Time after time

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This talk is based on joint, ongoing work with Cleo Condoravdi. See:

Chronos 2008
Introduction

• In the abstract for this talk, I presented a bunch of odd puzzles.
• All of them have to do with the interpretation of temporal prepositions.
• I’ll show that the puzzles can be solved using simple, very general assumptions about temporal interpretation, and simple meanings for the temporal prepositions.
Puzzle 1: data

Trilobites: 540m-251m years ago, Ammonites: 400m- 65m years ago

1. There were trilobites before there were ammonites. TRUE
2. There were ammonites before there were trilobites. FALSE
3. There were trilobites after there were ammonites. TRUE
4. There were ammonites after there were trilobites. TRUE

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Puzzle 1: after/before not inverses

• How come *before* and *after* do not behave like inverses?
• A standard analysis (Anscombe 1971) says it’s because *before* has universal force, and *after* doesn’t.
• *X before* Y would mean: some X time precedes all Y times.
• *X after* Y would mean: some X time precedes some Y time.
• Why should *before* be universal, but *after* existential?
Puzzle 2: data

Trilobites: 540m-251m years ago, Ammonites: 400m-65m years ago

5. There were trilobites long after there were any ammonites.  FALSE

6. There were ammonites long after there were any trilobites.  TRUE
Puzzle 2: after is like before after all

- Why does *after* behave like *before* in (5) and (6), involving *long after there were any*?
- Note that the standard universal analysis of *before* and existential analysis of *after* is of no help here.
Puzzle 3: data

• Typically, Negative Polarity Items (NPIs) like any are OK in before clauses, but not after clauses.

7. Barney died before any meteors fell.
8. * Barney died after any meteors fell.
Puzzle 3: Any

- Why are NPIs like *any* ok in *before* clauses but usually not in *after* clauses?
- The standard explanation is that only *before* is universal, and universals license NPIs. But this doesn’t explain:
- Why is *any* OK in long *after there* were any *trilobites*?
Puzzle 4: data

9. The dinosaurs died out long before they invented the wheel.

10.!?# The dinosaurs developed the wheel long after they died out.

11. On Dec. 9, the U.S. Supreme Court stopped the hand count before it was completed. *(USA Today, 5-15-2001.)*

12. The hand count was completed after the U.S. Supreme Court stopped it.
Puzzle 4: false before clauses

• Why is it that a *before* sentence can be true even when the *before* clause is false?
• And why does this not hold for *after*?
Puzzle 5: data

13. Servers will circulate with sherry and canapés while all of the delegates sign on at the front desk.
   (Could sign on intermittently for hours)

14. Servers will circulate with sherry and canapés while all of the delegates are at the front desk.
   (Simultaneous presence of delegates at desk)
Puzzle 5: simultaneous presence

• Why does stative *are at* give a simultaneous reading in *while all of the delegates are at the front desk*, but eventive *sign on* not do so?
Puzzle 6: data

15. Servers circulated with sherry and canapés before most of the dinosaurs were dead.

• Q: What’s the latest they could have started circulating?
• A: The cretaceous period.
Puzzle 6: before most

• But most of the dinosaurs were dead an hour ago (indeed, all of them).
• So why wouldn’t (15) be true if sherry and canapés circulation only began an hour ago?
First part of proposal:
Schema for temporal modifiers

- \([S + \text{Mod}]\) is true at an interval I iff \([S]\) is true in a part J of I, and J is \([\text{Mod}_I]\)
Example

[David left on Tuesday] is true in the first week of September

iff

[David left] is true in a part J of that week, and J is [Tuesday\textsubscript{first-week-of-September}]

• This example is simple, but the schema is very general. (Beaver & Condoravdi 2007 uses an even more general version.)
Second part of proposal: meanings of temporal modifiers

• *Before* and *after* have simple relational meanings, with no quantification.
• These meanings relate intervals rather than times (with a<b implying no overlap).
• In general, temporal prepositions have two readings:
  – a point reading (first end point)
  – an interval reading
• For interval denoting complements (NPs), we just use the interval, but for proposition denoting complements, the point reading is the default.
Puzzle 1: data

Trilobites: 540m-251m years ago, Ammonites: 400m-65m years ago

1. There were trilobites before there were ammonites. TRUE
2. There were ammonites before there were trilobites. FALSE
3. There were trilobites after there were ammonites. TRUE
4. There were ammonites after there were trilobites. TRUE

Chronos 2008
Puzzle 1, sentence (1)

[There were trilobites before there were ammonites] is true in the last billion years
   iff
[There were trilobites] is true in a part J of the last billion years, and J is
   [before there were ammonites] the last billion years
   iff
i.  [There were trilobites] is true in a part J of the last billion years
ii.  J<K
iii.  K is the earliest end of an interval in I for which [there were ammonites] is true

•  Conclusion: there have to have been trilobites prior to the first period when there were ammonites.
•  And there were. Ergo (1) is true.

Chronos 2008
Puzzle 1, sentence (2)

There were ammonites before there were trilobites] is true in the last billion years
iff
i. [There were ammonites] is true in a part J of the last billion years
ii. J<K
iii. K is the earliest end of an interval in I for which [there were trilobites] is true

Conclusion: there have to have been ammonites prior to the first period when there were trilobites.
• There weren’t. Ergo (2) is false.
Puzzle 1, sentence (3)

[There were trilobites after there were ammonites] is true in the last billion years

iff

i. [There were trilobites] is true in a part J of the last billion years

ii. J>K  \hspace{1cm} (note: sign changed direction!)

iii. K is the earliest end of an interval in I for which [there were ammonites] is true

• Conclusion: there have to have been trilobites later than the first period when there were ammonites.

• There were. So (3) is true.

Chronos 2008
Puzzle 1, sentence (4)

[There were ammonites after there were trilobites] is true in the the last billion years
  iff
i.  [There were ammonites] is true in a part J of the last billion years
ii.  J>K
iii. K is the earliest end of an interval in I for which [there were trilobites] is true

• Conclusion: there have to have been ammonites later than the first period when there were trilobites.
• There were. So (4) is true.
Puzzle 1: solution

• How come *before* and *after* do not behave like inverses?
  – In a modifier of the form *before* $S$ or *after* $S$, we need to derive from $S$ a temporal value to pass on to the preposition.
  – The default operation takes the end of the earliest interval when $S$ is true.
  – The temporal asymmetry of this operation produces the appearance of *after* and *before* being non-inverses.

• Why should *before* be universal, but *after* existential?
  – They aren’t. They’re just orderings over intervals.
Puzzle 2: data

Trilobites: 540m-251m years ago, Ammonites: 400m- 65m years ago

5. There were trilobites long after there were any ammonites.  FALSE

6. There were ammonites long after there were any trilobites.  TRUE
Puzzle 2: sentence 5

• Both the degree modifier long and the NPI any (we turn to this in a moment) tend to induce complete interval readings for after.

[There were trilobites long after there were any ammonites] is true in the last billion years

iff

i. [There were trilobites] is true in a part J of the last billion years
ii. J \gg K
iii. K is the complete interval in I for which [there were any ammonites] is true

• Conclusion: there were trilobites long after the last ammonites.
• There were not, so (5) is false.
Puzzle 2: sentence 6

[There were ammonites long after there were any trilobites] is true in the last billion years
iff
i. [There were ammonites] is true in a part J of the last billion years
ii. J >> K
iii. K is the complete interval in I for which [there were any trilobites] is true

• Conclusion: there were ammonites long after the last trilobites.
• There were, so (6) is true.
Puzzle 2: solution

• Why does after behave like before in (5) and (6), involving “long after there were any”?
  – Quantitatively large degree modifiers tend to induce complete interval readings, and any does too (for reasons to which we will turn).
  – But after a complete interval is the same as after the end of that interval, i.e. the reverse of what before produces with point readings (before the start).
  – So this special case reading of after mirrors the default reading of before, and that’s why we get similar judgment patterns.
Puzzle 3: data

• Typically, Negative Polarity Items (NPIs) like *any* are OK in *before* clauses, but not *after* clauses.

7. Barney died before any meteors fell.
8. * Barney died after any meteors fell.
Background on NPIs

• Negative polarity items are licensed in the same places that predicates can be strengthened while preserving truth. (Fauconnier 75, Ladusaw 79 von Fintel 99)

• Rain fell doesn’t imply Heavy rain fell, ergo Any rain fell is bad.

• But I doubt rain fell does imply I doubt heavy rain fell, ergo I doubt any rain fell is good.
Puzzle 3: sentence 7

• Given the presupposition that some big meteors fell, *Barney died before meteors fell* implies that *Barney died before big meteors fell*.

• So strengthening is allowed in *before* clauses, and that’s why *Barney died before any meteors fell* is OK.

• This is predicted on the first endpoint reading: if Barney’s death was prior to the first meteor falling, it was prior to the first big meteor falling.
Puzzle 3: sentence 8

• But even given the presupposition that some big meteors fell, *Barney died after meteors fell* does not imply that *Barney died after big meteors fell*.

• So strengthening is not (generally) allowed in *after* clauses, and that’s why *Barney died after any meteors fell* is bad.

• Again, this is predicted on the first endpoint reading: the fact that Barney’s death was later than the first meteor, tells us nothing about whether it was later than the first big meteor.
Puzzle 3: back to sentence 5 and 6

• So why is any OK in long after there were any?
• Given that some big meteors fell, if Barney died long after (the whole interval when) meteors fell, then he must have died long after (the whole interval when) big meteors fell.
• So Barney died long after any meteors fell is predicted to be OK, and similarly for (5) and (6).
Puzzle 3: solution

• Why are NPIs like *any* ok in *before* clauses but usually not in *after* clauses?
  – Because first endpoint readings predict strengthening inferences for *before* clauses, but not *after* clauses.

• Why is *any* OK in “long after there were *any* trilobites”?
  – Because sometimes an interval reading is salient, and under this reading strengthening is predicted for after too.
Puzzle 4: data

9. The dinosaurs died out long before they invented the wheel.

10. !?# The dinosaurs developed the wheel long after they died out.

11. On Dec. 9, the U.S. Supreme Court stopped the hand count before it was completed. (*USA Today, 5-15-2001.*)

12. The hand count was completed after the U.S. Supreme Court stopped it.
Third part of proposal

• Much work on temporal logic and semantics uses branching models of time.
• In such a model, multiple options are available for the future, but there is only one past.
• We assume that in calculating what holds in the future from a given point, we consider by default only typical continuations (so-called “inertial worlds”, e.g. Dowty 1979).
• Claim: such a model, combined with the assumption that main clauses are by default evaluated in the actual world, predicts that after clauses are veridical, but before clauses may not be.
• See Beaver and Condoravdi (2003) for formal details
Before in branching time
Puzzle 4: sentence 9

• If (9) *The dinosaurs died out long before they invented the wheel* is true, then, by assumption, the main clause must be true, i.e. the dinosaurs died out at some time.

• The before clause claims that in typical future from the point at which that occurred, the dinosaurs invent the wheel.

• So (9) is true if
  i. the dinosaurs died out,
  ii. the destruction of the dinosaurs (the Chicxulub Impact?) was atypical, and
  iii. the natural evolutionary path of the dinosaurs would have included appropriate technology.
Puzzle 4: sentence 10

• For (10) *The dinosaurs invented the wheel long after they died out* to be true, then, once again, the main clause must be true.
• It follows that the dinosaurs invented the wheel.
• The after clause is in the past from the main clause.
• Since time does not branch backwards, the dinosaurs must have died out not only in the past from the main clause, but also in our own past.
• Hence the oddity of (10), since it claims both that the dinosaurs actually did die out, and that they nonetheless invented the wheel sometime later.
Puzzle 4: solution

• Why is it that a *before* sentence can be true even when the *before* clause is false?
  – Because the *before* clause only has to hold in typical futures from the point at which the main clause event starts.

• And why does this not hold for *after*?
  – Because there is only one past, and typicality of continuations is not relevant.
Puzzle 5: data

13. Servers will circulate with sherry and canapés while all of the delegates sign on at the front desk.
   (Could sign on intermittently for hours)

14. Servers will circulate with sherry and canapés while all of the delegates are at the front desk.
   (Simultaneous presence of delegates at desk)
Third part of proposal

• Consider:
16. Barney was happy between January and June.
17. Barney died between July and December.
• It seems happiness characterized Barney for 6 months, but how long did he die for?
• This leads to a speculative suggestion:

  – By default we take stative sentences to be true at an interval I iff the state characterizes the entire interval.
  – An eventive (or perhaps just telic) sentence is true at any interval such that the event holds at some part of that interval.
Third part of proposal continued – two further claims

• While clauses only have whole interval readings.

• All $X \ Y$ is true in $I$ iff

  for each $x$ in $X$, $x \ Y$ is true in $I$. 
Puzzle 5, sentence 13

- Consider *while all of the delegates sign on at the front desk*.
- *sign on* is eventive, so *x signed on at the front desk* is true in any interval such that x signed on in a part of it.
- *all of the delegates sign on at the front desk* is true in any interval I such that for each delegate, that delegate signed on at the front desk in I
- So *all of the delegates sign on at the front desk* is true at any interval I such that for each delegate, that delegate signed on in a subpart of I.
- The while clause then picks the most salient such interval, i.e. the smallest interval in which everybody signed on.
- There is no requirement of simultaneity.
Puzzle 5, sentence 14

• Now consider *while all of the delegates are at the front desk.*

• *is at the front desk* is stative, so *x is at the front desk* is true in any interval such that *x* being at the desk characterizes the entire interval.

• *all of the delegates are at the front desk* is true in any interval I such that for each delegate x, *x is at the front desk* is true at I

• So *all of the delegates are at the front desk* is true at any interval I such that for each delegate x, *x is at the front desk* characterizes the entire interval.

• For there to be any such interval, the delegates must all be simultaneously at the front desk.
Puzzle 5: solution

• Why does stative *are at* give a simultaneous reading in *while all of the delegates are at the front desk*, but eventive *sign on* not do so?
  – Because stative sentences are by default true at an interval iff they characterize the entire interval, whereas eventive sentences need only be true at a part of an interval.
Puzzle 6: data

15. Servers circulated with sherry and canapés before most of the dinosaurs were dead.
Puzzle 6: sentence 15

- The proposal that, by default, before has a first endpoint reading solves this problem immediately.
- Although it’s true that most of the dinosaurs were dead an hour ago, that was not the first such time.
- The first such time, i.e. the first endpoint, was in the Cretaceous, so (15) claims that servers circulated before then.
Puzzle 6: aside on accomplishments

• The solution to the *before most* problem relates to another thorny issue, how temporal prepositions combine with accomplishments.

18. David was obnoxious before he drank (even) three beers.
• The natural reading for this is just the same first endpoint reading: before the first time he completed the drinking of three beers.
• But note that Heinemaki (1974) had to resort to a special stipulation of how before combines with accomplishments. And yet there’s another reading she still didn’t get:

19. David drank two whiskeys before he drank three beers.
• Here a complete interval reading is also available, as predicted by the proposal.
Puzzle 6: solution

• So why wouldn’t (15) be true if sherry and canapés circulation only began an hour ago?
  – Because (15) gets the standard default reading for before sentences, the first endpoint reading.
Discussion

• I have made two new claims, and a few more standard assumptions.

Claim 1: temporal prepositions have two main readings, a first endpoint reading, and an interval reading.

Claim 2: eventive sentences are true at superintervals, but by default stative sentences are not.

• Re. claim 2, I have only presented limited evidence, and not discussed the full range of aspectual types. Still, I think there’s something right about it, and I’m interested in your comments.

• Re. claim 1, I feel more confident: it solves a range of empirical problems cleanly, and for the first time.
**Discussion (cont.)**

- Claim 1 also suggests a direction for future work in understanding more fully the typology of temporal prepositions.
- Here is a start:

<table>
<thead>
<tr>
<th></th>
<th>First endpoint</th>
<th>Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Before</strong></td>
<td>Default</td>
<td>Distinct for accomplishments</td>
</tr>
<tr>
<td><strong>After</strong></td>
<td>Default</td>
<td>Distinct for states, activities, but only prominent from distant perspectives</td>
</tr>
<tr>
<td><strong>While</strong></td>
<td>Ruled out semantically</td>
<td>Default</td>
</tr>
<tr>
<td><strong>Until</strong></td>
<td>Available (default?)</td>
<td>Distinct for accomplishments</td>
</tr>
<tr>
<td><strong>When</strong></td>
<td>Available?</td>
<td>Default?</td>
</tr>
</tbody>
</table>

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Take home exercise

20. Every other eon after about a hundred thousand years, servers circulate with sherry and canapés for twelve hours on a Saturday and the wee hours of the following Sunday morning in early March one year while delegates stream toward the front desk.