



On Temporal Quantification*

Edgar Onea

University of Göttingen

edgar.onea@zentr.uni-goettingen.de

Abstract. Generally, it is assumed ever since Pratt & Francez (2001) that temporal expressions have a context-dependent meaning in the sense that they not only denote a set of time intervals according to their lexical content but rather their denotation is additionally restricted to some contextual time. Hence, *Monday* does not just denote the set of Mondays but a function from time intervals to the Mondays in them. This is useful in dealing with concomitant quantifiers such as *John kissed Mary every second semester on every Monday* for it allows them to restrict each other domain of quantification. In this paper I propose a way to eliminate this context dependency of temporal expressions building up on an idea of Irene Heim that domain restriction in the temporal domain is a matter of presupposition projection. In particular I argue that temporal prepositions presuppose that their argument, a time interval, intersects a higher time interval. This not only helps to derive concomitant quantification but also solves some classical problems of competing theories.

1 Introduction

Temporal quantification, i.e. the compositional derivation of the truth conditions of a sentence like (1), is a classical issue in semantic theory and a hard one at the same time. I think a fair amount of confusion is around in the literature concerning this topic for the most part due to uncertainty about the readings that should and should not be derived.

- (1) John called on every first Monday after every competition that he won in every second decade.

In this paper I will develop a not too complicated theory of temporal quantification in the framework of transparent LF that tackles two of these confusions. First, scholars have assumed that time denoting expressions, such as *Monday* have context dependent denotations. I will show that this assumption is both theoretically and empirically inadequate and I will show how to replace it by

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postulating that temporal prepositions are presuppositional. Second, real quantifier stacking, i.e. applying several quantifiers to the same thematic role, and concomitant quantifiers that restrict each other's domain of quantification are different phenomena. In fact, I will argue that it is indeed possible (and at times necessary) to apply several temporal prepositional phrases in the same clause.

The first section explains the two problems to be discussed. First, the issue of the interaction between temporal quantifiers and tense, which lead to the introduction of context dependent meanings for temporal expressions, and second, the problem of stacked quantifiers. In the following I first present a theoretical argument against context dependent meanings, followed by a sketch of a theory for dealing with temporal quantification partly following von Stechow (2002). In passing, I propose a particular version of the well known *predicate abstraction* rule of Heim & Kratzer (1998). Finally I discuss the case of stacked temporal prepositional phrases and conclude the paper.

2 The Problems of Temporal Quantification

Temporal quantification is complicated because the interpretation of temporal quantifiers needs to interact with the tense operator, which seems to get quite murky. To see this, consider a fairly simple example like (2) from Ogi-hara (1994). If there were no tense involved the sentence would not pose any problems, however as soon as we want to consider the fact that the calling took place in the past, both conceivable representations that attempt to model this interaction in terms of scope given in (2a) and (2b) are nonsensical. What we really need is the representation in (2c), which uses the past as a domain restriction when quantifying over Mondays, but getting the past to restrict the domain of quantification of *every* is compositionally non-trivial, given standard assumptions about the place of tense in the syntactic representation of (2), in particular, past is not directly combined with *Monday*.

(2) John called every Monday.

- a. $\exists i.past(i) \wedge \forall x.Monday(x) \rightarrow in(x, i) \wedge call(J, i)$
- b. $\forall x.Monday(x) \rightarrow \exists i.past(i) \wedge in(x, i) \wedge call(J, i)$
- c. $\exists i.past(i) \wedge \forall x.Monday(x) \wedge in(x, i) \rightarrow call(J, i)$

The standard proposal to solve the problem is to assume a higher-order meaning of time-denoting expressions such as *meeting*, *Monday*, *year* etc. such that they do not simply denote sets of time intervals, as naturally represented in (3a), but rather functions from time intervals into sets of time intervals as in (3b). This is useful, since it provides a lexical slot in time denoting expressions which can be used to essentially get the dependency on the past into the restric-

tor of the quantifier, as required in (2c). The lexical entry in principle allows for something like (3c), which allows the interaction between the past operator and the restrictor of the quantifier *every* via the variable j . (Getting this to work is still non-trivial but at least the basic ingredients are there.)

- (3) a. $\llbracket \textit{Monday} \rrbracket = \lambda i. \textit{Monday}(i)$
 b. $\llbracket \textit{Monday} \rrbracket = \lambda i. \lambda j. \textit{Monday}(i) \wedge \textit{in}(i, j)$
 c. $\llbracket \textit{everyMonday} \rrbracket = \lambda Q. \lambda j. \forall x. \textit{Monday}(x) \wedge \textit{in}(x, j) \rightarrow Q(x)$

I will argue in this paper that this way of thinking is conceptually and empirically inadequate and show how to get rid of it.

Temporal quantifiers tend to have another problem as well, namely that they may come *stacked*, as in (4). Pratt & Francez (2001) argue that this is the very same problem as the interaction with tense. This is because Pratt & Francez (2001) apply both quantifiers one after the other at the clause level, as in (4a), and attempt to model the fact that they restrict each other's scope. For them, *every Monday* in (4) quantifies over every Monday that is in every second year, just the same way as one would model that every Monday actually quantifies over every Monday that is in the past for (2).

I think the argument of Pratt & Francez (2001) is correct, although the cases in which we really need stacking of temporal quantifiers, are rare, and distinguishable truth conditionally, whenever no real quantifiers are involved but rather definite descriptions. For most cases, temporal quantifiers modify each other like in (4b), as argued in von Stechow (2002). So, in (4), *on every second year* is interpreted as directly modifying *Monday*. Therefore, there is no stacking of quantifiers here. We rather have an embedding problem. This is modeled in a completely different way than the interaction with tense. Such a solution is rather similar to an intuitive treatment of (5), which does not seem particularly puzzling and crucially has nothing to do with time.

- (4) John called every Monday on every second year.
 a. John called [every Monday] [on every second year]
 b. John called [every Monday [on every second year]]
- (5) Peter called every son of every son of Michael.

Interestingly, the LF-style given in (4a) is used by Pratt & Francez (2001) to derive the so-called *short reading* of temporal prepositional phrases, readings that are ultimately intersective, i.e. the calling must be both every Monday and on every second year, with the twist, however, that only Mondays are considered that are in every second year. An LF-like (4b) is used by von Stechow

(2002) to derive the so called *long reading* which only requires the calling to be on Monday, but knowing that Mondays are within years makes the difference hard to see in such examples. And, finally, Beaver & Condoravdi (2007) use the LF (4a) and derive the long reading with it.

The short readings do exist, however, and cannot be reduced to scope variation in long readings. Consider (6). The first two readings, (6a) and (6b) are available for von Stechow (2002), Pratt & Francez (2001) and Beaver & Condoravdi (2007), but the third reading, the short reading, is only predicted by Pratt & Francez (2001). That is not quite true, however, for Pratt and Francez would require either the Tuesday to be after the meeting or the meeting to take place on Tuesday, hence, making (6c) truth conditionally equivalent to either (6a) or (6b). Beaver & Condoravdi (2007) are aware of this fact and explicitly postulate that we only need to derive the readings in (6a) and (6b), the short reading coming for free then.

- (6) John called after the meeting on Tuesday.
- a. John called after the meeting which was on Tuesday.
 - b. John called on Tuesday which was after the meeting.
 - c. John called in the intersection between Tuesday and the time after the meeting.

But assume the following scenario. There is a meeting which starts on Monday at 2 pm and finishes on Tuesday at 2 pm. Now, (6c) requires a calling event to take place between Tuesday 2 pm and the end of Tuesday. I think this reading actually exists and does not boil down to neither (6a), since the meeting was not on Tuesday, nor (6b), since the Tuesday under discussion did not start after the meeting. Superficially, this could be solved by allowing overlapping between time intervals instead of inclusion, hence getting the readings (7a) and (7b). Unfortunately, however, not even the reading (7b) captures the short reading entirely correctly, for it would allow the calling to take place in a part of Tuesday that is during the meeting, for instance Tuesday at 1 pm, which is contrary to the fact.

- (7) a. John called after the meeting which overlaps Tuesday.
 b. John called on Tuesday which overlaps the time after the meeting.

Getting a unified account for both kinds of readings is the natural task arising. Such a theory does not exist, however. To be clear, all existing theories fail already in singling out the right Tuesday for the reading in (6c).

Summing up there are two problems to solve. Getting rid of context dependent denotations for time-denoting expressions, and distinguishing between

real temporal PP stacking and the case of embedded quantification.

3 Against Context Dependent Denotations

It should be the null-hypothesis that temporal expressions have no context dependent denotation, so actually one needn't argue against them, but rather in favor of such denotations. That never actually happened. Still, I will give some additional reasons to refrain from assuming such denotations.

Intuitively, *Monday* denotes the set of Mondays simpliciter, just like *chair* denotes the set of chairs in a model. In order to get a more constrained set of chairs or Mondays we need to do additional work. Whenever possible we should not mess around with this intuition. And indeed, even very simple sentences like (8) would get problematic if we did.

(8) This is a Monday.

One could argue that *Monday* is ambiguous. But even this does not seem to hold generally. It rather seems that (8) cannot have a reading which can be paraphrased as *This is a Monday in t*. Consider for instance the dialogue in (9) and assume that the day Mary killed the cat was two years ago, but indeed a Monday. If Monday denoted Mondays in a salient interval, one would expect the answer (9b) to be at least conceivable, since the day under discussion is not in the salient interval, hence the sentence is just false. But as a matter of fact, it (9b) is completely nonsensical, whereas the answer (9a) is good.

- (9) A: Last year, Peter called every Monday.
 B: No, the day on which Marry killed the cat was a Monday and Peter did not call.
- a. A: No, that Monday is not relevant, for it was more than two years ago.
 - b. A: ??No, that's not a Monday, for it was more than two years ago.

Yet another argument involves deictic expressions like *today*, *this year*. Such expressions also need to interact with the tense operator, hence, it is expectable that their denotation will also be analogous, including a context dependent variable.¹ So, we get the representations in (10) or something similar. But binding *j* by the past operator would predict that today is part of the past, which is nonsense, for as long as today is not over, some part of it will be part of the present and part of it will even be in the future.

¹ Of course one could assume that deictic expressions are interpreted higher than tense, but even so, the intersection between e.g. *today* and past will somehow need to be modeled.

$$(10) \quad \lambda j. \lambda i. \text{today}(i) \wedge \text{in}(i, j)$$

A final argument is based on example (11). The example seems perfectly natural. But if, indeed, *meeting* meant meeting in x and x were bound by past, we would require a past meeting, however, as the continuation shows, the meeting is a future one although the tense operator is past. This, again, is absolutely impossible according to the theory of Pratt & Francez (2001) or von Stechow (2002). In fact the same applies to any theory that uses context dependent denotations for time denoting expressions.

- (11) John called before the meeting, just as he promised. Look, the meeting will be tomorrow, and he already called.

I conclude that assuming that time denoting expressions have a context dependent denotation leads to more problems than it solves. If temporal quantification can be made to work with such denotations, they should be abandoned. In the next section I give an explicit proposal to this extent.

4 The Proposal

The system I propose in the following involves three aspects. First, I need the lexical entries and the syntactic representation. Then, I need a theory of presupposition projection. Finally I derive some examples and discuss some of the benefits of the theory both with embedded quantifiers modifying each others restrictor, and with real quantifier stacking.

4.1 Basic Elements

I assume that time-denoting expressions (or event-denoting expressions coerced to time) have simple lexical meanings as given in (12) for a couple of examples. I tacitly assume that all time variables involved in natural language are intervals and omit writing up their types for simplicity.

- (12) a. $\llbracket \text{Monday} \rrbracket = \lambda x. \text{Monday}(x)$
 b. $\llbracket \text{year} \rrbracket = \lambda x. \text{year}(x)$
 c. $\llbracket \text{meeting} \rrbracket = \lambda x. \text{meeting}(x)$

I further assume that temporal prepositions come with a presupposition of adequacy, i.e. they presuppose that the time determined by their internal argument overlaps some contextually defined time, as shown in (13). Note that there is a huge conceptual advantage in including context-dependency in the meaning of functional words as compared to the lexical denotation of content words: for instance, all examples discussed in Section 3 do not apply to temporal expres-

sions headed by a preposition.

- (13) a. $\llbracket \text{during} \rrbracket = \lambda x. \lambda P. \lambda i. \lambda i [i \cap x \neq \emptyset]. P(x \cap i)$
 b. $\llbracket \text{before} \rrbracket = \lambda x. \lambda P. \lambda i. \lambda i [i \cap \text{tto}(x) \neq \emptyset]. P(\text{tto}(x) \cap i)$
 c. $\llbracket \text{after} \rrbracket = \lambda x. \lambda P. \lambda i. \lambda i [\overline{i \cap \text{tfrom}(x)} \neq \emptyset]. P(\text{tfrom}(x) \cap i)$

For the more technically interested reader: time intervals are treated as ordered sets of time points, as defined in (14) hence the set theoretical operation \cap applies and delivers an interval.

- (14) a. x is a time point iff $x \in \text{TIME}$.
 b. chron is a total function: $\text{TIME} \rightarrow \mathbb{R}$ defined in each model M .
 c. Iff $\text{chron}(x) < \text{chron}(y)$ then x precedes y .
 d. a is an INTERVAL iff
 $\forall x. x \in a \rightarrow x \in \text{TIME} \wedge \forall x, y. x, y \in a \wedge \text{chron}(x) < \text{chron}(y) \rightarrow$
 $\forall z. \text{chron}(z) > \text{chron}(x) \wedge \text{chron}(z) < \text{chron}(y) \rightarrow z \in a$

The operators tto and tfrom are defined in (15a) and (15b) respectively.

- (15) a. $\text{tto}(a) = \{x | x \in \text{TIME} \wedge \text{chron}(x) < \text{chron}(\text{MIN}(a))\}$
 b. $\text{tfrom}(a) = \{x | x \in \text{TIME} \wedge \text{chron}(x) > \text{chron}(\text{MAX}(a))\}$
 c. $\text{MIN}(a) = \iota x. x \in a \wedge \forall y. y \in a \wedge y \neq x \rightarrow \text{chron}(y) > \text{chron}(x)$
 d. $\text{MAX}(a) = \iota x. x \in a \wedge \forall y. y \in a \wedge y \neq x \rightarrow \text{chron}(y) < \text{chron}(x)$

Further I assume that tense is not an operator but rather a constant, like a proper name, as given in (16).

- (16) a. $\llbracket \text{PAST} \rrbracket = \text{tto}(\text{NOW})$
 b. $\llbracket \text{FUTURE} \rrbracket = \text{tfrom}(\text{NOW})$
 c. $\llbracket \text{PRESENT} \rrbracket = \text{NOW}$
 d. $\text{NOW} = \{x | \sqrt{(\text{chron}(x) - \text{chron}(\text{now}))^2} \leq r\}$
 $\text{now} = \text{the deictic time point}$
 $r = \text{contextually specified}$

In addition, I assume that aspect introduces temporal variables into a clause, as shown in (17) and that aspect existentially closes the event variable, but this assumption is not a necessary ingredient of the theory.²

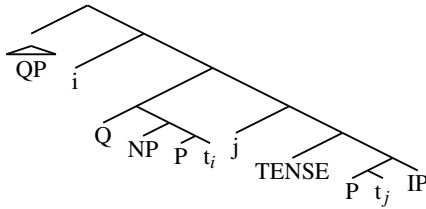
- (17) a. $\llbracket \text{PERFECTIVE} \rrbracket = \lambda P. \lambda i. \exists e. \text{in}(\tau(e), i) \wedge P(e)$

² In fact, in order to deal with the distributive readings of temporal quantifiers with *before* and *after* we might need additional interaction with events in the meaning of quantifiers in general, as argued in Krifka (1989), but I think there are alternative possibilities also: e.g. *after* could mean *not longer than x after* in those cases.

- b. $\llbracket PERFECT \rrbracket = \lambda P.\lambda i.\exists e.before(\tau(e), i) \wedge P(e)$
- c. $\llbracket IMPERF \rrbracket = \lambda P.\lambda i.\exists e.in(i, \tau(e)) \wedge P(e)$
- d. $before(a, b) = true$ iff $chron(MAX(a)) < chron(MIN(b))$
- e. $in(a, b) = true$ iff $chron(MIN(b)) < chron(MIN(a)) \wedge chron(MAX(b)) > chron(MAX(a))$

Coming to the syntax, I assume that any quantifier comes with a domain restrictor C and must be raised from the immediate argument position of any temporal preposition to a position higher than tense, which is more or less classical QR. I assume, further, that temporal quantifiers may appear as sisters of the restrictor argument of higher quantifiers, similar to von Stechow (2002), as shown in (18). In addition they can also be applied separately to an IP.

(18)



4.2 Presupposition Accommodation

Recall the original example (2), repeated here for convenience as (19). The needed reading is given in (19a). The problem is that the Mondays quantified over must be restricted to Mondays in the past. Therefore, we want the information that the Monday must be in the past to somehow enter the restrictor domain of the quantifier *every*. Competing theories achieve this by opening a slot in the representation of *Monday* such that *Monday* denotes a Monday in some interval. I rejected this line of attack altogether and proposed that instead what we have is a presupposition triggered by the covert *during* that its argument is in a contextually salient time. *Every Monday* will be raised out of the argument position of the preposition and it will end up in the highest possible position. The question, now, is whether one can accommodate this presupposition such that it enters the restrictor of *every*.

(19) John called (during) every Monday.

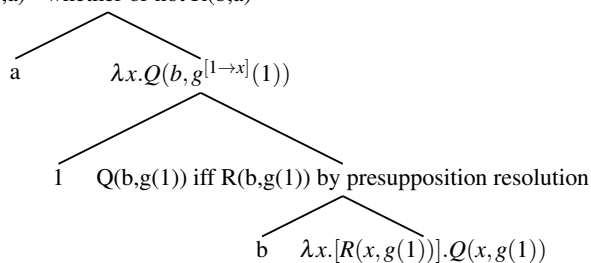
- a. $\exists i.past(i) \wedge \forall x.Monday(x) \wedge on(i, x) \rightarrow call(J, i)$

This could be a case of intermediate accommodation in the sense of Geurts & van der Sandt (1999). However, it has been forcefully argued by Beaver (2001), but see also von Stechow (2008), that intermediate accommodation does not exist. In my view this question is not totally settled and I prefer to remain agnostic

about this issue. For explicitness I will assume that what looks like intermediate accommodation is in fact global accommodation. In particular this means that intermediate accommodation appears to exist because there is a global domain reduction to the very same extent (to avoid presupposition failure).

A formal side note is in order here. I use predicate abstraction in the sense of Heim & Kratzer (1998) to model QR. Predicate abstraction, however, has one particularly unfortunate property, namely that it loses presuppositions attached to traces abstracted over. Consider the abstract case in (20). The reason why the presupposition attached to 1 is lost is that in the predicate abstraction rule, there is nothing that would save them. While the sister node of 1 is defined for any g such that $R(b,g(1))$, the higher node basically frees up this constraint.

(20) Q(b,a) - whether or not $R(b,a)$



The problem can be solved, however, with a small change in the predicate abstraction rule, given in (21). This rule now globally projects presuppositions after predicate abstraction as well, just as (presumably) originally intended in Heim & Kratzer (1998).

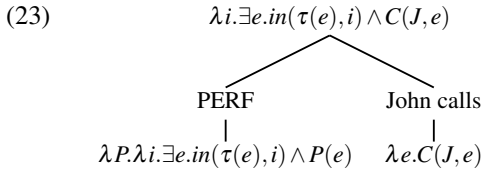
(21) **Predicate abstraction with presuppositions:** If γ is a tree consisting of α and β , and α is an index i , then for any g for which $\llbracket \beta \rrbracket^g$ is defined, $\llbracket \gamma \rrbracket^g = \lambda x. \llbracket \llbracket \beta \rrbracket^{g^{[i \rightarrow x]}} \text{ is defined} \rrbracket. \llbracket \beta \rrbracket^{g^{[i \rightarrow x]}}$

4.3 Embedded Quantification

I will derive one reading of each of the four examples given in (22a), (22b), (22c) and (22d) in the following. The derivations are given in classical transparent LF style.

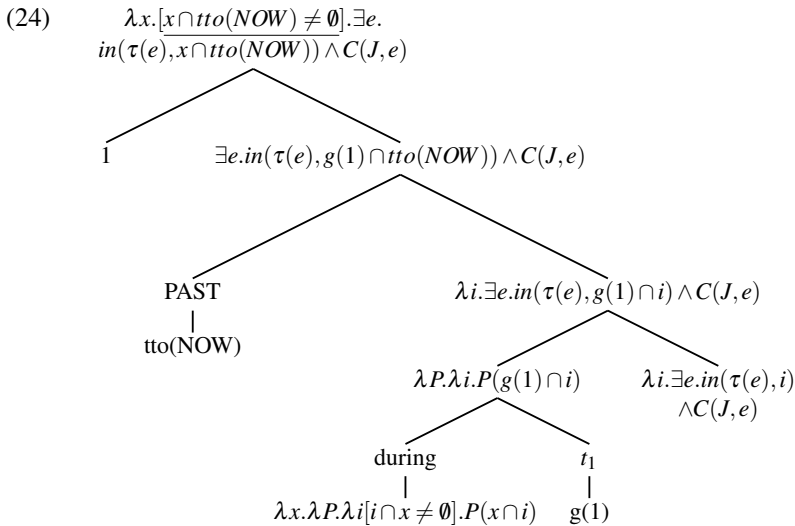
- (22)
- John called every Monday.
 - John called every Monday every summer.
 - John called today.
 - John called before the meeting.

I first derive the constituent *John called* with a perfective aspect, which will appear in each of the sentences, as shown in (23).



Note that any kind of temporal modification is made available by the presence of aspect. Until the event itself is built up, there is no time variable in play whatsoever. As noted before, the fact that I existentially close the event variable can be circumvented by treating it as a pronominal element.

I start with (22a). I assume that *every Monday* is headed by a covert preposition like *on* or *during*. First, I apply *during every Monday* to the result of (23), as shown in (24). Note that *every Monday* is only represented by the trace t_1 , being raised to a higher position in the tree. The whole tree fragment is only defined for assignments g such that $g(1) \cap i \neq \emptyset$, via the presupposition of *during*. In the next step I apply PAST to the result and lambda abstract via the rule (21), which now preserves the presupposition.



Now, all that remains to be done is to apply the QR-ed *every Monday* which goes trivially, as given in (25). The result is defined exactly if every Monday in C overlaps with the past, and suffers presupposition failure otherwise.

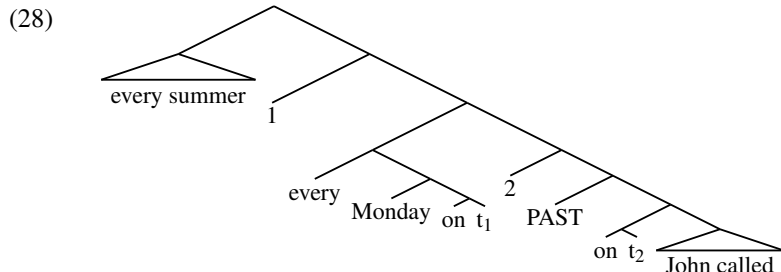
The arising reading is this: it is presupposed that all Mondays in *C* overlap the past (could be included, of course) and it is stated that in the overlapping part between each Monday in *C* and the past interval, there is an event of John calling. This predicts that whenever we are explicitly speaking about non-past Mondays, the sentence is strange.

$$(25) \quad \forall y.M(y) \wedge y \in C \rightarrow \exists e.in(\tau(e), y \cap tto(NOW)) \wedge C(J, e)$$

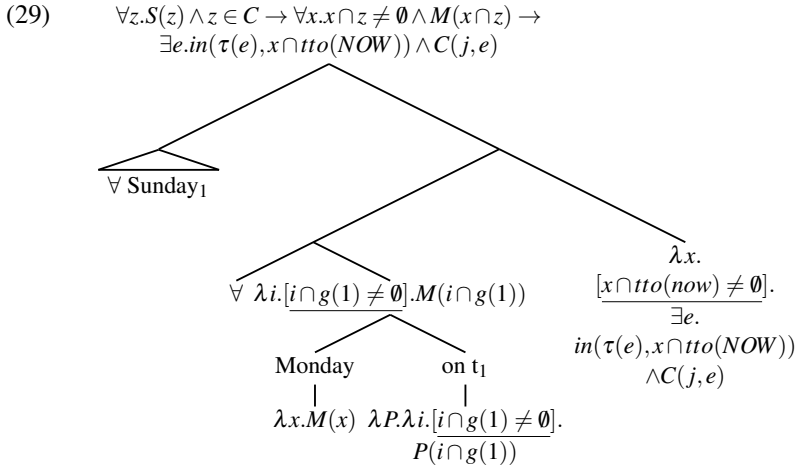
Consider a scenario in which A utters (26) in June. It seems to me that the answer in (26a) is at least more natural than the one in (26b). This is quite similar to the classical behavior of presuppositional sentences like in (27).

- (26) A: Speaking about the 52 Mondays this year, John called every Monday.
 - a. B: Well, that's only true for the past Mondays.
 - b. C: ?Of course he did.
- (27) A: Speaking about the 82 Million Germans, every German loves his Mercedes Benz.
 - a. B: Well, that's only true for those who have one.
 - b. C: ?Of course they do.

Let us now consider example (22b). This time, the quantified PP *during every summer* modifies directly the NP restrictor of the quantifier *every*, namely *Monday*. We get the structure given in (28).



The interesting question is, how *every summer* modifies *Monday*. The relevant part of the tree is given in (29). The presupposition associated with *on every summer* survives and results in the global presupposition that every summer in C overlaps the past, and the presupposition associated with *on every Monday* is locally accommodated as it ends up being in the restrictor of a universal quantifier. Apart from this, the computation is standard, hence embedded quantification poses no problem whatsoever for the system.



The problem of deictic expressions like *today* comes out trivially in the current approach, as shown in (30), which simply contains the predicted truth conditions for (22c). Presupposing that the past overlaps today is trivial and harmless.

- (30) John called today.
- a. asserts: $\exists e.in(\tau(e), tto(NOW) \cap \iota x.today(x)) \wedge C(J, e)$
 - b. presupposes: $tto(NOW) \cap \iota x.today(x) \neq \emptyset$

Finally, let us consider the example (22d), which turns out to be simpler than expected, cf. (31). The crucial point is that there is no presupposition that the meeting itself need be in the past. This is because *before x* only presupposes that the time before x will overlap the contextual time (the past). In a way, this is a fairly trivial presupposition, but if we had *after every meeting*, we had a more meaningful presupposition, as this would really require past meetings.

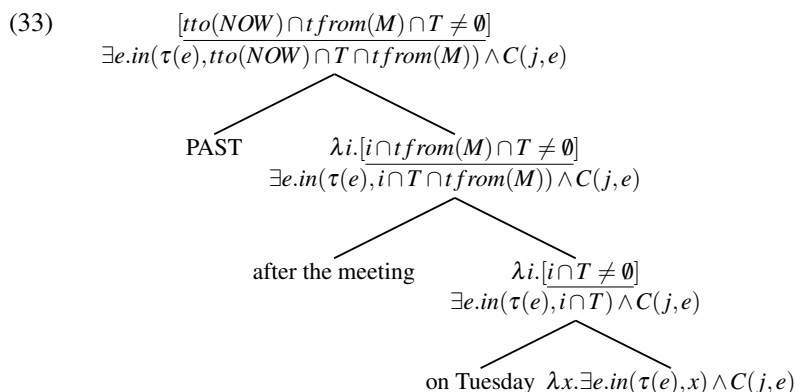
- (31) a. asserts: $\exists e.in(\tau(e), tto(\iota x.Meeting(x)) \cap tto(NOW)) \wedge C(J, e)(y)$
 b. presupposes: $\frac{tto(\iota x.M(x)) \cap tto(NOW) \neq \emptyset}{}$.

4.4 Stacking Quantifiers

Recall that (6), repeated here as (32), does not boil down to scope ambiguity alone but has a strong *short reading*. But for the scenario discussed in the introduction, this does not seem to suffice. Assume a meeting which starts on Monday at 2 pm and finishes on Tuesday at 2 pm. Now, (6c) requires a calling event to take place between Tuesday 2 pm and the end of Tuesday. As opposed to Pratt & Francez (2001) and von Stechow (2002) and Beaver & Condoravdi (2007) who actually even fail to find the right Tuesday in such a case (since there is no Tuesday in the time after the meeting and no Tuesday which includes the time after the meeting), the theory sketched here fails because it allows, in the second reading, the calling to take place on the right Tuesday, but during the meeting, i.e. in the part of Tuesday that is not after the meeting.

- (32) John called after the meeting on Tuesday
- a. John called in the overlapping time between the past and the time after the meeting which overlaps Tuesday
 - b. John called in the overlapping time between the past and the Tuesday which overlaps the time after the meeting

For this reason I assume that we need stacking temporal PPs as well to get the short reading of Pratt & Francez (2001). Fortunately, the system has absolutely no problems with stacking PPs. I demonstrate in (33) for (32) on a strongly simplified tree, in which M stands for *the meeting* and T for *the Tuesday*.



Stacking two real quantifiers which would undergo QR would result in presupposition failure. The problem is that we get two presuppositions hanging on both traces that depend on each other and thereby make global accommodation obscure. The only system that can handle these is Geurts & van der Sandt

(1999) but it is not clear whether those readings actually exist. Does (34) have a reading such that it presupposes that for every meeting there is a Tuesday such that that Tuesday overlaps both the time after that meeting and the time of the meeting and the calling must have taken place in the part of each Tuesday that is after the meeting? I think, the required reading does neither exist nor does it make particularly much sense. Remember that if the Tuesday was not overlapping the time of the meeting, we could reproduce the truth conditions with embedded quantification.

(34) Peter called after every meeting on every Tuesday.

5 Conclusion

In this paper I have shown first of all that it is possible to do temporal quantification without assuming any kind of context dependent lexical meanings for time-denoting expressions. This is a very important finding as it seems to deliver a solid ground for refuting a number of theories. In passing, a more elaborate version of predicate abstraction was given and in addition it has been shown that peculiar cases in which temporal prepositional phrases are really stacked can be dealt with without any further refinement of the system. Presumably, however, quantifier stacking involving more than one quantifier does not occur.

References

- Beaver, David. 2001. *Presupposition and Assertion in Dynamic Semantics*. Stanford:CA: CLSI Publications.
- Beaver, David & Cleo Condoravdi. 2007. On the Logic of Verbal Modification. In Paul Dekker Maria Aloni & Floris Roelofsen (eds.), *Proceedings of the sixteenth amsterdam colloquium*, 3–11. Amsterdam.
- von Stechow, Kai. 2008. What is presupposition accommodation again? *Philosophical Perspectives* 22(1). 137–170.
- Geurts, Bart & Rob van der Sandt. 1999. Domain restriction. In Peter Bosch & Rob van der Sandt (eds.), *Focus linguistic, cognitive and computational perspectives*, 268–292. Cambridge: Cambridge University Press.
- Heim, Irene & Angelika Kratzer. 1998. *Semantics in generative grammar*. Oxford: Blackwell.
- Krifka, Manfred. 1989. Nominal reference, temporal constitution and quantification in event semantics. In J. van Benthem, R. Bartsch & P. van Emde (eds.), *Semantics and Contextual Expression*, 75–115. Dordrecht: Floris.

- Ogihara, T. 1994. Adverbs of Quantification and Sequence-of-Tense phenomena. In M. Harvey & L. Santelmann (eds.), *Proceedings of semantics and linguistic theory salt iv*, 251–267. Ithaca, NY: Cornell University.
- Pratt, Jan & Nissim Francez. 2001. Temporal Generalized Quantifiers. *Linguistics and Philosophy* 24. 187–222.
- von Stechow, Armin. 2002. Temporal Prepositional Phrases with Quantifiers: Some Additions to Pratt and Francez (2001). *Linguistics and Philosophy* 25(5-6). 755–800.