional explanation raises deeper ques-
tions. Why can’t they were pacified be accommo-
dated into the discourse context provided by (1)?
What knowledge is it that leads to failure in this
case, but success when we try to accommodate Ma-


dor launched a charm offensive? Intuitively, the
reader’s background knowledge affects accommodation:
world knowledge (WK) and pragmatic maxims can make accommodation impossible.1 So to make

1Background knowledge is also essential to the expla-
the basic explanation precise, we need a formal the-
ory of how such knowledge constrains accommoda-

Van der Sandt and Geurts (1991) provide a formal
mechanism for presupposition accommodation in
DRT, but they provide only informal heuristics that
stipulate how background knowledge might affect the
process. We extend their ideas, by providing a for-
mal specification of those heuristics. We embed their
account of accommodation in DICE (Discourse and
Commonsense Entailment) (Lascarides and Asher
1991, 1993; Lascarides et al 1992). DICE permits us
to model the interactions between linguistic knowl-
edge (Lk) and WK which lead to the assignment of
discourse coherence relations between propositions
introduced by text segments, and temporal-causal
relations between the eventualities they denote. The
primary proposal is that the accommodation of pre-
suppositions from temporal subordinate clauses be
modelled as discourse attachment, so that accommo-
dation is properly constrained by the reader’s back-
ground knowledge. Let us call this basic idea accom-
modation by discourse attachment (ADA).

Although we contrasted presuppositional accounts
with classical DRT approaches, there are clear in-
stances where a temporal subordinate clause has no
special rhetorical role in a discourse, but acts in-
stead as a temporal adverb. Such instances are less
problematic for classical approaches than cases like
(1,2b), but at the same time would pose problems for
an account of temporal connectives that relied ex-
clusively on ADA. Consider texts (3,4a) and (3,4b),
modified from Hamann (1989:83–84):

(3) I’m not a useless driver.

(4) a. I could drive before you were born.
b. you were born after I could drive.

(3,4a) and (3,4b) are temporally equivalent, but only
the former is discourse coherent. If ADA were the
whole story, then (3,4a) would be analysed as inco-
erent, since no rhetorical connection can be located
between the speaker’s driving ability and the hearer’s
birth. But (3,4a) is coherent, because the reference
to birth is simply functioning as an adverbial, locat-
ing the starting point of driving in the distant past.

We will therefore suggest that the primary pro-
posal, where accommodation involves discourse at-
tachment, must leave room for the possibility that
presupposed eventualities can be directly added to
discourse context, without any discourse relations
being involved. Let us call this latter idea accommo-
dation by temporal adhesion (ATA). Our treatment of
temporal connectives combines ADA and ATA; it thus
effectively deals with temporal subordinate clauses by
bringing together the presuppositional account

nation of the presuppositions of the counterfactual uses of before, first observed by Heijmäki (1972:139). We
have no space to discuss these here, unfortunately.
and the classical DRT account. We now briefly review the two basic ingredients of the account: A mechanism for presupposition accommodation, and a theory of discourse attachment.

4 A mechanism for presupposition accommodation

Van der Sandt and Geurts (1991) assume that presuppositions are anaphora with semantic content. They distinguish cases in which presuppositions are ‘cancelled’ from those in which they are ‘realised’. The cancelling of presuppositions is explained away as binding of anaphora. In other words, cancellation occurs when there is an appropriate antecedent in the reader’s model of the discourse context that can be identified with the presuppositional material in the clause currently being processed. For example, in sentence (5), the presupposition normally associated with his wife—which is that John has a wife—is cancelled by the conditional clause if John is married, which produces an antecedent in the reader’s model of the context to which his wife can be bound.

(5) If John is married, then his wife will be happy.

The realising of presuppositions is handled through accommodation. Suppose there is no appropriate antecedent in the reader’s model of the discourse context to which the presuppositional material can be bound. In that case, the reader attempts to add the material to the discourse context, subject to certain constraints; for example, that the result of the addition must be logically consistent.

Sentences containing presuppositions are represented as a sentence DRS (or SEDRS) which is a triple containing: a set of discourse markers; a set of DRS conditions; and a (possibly empty) set of SEDRSs. The latter set demarcates those parts of the sentence that are presupposed, and that must therefore be bound or accommodated to the preceding discourse context; the former sets are those parts of the sentence that aren’t presupposed. Binding is achieved through identifying the presupposed discourse referents with those already in the context. Accommodation is achieved through adding the presuppositional material to part of the discourse context; this process is subject to certain informal heuristic constraints.

Van der Sandt and Geurts provide a definition of subordination involving SEDRSs which extends that of traditional DRT. A hierarchical structure is thus defined, and an order of priority for dealing with presuppositions can then be specified. The order is: try binding at a lower level; binding at a higher level; accommodating at a higher level; accommodating at a lower level.

5 A mechanism for discourse attachment

As mentioned before, we wish to enrich van der Sandt and Geurts’ process of accommodation by using a general theory of discourse attachment; by doing this we provide a formal specification of the constraints on accommodation imposed by the reader’s background knowledge. The general theory of discourse attachment we will use is DICE.

DICE rests on a semantically-based theory of discourse structure called Segmented DRT (SDRT) (cf. Asher 1993). SDRT starts with traditional DRSSs (cf. Kamp 1981), but goes on to assume with Grosz and Sidner (1986) that candidate discourses possess hierarchical structure, with units linked by discourse relations modelled after those proposed by Hobbs (1985) (cf. also Mann and Thompson 1987, Scha and Polanyi 1988). The resultant representations are called segmented DRSSs (or SDRSSs). Here, we use five discourse relations: Narration, Background, Result, Explanation and Elaboration. The latter two are subordinating relations, and the proposition introduced by the current sentence can attach only to the previous constituent of the SDRSSs for the text so far, or constituents it elaborates or explains.

SDRT defines those parts of an SDRSS that are available for attachment with new information via a discourse relation. DICE is a logical theory of discourse attachment, which explains how to infer which discourse relation to use. DICE specifies rules that represent the reader’s background knowledge, and these interact via the nonmonotonic logic Commonsense Entailment (CE) proposed by Asher and Morreau (1991), to determine the discourse relations between propositions introduced in a text, and the temporal relations between the eventualities they describe. We here indicate some plausible rules and the inference patterns validated by CE, and demonstrate how they are involved in discourse attachment.

The rules that capture WK and LK allow us to reason about the value of the update function (τ, α, β), meaning “the representation τ of the text so far (of which α is already a part) is to be updated with the representation β of the current clause via a discourse relation with α”. Let eo be a term referring to the main eventuality described by the clause α; and let revolt(b, eo) mean that this eventuality is a backbencher revolt. As usual, we represent the defeasible connective as a conditional >. The following schemas are some rules for calculating implicatures:

- **Narration**:
  \[(τ, α, β) > \text{Narration}(α, β)\]

- **Axiom on Narration**:
  \[\text{Narration}(α, β) → e_α < e_β\]

\[e_α\] abbreviates me(α), which is formally defined in Lascarides and Asher (1993). The indefeasible rules are necessary; we have here omitted the \[\square\] operators.

262
of knowledge. The former is pure WK; normally an
feasible LK, and the axioms on them indefeasible LK.

In particular, Narration and its axiom let us say that
form a narrative or background, then they must have
impose various constraints on the topic structure of
the clauses are discourse-related somehow, the events
don't normally overlap, regardless of whether they are connected or not. Because there is conflict among defeasible rules with unrelated antecedents, a Nixon Diamond crystallises. Consequently, no temporal or discourse relation can be inferred, and so no representation of (7) is constructed, leading to discourse incoherence.

6 The proposal: accommodation by discourse attachment

The basic explanation of the defectiveness of (2b,d) relied on the idea that temporal clauses are presupposed; even though (2b) may be taken to refer to the same temporal structure $E_1$ as (2a), it is pragmatically inappropriate. In making this explanation more precise, we wish to characterise presupposition accommodation as a process of discourse attachment; and failure to accommodate thus involves failure to attach, or, in other words, (local) discourse incoherence. In the (1,2) examples, failure to attach at a particular site can be fatal, as we will see shortly.

More precisely: (i) Subordinate temporal clauses are presupposed. (ii) If binding the presupposition fails, then it must be accommodated. (iii) If accommodation is necessary, then it is assumed in the first instance that the proposition introduced by the subordinate clause plays a rhetorical function in the dis-

---

3 There are two versions of this rule; the other covers the cases where the second clause is stative.
course, and so accommodation proceeds via discourse attachment. The presupposition must be attached to the discourse structure by a discourse relation, before the DRS of which it is a sub-part is attached. (iv) In that case, the presupposition can be discourse related to: either prior discourse or the DRS corresponding to its matrix clause. (v) If, on the other hand, accommodation via discourse attachment fails, then the assumption that the subordinate clause plays a rhetorical role is defeated, and accommodation is attempted via the addition of the presupposed event to the discourse context. (vi) If the presupposition is successfully attached, an attempt is made to discourse-relate the resultant constituents of the discourse, using the reader's background knowledge. 5

So, presuppositions can lead to incoherence in at least four ways. First, binding may be successful, but the resultant constituents of the discourse may fail to attach together (as in (3,4b)). Secondly, binding may fail, while ADA is successful, and then the resultant constituents of the discourse may fail to attach together (as in (1,2b)). Thirdly, binding and ADA may fail, while ATA is successful—as in (3,4a)—but then, in contrast to (3,4a), the resultant constituents may fail to attach together. Finally, binding and both types of accommodation may fail.

To reflect this process of interpreting temporal connectives in a discourse context, we propose that discourse attachment be split into four stages, of which the third has three main parts:

1. We build the sentence DRS (or SEDRS) for the sentence containing the temporal connective.

2. We then calculate the temporal implicatures for the SEDRS, that arise from the temporal connective used, if there are any.

3. We then handle the presupposition: (a) We attempt to bind. If that fails, (b) we attempt accommodation, by attempting discourse attachment between available SDRSs and the third sub-part of the SEDRS (which corresponds to the presupposed clause). If the presupposition is bound or accommodated by discourse attachment, we go to (4). But if (b) fails, then (c) we attempt accommodation by adding the third sub-part of the SEDRS to an available SDRS, and if this is possible, we go to (4). If (c) fails, then we fail on the grounds of incoherence.

4. Attempt discourse attachment between the current DRS and available SDRSs. If attachment succeeds, go to (1) with the next sentence. If not, fail on the grounds of incoherence.

7 Temporal information from connectives

First of all, we register Hamann's (1989:76) observation that before and after operate on points by placing in the SEDRS the relevant precedence conditions on the points of time at which the eventualities are asserted to hold. We fold states into this picture by introducing a default 'inceptive' reading for temporal connectives; conn here varies over before and after; an eventuality is instate if it's inceptive. That is, instate(e_t) is true only if the time discourse referent t introduced in the DRS δ is the time where e_t starts.

- Inceptiveness with Connectives (IC1):
  \[ \beta = \text{conn}(\delta, \gamma) \land \text{state}(e_\gamma) > \text{instate}(e_\delta) \]

- Inceptiveness with Connectives (IC2):
  \[ \beta = \text{conn}(\delta, \gamma) \land \text{state}(e_\gamma) > \text{instate}(e_\gamma) \]

In words, δ before/after γ normally entails that δ and γ are to be interpreted inceptively, if either of them are stative.

It is suggested that when clauses, by contrast, do not implicate inceptiveness; indeed they do not have any special temporal implicatures (cf. Moens and Steedman 1988). However, it can be argued that when does have a causal implicature: it serves to restrict the kinds of contingency relationships that can hold between eventualities; in particular, it defensibly cuts off one possibility:

- No Cause:
  \[ \text{when}(\alpha, \beta) > \neg\text{cause}(e_\alpha, e_\beta) \]

8 Worked examples

To demonstrate how the approach works, we here treat several types of cases involving presupposition accommodation: first, we deal with two pairs of cases where accommodation via discourse attachment succeeds; in one pair the result is coherent, and in the other it isn't. Then we will deal with a case where binding and accommodation by discourse attachment fail, but accommodation by temporal addition succeeds. Finally, we will deal with a case where the presupposition is bound. The coherent cases treated here are (1,2a) and (1,2c), involving after and when and (3,4a), involving before; the incoherent cases are (1,2b) and (1,2d), involving before and when, and (3,4b), involving after.

8.1 Discourse attachment with coherence

Consider text (1,2a):

1. The backbenchers were in revolt.

2. a. They were pacified after Major launched a charm offensive.

Let the logical representation of (1) be \( \alpha \), and the SEDRS for (2a) be \( \beta_t \); note that the precedence condition \( t_3 < t_2 \) is incorporated into the DRS for the matrix clause.

---

5 Points (iii) and (iv) correspond to ADA; point (v) to ATA.

264
In the first stage of discourse attachment, we build the representation for $\beta_a$ just given. In the second stage, we add its temporal implicatures. By IC1, we come to believe via Defeasible Modus Ponens that the state of pacification doesn't just hold at $t_2$; it starts there.

In the third stage, we attempt to deal with the presupposed part of $\beta_a$. Let $\gamma$ be the presuppositional clause corresponding to $e_3$, and $\delta$ the matrix corresponding to $e_2$. $\gamma$ will fail to bind to $\alpha$. Can it attach? We assume $(\alpha, \alpha, \gamma)$, and so the line of reasoning is exactly that used for (6), and a Background relation holds between the revolt and the charm offensive. Once $\gamma$ has been attached, we move on to the final stage of processing: we must attach the DRS which remains when $\gamma$ has been deleted from it. Call this $\epsilon$.

\[ (c) \quad [e_2, t_2][\text{pacified}(b, e_2), \text{hold}(e_2, t_2), t_2 < \text{now}, t_3 < t_2] \]

The only open constituent in the SDRS built so far is $\gamma$, because the relation in the SDRS is Background($\alpha, \gamma$). So we assume $(r, \gamma, \epsilon)$, and find that Narration, States Overlap and the Charm Law apply. States Overlap conflicts with what has already been accepted via IC1. Furthermore, it conflicts with the Charm Law, which is more specific. So, cause($e_3, e_2$) and Narration($\gamma, \epsilon$) are inferred. By the causal relation, the antecedent to Result is now verified, and so Result($\gamma, \epsilon$) is also inferred. So, in brief, the first state functions as background to the presupposed event, of which the second sentence's state is the result.

Of the versions of (2) involving the connective when, only one is coherent in the discourse context, and its analysis is very similar to that of (2a) just given.

(1) The backbenchers were in revolt.

(2) c. They were pacified when Major launched a charm offensive.

Just as with (2a), the presupposed charm event is successfully accommodated with respect to the preceding discourse, and the main clause state of pacification is then attached as its result. There are two differences in the analysis: the semantics of when places no conditions in the matrix clause $\delta$ on the temporal relation between $e_2$ and $e_3$; however, in the second stage of discourse attachment, further implicatures are added ($\neg$cause($e_2, e_3$): the pacification did not cause the charming). In spite of these temporal differences, the final discourse structure is the same.

8.2 Discourse attachment without coherence

Now, let us consider two cases where accommodation doesn't ultimately deliver a coherent discourse. In both of these cases, accommodation fails with respect to the previous discourse context, but then succeeds within the sentence. Incoherence only follows because the resulting structure cannot finally be attached to the previous discourse context.

First, take (1,2b).

(1) The backbenchers were in revolt.

(2) b. Major launched a charm offensive before they were pacified.

We have observed that (2b) denotes the same temporal structure as (2a), but that it seems incoherent in the context of (1). Here, we provide one way to account for why the presupposition fails.

The SEDRS corresponding to (1) is $\alpha$ and the SEDRS for (2b) is $\beta_b$.

\[ (\beta_b) \quad \{(e_3, t_3), \{\text{charm}(a, b, e_3), \text{hold}(e_3, t_3), \text{now} \} \} \]

In the first stage of discourse attachment, we build the representation for $\beta_b$ just given. In the second stage, we add its temporal implicatures. By IC2, we come to believe that the state of pacification doesn't just hold at $t_2$; it starts there.

In the third stage, we attempt to deal with the presupposed part of $\beta_b$. Let $\gamma$ be the presuppositional clause corresponding to $e_3$ (the pacification), and $\delta$ the matrix corresponding to $e_2$ (the charming). $\gamma$ will fail to bind to $\alpha$. Can it attach? We assume $(\alpha, \alpha, \gamma)$, and so the line of reasoning is exactly that used in (7), and so no discourse relation can be found.

Having failed to attach the presupposition at the higher level, we attempt to attach it to its own matrix clause. We assume $(r, \delta, \gamma)$, and find that Narration, States Overlap and the Charm Law apply. The Charm Law's conclusion follows by the Penguin Principle, i.e., $e_3$ causes $e_2$; and by a further application of the principle, we conclude that a Result relation holds between $\delta$ and $\gamma$. Call the resultant SDRS $\epsilon$.

At the final stage of processing, we must attach $\epsilon$ to the prior discourse---$\alpha$. Which rules apply when attaching $\epsilon$ to $\alpha$? $(\tau, \alpha, \epsilon)$ is added to the reader's KB, and so Narration, States Overlap and the Revolt Law all apply. To properly discuss this case, we introduce here a further law that will apply: one which reflects the Gricean maxim 'Be Orderly'. In Lascarides, Asher and Oberlander (1992:4--5), we presented a rule that constrained orderly text with respect to causation: the law reflected the intuition that one should not describe things in the order cause-effect-further causes of that effect, or effect-cause-further
effect of that cause. Here, we offer a generalisation of this law. Suppose we define two eventualities presented in a text as **conceptually immediate** if (a) one causes the other, and (b) the clauses that describe them are discourse-related. Then the pragmatic maxim below captures the intuition that nothing described elsewhere in a text should come between two conceptually immediate events.

- **Conceptual Immediacy:**
  \[ \langle \tau, \alpha, \beta \rangle \land \beta \rightarrow Result(\gamma, \delta) \]
  \[ \neg(e_a < ibd(e_\beta) < e_b) \land \\
  \neg(e_a < fbd(e_\beta) < e_b) \]

In words, Conceptual Immediacy states that if the constituent \( \beta \) is to be attached to \( \alpha \), where \( \beta \) contains \( Result(\gamma, \delta) \) (and so \( e_\gamma \) causes \( e_\delta \)), then the start of \( e_\alpha \) (i.e., \( ibd(e_\alpha) \)) and the end of \( e_\alpha \) (i.e., \( fbd(e_\alpha) \)), cannot come in between \( e_\gamma \) and \( e_\delta \).

Conceptual Immediacy has an impact on the analysis of (2b), because it applies in the attachment of \( \epsilon \) to \( \alpha \), together with the laws we have already mentioned. Here, Conceptual Immediacy means that normally, the point where the revolt starts or finishes cannot come in between the charm offensive and the pacification. States Overlap means that normally, the revolt overlaps with the event structure described in \( \epsilon \). So States Overlap and Conceptual Immediacy together say that normally, the revolt starts before the charm offensive, and continues until at least after the pacification has started. But this would mean that the revolt and pacification overlap, and this contradicts the Revolt Law. Thus Conceptual Immediacy and States Overlap on the one hand, and the Revolt Law on the other, are in irresolvable conflict, since the antecedents of these laws are unrelated. So no conclusions about discourse structure can be inferred, leading to incoherence.

Under this analysis, (2b) is coherent in isolation, but incoherent in the context of (1). The notion of orderliness in discourse plays a crucial role in this explanation: eventualities that are causally connected preclude other eventualities described in the discourse from intervening between them.

The other case of incoherence involves the connective when:

1. The backbenchers were in revolt.
2. ?Major launched a charm offensive when they were pacified.

The SEDRS corresponding to (1) is \( \alpha \), and in the first stage of processing, we build the SEDRS \( \beta_\alpha \) as the representation of (2d):

\[
(\beta_\alpha) \quad \{\{e_2, t_2\}, \{charm(a, b, e_3), hold(e_3, t_3), t_3 \prec now\}, \\
\{\{e_2, t_2\}, \{pacified(b, e_2), hold(e_2, t_2), t_2 \prec now\}, \emptyset\}
\]

In the second stage, we add its temporal implicatures: by No Cause, \( \neg cause(e_3, e_2) \) is added to the matrix clause \( \delta \). This means that the charming didn’t cause the pacification; apart from anything else, this implicature renders (2d) an inappropriate vehicle for a speaker who wished to describe the course of events \( E_1 \) we have been discussing.

In the third stage of processing, as with (2b), both binding and accommodating \( \gamma \) to \( \alpha \) fail, and so we assume \( (r, \delta, \gamma) \). The laws that apply are: Narration, States Overlap and the Charm Law. The Charm Law is the most specific, but its consequent is inconsistent with what is already known concerning causal structure. Thus, States Overlap, which is the next most specific law, wins. So we infer \( Background(\delta, \gamma) \). Call the resultant SDRS \( \epsilon \). We must now assume \( (\alpha, \alpha, \epsilon) \).

The rules that apply are: Narration, States Overlap and the Revolt Law. Notice that in contrast to (2b), Conceptual Immediacy no longer applies, because \( \epsilon \) doesn’t entail \( Result(\gamma, \delta) \). Given the temporal structure entailed in \( \epsilon \), the consequent of States Overlap would entail that the revolt and pacification overlap. But the Revolt Law entails the opposite. So a Nixon Diamond crystallises and the discourse is incoherent.

From examining (1,2b) and (1,2d), it should be apparent that managing to accommodate a presupposition by discourse attaching it to its matrix is not in itself sufficient for discourse coherence. The SDRS formed must still be attached within the preceding discourse context. It is this second attachment that fails to occur in these cases. Both Conceptual Immediacy and No Cause can yield discourse incoherence. In (2d), for example, if it weren’t for No Cause, the Charm Law would have won during accommodation instead of States Overlap. This would have changed the set of laws which apply when attaching \( \epsilon \) to \( \alpha \), leading to different inferences about the discourse.

### 8.3 Temporal addition with coherence

Now consider text (3,4a):

1. I’m not a useless driver.
2. a. I could drive before you were born.

The logical forms of the two sentences are respectively \( \alpha \) and \( \beta_\alpha \):

\[
(\alpha) \quad \{e_1, t_1\}, \neg useles-driver(a, e_1), hold(e_1, t_1), t_1 \prec now
\]

\[
(\beta_\alpha) \quad \{\{e_2, t_2\}, \{can-drive(a, e_2), hold(e_2, t_2), t_2 \prec now, t_2 \prec t_3\}, \\
\{\{e_3, t_3\}, \{born(b, e_3), hold(e_3, t_3), t_3 \prec now\}, \emptyset\}
\]

Now, in the first stage of processing, we build the SDRSS just given. In the second stage, we add the temporal implicatures, and find that being able to drive didn’t just hold at \( t_2 \), it started there.

In the third stage, we deal with the presupposition. Call the third sub-part of the SDRS \( \gamma \). \( \gamma \) can’t bind to the context, and so we assume \( (\alpha, \alpha, \gamma) \), and the laws that apply are: Narration and States Overlap. But inferring \( Background \) via the Cascaded Penguin...
In the first stage of processing, we build the SEDRS just given. In the second stage, we add the temporal implicatures, and find that being able to drive doesn’t just hold at t2, it starts there.

In the third stage, we deal with the presupposition. We assume here that the Identify Drive Law forms part of the reader's KB: it captures the intuition that not being a useless driver and being able to drive are one and the same eventuality:

- **Identify Drive Law:**
  \[
  \neg \text{useless-driver}(a, e) \iff \text{can-drive}(a, e)
  \]

Because of the Identify Drive Law, we can bind the presupposed material γ to a. So we then go onto the fourth stage of processing, and attempt to attach the matrix clause δ—which represents you were born—to a. By the constraints on topic structure imposed by Background and Narration, attachment of δ to a fails, for just the same reasons as it did before. Here, in contrast to (3,4a), the violation of the topic constraints is fatal, because you were born is a main clause. It cannot be reinterpreted as a temporal adverbial when discourse attachment has failed.

9 Conclusion

By concentrating on a simple but pervasive phenomenon concerning the interpretation of temporal connectives, we have extended a formal mechanism to show how interacting discourse context, WK and LK determine which presupposed eventualities can be accommodated. The way in which accommodation is handled depends on the content of the presupposed clause, and we pointed to some interesting behaviour in this connection.

On the one hand, when accommodation by discourse attachment fails, accommodation by temporal addition can still succeed. In such cases, a purely temporal reading of the subordinate clause is forced, and this leads to very weak coherence constraints for the discourse as a whole. These weak constraints are akin to those in classical treatments of temporal connectives in DRT; however, our analysis still differs somewhat, eschewing as it does reference times. On the other hand, even when accommodation by discourse attachment succeeds, there is no guarantee that the text is coherent; presupposition accommodation is a necessary, but insufficient, part of the process of discourse structure retrieval.

References

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

[Asher and Morreau, 1991] Nicholas Asher and Michael Morreau. Common Sense Entailment: A Modal Theory of Nonmonotonic Reasoning. *Proceedings of the 12th Interna-
[Grosz and Sidner, 1986] Barbara Grosz and Candace Sidner. Attention, Intentions, and the Structure of Discourse. *Computational Linguistics*, 12: 175–204.

[Hamann, 1989] Cornelia Hamann. English Temporal Clauses in a Reference Frame Model. In Schopf, A. (ed.) *Essays on Tensing in English*, Volume II: *Time, Text and Modality*, pp31–153.

[Heinämäki, 1972] Orvokki Heinämäki. “Before”. *Papers from the Eighth Regional Meeting of the Chicago Linguistics Society*, 139–151. University of Chicago, Chicago, Illinois.

[Hinrichs, 1986] Erhard Hinrichs Temporal anaphora in discourses of English. *Linguistics and Philosophy*, 9, 63–82.

[Hoeks, 1985] Jerry R. Hobbs. On the Coherence and Structure of Discourse. Report No. CSLI-85-37, Center for the Study of Language and Information, October, 1985.

[Kartunnen, 1973] Lauri Kartunnen. Presuppositions of Compound Sentences. *Linguistic Inquiry*, 4, 169–193.

[Kamp, 1981] Hans Kamp. A theory of truth and semantic representation. In Groenendijk, J. A. G., Janssen, T. M. V. and Stokhof, M. B. J. (eds.) *Formal Methods in the Study of Language* 136, 277–322. Amsterdam: Mathematical Centre. Tracts.

[Lascarides and Asher, 1991] Alex Lascarides and Nicholas Asher. Discourse Relations and Defeasible Knowledge. *Proceedings of the 29th Annual Meeting of the Association for Computational Linguistics*, 55–63, Berkeley, Ca, June 1991.

[Lascarides and Asher, 1993] Alex Lascarides and Nicholas Asher. Temporal Interpretation, Discourse Relations and Common Sense Entailment. To appear in *Linguistics and Philosophy*.

[Lascarides, Asher and Oberlander, 1992] Alex Lascarides, Nicholas Asher and Jon Oberlander. Inferring Discourse Relations in Context. *Proceedings of the 30th Annual Meeting of the Association for Computation Linguistics*, pp1–8, Newark, Delaware, June 1992.

[Leonard, 1979] David Lewis. Score-keeping in a Language Game. *Journal of Philosophical Logic*, 8, 339–359.

[Mann and Thompson, 1987] William Mann and Sandra Thompson. Rhetorical Structure Theory: A theory of text organisation. Technical Report ISI/RS-87–190, USC/ISI, June 1987.

[Moens and Steedman, 1988] Marc Moens and Mark J. Steedman. Temporal ontology and temporal reference. *Computational Linguistics*, 14, 15–28.