Temporal dependencies: anaphora vs. movement

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Introduction

A temporal modifier can depend on another one. Pratt and Francez (2001) call this a *temporal cascade*:

(1) a. On every Sunday, it rained before noon.
b. Last summer, in no month did Wolfgang play tennis every Sunday.

Pratt and Francez analyse these dependencies semantically. Each temporal PP adjoins to the VP:

(2) a. ⟦W play tennis every Sunday⟧ = λi.every Sunday within i contains a W-play-tennis event
b. ⟦in no month⟧ = $\lambda P \lambda j$. no month within j contains a P-interval
c. ⟦(1b)⟧ = no month within last summer contains an interval within which every Sunday contains a W-play-tennis event

von Stechow (2002) gives a QR-based syntactic account. Only one PP adjoins to the VP:

(3) [Last summer] λi [[no month (in) t_i] λj [every Sunday (in) t_j] λk [W. played (in) t_k]]

Stechow claims that Pratt and Francez fail to account for long-distance temporal dependencies:

(4) I saw Mary in New York before she claimed that she would arrive. (Larson, 1990)
a. 'before the time at which she made that claim'
b. 'before her presumed arrival'

As noted by Geis (1970), such dependencies are subject to island constraints, like movement:

(5) I saw Mary in New York before she **made the claim** that she would arrive.
a. *Available:* 'before the time at which she made that claim'
b. *Unavailable:* 'before her presumed arrival'

For this reason Stechow analyzes *all* temporal dependencies, including cascades, as movement.

I claim that temporal cascades are anaphora-like (as opposed to Geis dependencies).

Temporal cascades violate islands, unlike movement

(6) a. Every year, John got anxious because he needed to file taxes in April.
b. *In what month did John get anxious this March because he needed to file taxes?

(7) a. Every year, some guy who needs to file taxes in April gets anxious in March.
b. *In what month did some guy who needs to file taxes get anxious in March?

(8) a. Last year, I wonder if John went to France in August or in September.
b. *When do you wonder if John went to France?

(9) a. On most days, that it rains in the afternoon is a good possibility.
b. *On which days is that it rains a good possibility?

Temporal cascades behave like implicit variables and domain restrictions

Implicit variables can be bound by quantifiers (e.g. Partee, 1989):

(10) [Every sports fan in the country]^i was at a local$_i$ bar watching the payoffs.

Implicit variables can be bound by temporal antecedents:

(11) [In most years]^i, I passed the exam$_i$.

Domain restrictions of quantifiers and definites can be bound by quantifiers:

(12) [Only one class]^i was so bad that no student$_i$ passed the exam$_i$. (Heim, 1991)

Domain restrictions of quantifiers and definites can be bound by temporal antecedents:

(13) [Last year]^i, [on most days$_i$]^j it rained in the afternoon$_j$. (Beaver and Condoravdi, 2007)

Temporal cascades are not dependent on c-command

Both anaphora and temporal cascades can be bound out of a DP:

(14) a. [Every boy]^i's mother likes him$_i$.
b. [Every leap year]^i's leap day falls on [February 29^{th}]$_i$.

Both anaphora and temporal cascades can be "donkey"-bound by an indefinite:

(15) a. If/Whenever [a man]^i sees [a donkey]^j, [he]$_i$ beats [it]$_j$.
b. If/Whenever [a man]^i spends [a week]^j in the mountains, [he]$_i$ hikes [every day]$_j$.
c. Every man who owns [a donkey]^i beats [it]$_i$.
d. Every man who spends [a week]^i in the mountains hikes [every day]$_i$.

Temporal cascades do not stop at sentence boundaries

Temporal cascades exhibit quantificational (16) and modal (17) subordination:

(16) a. Most books contain a table of contents. In some, it is at the end.
b. Every year, Arnim spends a week in the mountains. In some years, he hikes every day.

(17) a. A wolf might come in. It would eat you first.
b. Arnim might spend the next summer in the mountains. He would hike every day.

Temporal cascades can give rise to paycheck readings

Paycheck readings arise when an expression picks up an entity x and a function f, and denotes $f(x)$.

(18) The wise man^i gave his$_i$ paycheck^f to his wife. The foolish man^j gave **it**$_{f(j)}$ to his mistress.

Paycheck readings also occur in the temporal domain. Here, f maps years to their March months:

(19) a. This year^i I did my taxes in March$_i^f$. **That**$_{f(j)}$'s also when I did them last year^j.
b. This year^i I did my taxes in March$_i^f$. Last year^j, I also did them **then**$_{f(j)}$.

Analysis sketch

With P&F and Stechow, I assume that sentence radicals are predicates of intervals (20a). The meaning of *before* can be paraphrased as "at some time prior to" (20b). I will write S for interval predicates.

(20) a. ⟦it rains⟧ = $\lambda i \exists e$[rain$(e) \wedge \tau(e) \subseteq i$] to be paraphrased as λi[it-rains-within(i)]
b. ⟦before⟧ = $\lambda i \lambda S \exists j[S(j) \wedge j < i]$

For quantified PPs, we use argument raising (Hendriks, 1993):

(21) a. ⟦every Sunday⟧ = $\lambda S \forall j$[Sunday$(j) \rightarrow S(j)$] (type $\langle it, t\rangle$; preliminary)
b. ⟦AR(before)⟧(⟦every Sunday⟧) = $\lambda S \forall i$[Sunday$(i) \rightarrow \exists j[S(j) \wedge j < i]$]

To avoid quantifying over all Sundays, we contextualize temporal expressions with another λi slot.

(22) a. ⟦every Sunday⟧ = $\lambda i \lambda S \forall j$[Sunday$(j) \wedge j \subseteq i \rightarrow S(j)$] (type $\langle i, \langle it, t\rangle\rangle$)
b. ⟦noon⟧ = λi[the-noon-of(i)] (type ii)

This λi slot should be passed up to the next temporal antecedent: tense or a temporal PP.

(23) PAST^i [On every Sunday$_i$]^j, it rain before noon$_j$.

Since temporal cascades are anaphoric, we need a framework that handles anaphoric relations. Variable-free semantics (VFS, Jacobson, 1999) is similar to Pratt and Francez, but gives us longer dependencies.

In VFS, a generalized Geach rule $\mathbf{g}_c$ passes up an anaphoric dependence of type c. Informally, $\mathbf{g}_c$ tells a function f that its argument has one more lambda slot than expected, and passes the slot upwards.

(24) ⟦$\mathbf{g}_e$(John)($\mathbf{g}_e$(thinks)($\mathbf{g}_e$(Bill))(($\mathbf{g}_e$(loves))(her)))⟧ = λx[think(john, love(bill, x))]

Jacobson's $\mathbf{g}_c$ is triggered by the type mismatches created by contextualization.

(25) a. ⟦$\mathbf{g}_i$(before)⟧ = $\lambda f \lambda i \lambda S \exists j[S(j) \wedge j < f(i)]$
b. ⟦$\mathbf{g}_i$(before)⟧(⟦noon⟧) = $\lambda j \lambda S \exists j[S(j) \wedge j <$ the-noon-of$(j)]$
c. ⟦$\mathbf{g}_i$(AR(before))⟧(⟦every Sunday⟧) = $\lambda i \lambda S \forall j$[Sunday$(j) \wedge j \subseteq i \rightarrow \exists k[S(k) \wedge k < j]$]

To apply a temporal PP to a sentence radical S (of type $\langle it\rangle$) such as *it rain*, we first lift S so that it takes the PP as an argument. Then we tell S via $\mathbf{g}_i$ that the PP has one more lambda slot than expected:

(26) a. ⟦$\mathbf{g}_i$(**lift**(⟦it rain⟧))⟧ = $\lambda R_{\langle i,\langle i,it\rangle\rangle} \lambda j[R(j)(\lambda i$.it-rains-within$(i))]$
b. ⟦it rain before noon⟧ = ⟦(26a)⟧(⟦(25b)⟧) = $\lambda i \exists j$[it-rains-within$(j) \wedge j < \tau($the-noon-of$(i))]$

We can now apply another temporal PP in the same way, and/or apply tense to close off the sentence.

Summary

Temporal dependencies in cascaded PPs are anaphoric and not movement-based, as opposed to Geis sentences. Pratt and Francez's system can be modified to take von Stechow's criticism into account.

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