Toward a more fine-grained theory of temporal adverbials[*]

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Abstract In this paper I propose that a core property of adverbial meaning is the ability (or the lack thereof) of an adverbial to introduce a new time discourse referent. The core data comes from *that same day* in narrative discourse. I argue that unlike other previously studied temporal adverbials—which introduce a new time discourse referent and relate it to the speech time or a previously mentioned time—*that same* retrieves two salient times from the input context, i.e. it is 'twice-anaphoric', without introducing one of its own. Moreover, I argue that the adverb *currently* is like *that same day* in not introducing a new time discourse referent; it constrains the temporal location of a described eventuality relative to a salient time previously introduced into the discourse context. The analysis that I propose is implemented within Compositional Discourse Representation Theory. It illustrates how adverbial meaning can be integrated within a more general theory of temporal interpretation.

Keywords: adverbials, anaphora, deixis, compositional discourse representation theory

1   The puzzle

Adverbs are typically described as being *deictic, anaphoric*, both or neither.[1] The discourses in (1)-(5) illustrate these distinctions. In (1), the adverbless clauses—taken from the middle of a story—exemplify *narrative progression*: the temporal

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[1] Cf. Vegnaduzzo 2001, where temporal adverbs are classified as being *inherently deictic, inherently anaphoric* or *contextually anaphoric*. I choose the classifications that I do because it is convenient to relate the adverbial distinctions to two binary features: +/- anaphoric and +/- deictic (see Fig. 1 below). These features are not meaning components, but just descriptive abbreviations.

location of each described event depends on the temporal location of the previous event and the times of the described events correlate with the order of appearance.

(1)   a.   …Sue gave Fido a bath and cleaned our house.
        b.   My wife hired her and gave her a check for one month in advance…

In (2), the times of the described events also correlate with the order of appearance. However, unlike in (1b), the temporal location of the hiring event described in (2b) does not depend on the discourse context. We infer that the hiring took place the day prior to the speech time regardless of (2a). For this reason *yesterday* is typically called a *deictic* adverb: its meaning is dependent on the context of utterance.

(2)   a.   …Sue gave Fido a bath and cleaned our house.
        b.   **Yesterday,** my wife hired her and gave her a check for one month in advance…

In (3), we see narrative progression as in (1). The difference between (1b) and (3b) is that the latter is more specific about the temporal location of the hiring: *the day after* requires this event to be located after a salient day previously mentioned in the discourse (i.e. May 12, 1984). Adverbs whose meaning is dependent on discourse context in this way are typically called *anaphoric*.

(3)   a.   On May 12, 1984, Sue gave Fido a bath and cleaned our house.
        b.   **The day after,** my wife hired her and gave her a check for one month in advance.

In (4), the times of the described events correlate with the order of appearance as in (1)-(3). However, the temporal location for the hiring event depends neither on the discourse context or the context of utterance. Such is the case because *on June 13, 1985* is a proper name adverbial, referring to the only June 13, 1985 in the history of the world. Adverbs of this sort are neither deictic or anaphoric (cf. Kamp and Reyle's 1993 notion of *calendar adverbial*).

(4)   a.   On May 12, 1984, Sue gave Fido a bath and cleaned our house.
        b.   **On June 13, 1985,** my wife hired her and gave her a check for one month in advance.

Finally, in (5), there are two possible interpretations: (i) the hiring event took place on the closest Sunday *after* the house cleaning or (ii) the hiring event took place on the closest Sunday *prior* to the speech time. The former interpretation

	Retrieve a time anaphorically from the discourse context?	*Make reference to the context of utterance?*
May 12, 1984	No	No
Yesterday	No	Yes
the day after	Yes	No
on Sunday	Yes	Yes

Figure 1   Typology of adverbs (to be revised)

demonstrates the anaphoric usage of *on Sunday* that is on a par with *the day after* in (3), while the latter interpretation demonstrates the deictic usage of *on Sunday* that is on a par with *yesterday* in (2).[2]

(5)   a.   3 weeks ago on Friday, Sue gave Fido a bath and cleaned our house.
       b.   **On Sunday,** my wife hired her and gave her a check for one month in advance.

Fig. 1 above summarizes the typology of temporal adverbs that is generally assumed and exemplified by (2)-(5). One question that arises is: what is adverbial meaning like? That is: what are the ingredients that are common to the adverbials in Fig. 1? A good starting point is the analysis proposed by Partee (1984), according to which the semantic function of a temporal adverbial is to introduce a time discourse referent (DREF) into the discourse context. This DREF serves as the temporal location, or REFERENCE TIME, for the described event(s). The DREF introduced by deictic adverbs is related to the speech time, while the DREF introduced by anaphoric adverbs is related to discourse context. To the best of my knowledge, most (if not all) researchers working on temporal interpretation assume some version of this idea (even if implicitly).

The beauty of Partee's proposal is that it allows us to have an elegant theory of temporal anaphora. The crux of the theory is that (i) described events are always contained within the REFERENCE TIME, where (ii) the REFERENCE TIME is either the time denoted by a temporal adverbial or, (iii) in cases where a temporal adverbial is not present, it is the time 'just after' a previously mentioned discourse event.[3] For example, according to this theory, the cleaning event described in (1b) would be located within the time 'just after' the bath-giving event described by

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[2] To the best of my knowledge, Kamp and Reyle (1993) were the first to discuss the mixed properties of *on Sunday* and related adverbials (e.g. *in April, on April 15, at 9, at 9:15am*).
[3] Here I ignore the fact that grammatical elements other than adverbials (e.g. *when-clauses*) could also supply a REFERENCE TIME.

the previous clause.[4] Similarly, the hiring event described in (1b) would be located within the time 'just after' the cleaning event described in (1a), and so on. In this way, we account for the narrative progression in (1).

In (2b)-(5b), the hiring event would be located within the time denoted by the adverbial and not the time 'just after' the cleaning event described in (2a)-(5a). This is guaranteed via a deterministic 'update' of the REFERENCE TIME by the temporal adverbial, which fixes the temporal location of a described event; previously established REFERENCE TIMES no longer play an 'active' role.

Despite the elegance of this analysis, I argue in this paper that a temporal adverbial need not introduce a new time DREF into the discourse context—in addition to being +/- deictic and +/- anaphoric, a core property of adverbial meaning is whether an adverb is +/- in its ability to introduce a new time DREF. My argument is based on adverbial transparency to narrative progression. To see what I have in mind, consider the discourse in (6), which is like the other discourses we have seen thus far except that it has the adverb *that same day* in (6b). What is interesting about this discourse is that *that same day* does not alter the narrative progression that we saw in (1)—the adverb is, as it were, 'transparent to the progress'. That is, specifying that the hiring took place on the same day as the house cleaning does not block the additional inference that the hiring took place after the house cleaning.[5]

(6) a. On May 12, 1984, Sue gave Fido a bath and cleaned our house.
     b. **That same day,** my wife hired her and gave her a check for one month in advance.

The transparency of *that same day* is also evident in non-narrative contexts. For example, consider the discourse in (7), where we infer the so-called PARALLEL discourse relation in (7b) (Hobbs 1990)—i.e. there is no order that events described in (7b) are understood to have occurred in (though both are understood to follow the event described in (7a)).

(7) a. My mother made a lot of good Puerto Rican food last week.
     b. Two days ago, Jessica ate chicken with rice. Sam ate rice and beans.

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[4] As noted by Dowty (1986), 'just after' is deliberately vague. The point is that…reference times "immediately" follow one another in the sense that each successive sentence presents the very next event that transpires that is important enough to merit the speaker's describing it to the hearer, given the purpose of the narration" (*ibid*: 47); see also discussion in Kamp 1979.
[5] The same can be said about related adverbs like *that same week* and *that same month*, viz. (i), and presumably related adverbials like *that very day, that day,* among others.

(i) {The week/month} before your birthday, Sue gave Fido a bath and cleaned our house. That same {week/month}, my wife hired her and gave her a check for one month in advance.

As illustrated in (8), specifying that Sam's eating rice and beans took place on the same day as Jessica's eating chicken does not provide any new information that is not already inferred in (7).

(8) a.   My mother made a lot of good Puerto Rican food last week.
     b.   Two days ago, Jessica ate chicken with rice. **That same day**, Sam ate rice and beans.

The parallel between (7) and (8) is expected if we assume that the REFERENCE TIME for Sam's eating rice and beans is the same whether or not *that same day* is there, i.e. the day that precedes the speech time by 48 hours. The parallel between (1) and (6), however, is surprising. According to Partee's theory, the hiring event described in (6b) is contained within the REFERENCE TIME that is specified by *that same day*. If we assume a naïve semantics for this adverbial, namely that it denotes a 24-hour interval of time previously mentioned in the discourse, then we would say that *that same days* picks out May 12, 1984. While this correctly predicts that the hiring event described in (6b) took place on this day, nothing is said about how this event is ordered with respect to the cleaning event described in (6a), which also take places on May 12, 1984.

One possible approach to dealing with (6) is to say that the transparency of *that same day* is a reflex of its semantics, combined with independently motivated temporal constraints imposed by so-called *coherence relations*, which characterize the possible ways in which successive utterances could be connected to form a coherent discourse. For example, if we were to adopt Kehler's 2002 analysis of discourse coherence, we could say that *that same day* in (6) refers to May 12, 1984 (as we would expect) and the OCCASION relation is responsible for the narrative progression. The OCCASION relation is defined below, in (9), and should be read as follows: *if* OCCASION *holds between a pair of sentences S_1 and S_2, then the eventualities E_1 and E_2 described by S_1 and S_2 respectively are ordered by the complete precedence relation.*

(9)   OCCASION$(S_1, S_2) \rightarrow E_1 <_t E_2$

The question that arises is: Why should OCCASION be inferred in (6)? Following Hobbs 1979; 1990, Kehler assumes that a particular coherence relation is inferred based on world knowledge given that this knowledge is "consistent with any temporal relations imposed by the tenses used" (*ibid*: 191). Since the (simple) past tense is compatible with all coherence relations on Kehler's theory[6],

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[6] It denotes a precedence relation between the described event and the speech time (*ibid*: 190).

OCCASION should be inferable in (6) based solely on our assumptions about the world. This, however, seems unlikely. If world knowledge tells us anything about when people work in relation to when they are hired is that people typically begin work *after* being hired; people typically do not clean other people's things as a volunteers. However, in (6), we infer that the hiring took place *after* the cleaning.[7]

Note that the claim here is not that inferences about event ordering are divorced from constraints imposed by coherence relations. Research on discourse coherence has persuasively shown such relations are crucial to our understanding of temporal interpretation.[8] Rather, the claim here is that coherence relations are not responsible for the narrative progression in (6).[9] And if that is right, then we need an alternative analysis for discourses of this sort. In particular, we need a theory in which *that same day* does not block off independent rules of the grammar that account for the narrative progression (or any other temporal ordering that may arise with *that same day*).[10]

In the next two sections, I will analyze a simplified version of (6) using Compositional Discourse Representation Theory (CDRD, Muskens 1995). The punch-line of the analysis is: some temporal adverbials do not introduce a new time DREF into the discourse context, but merely constrain the temporal location of a described event relative to a salient time DREF previously introduced into the discourse context. I propose that the semantic function of *that same day* is two-fold: (i) find a salient time antecedent t that has the property of being a day and (ii) require that t take place throughout an already established REFERENCE TIME, within which the described event takes place. The idea is, then, that *that same day* retrieves two salient times from the input context, i.e. it is 'twice-anaphoric'. This is what I propose to be the crucial difference between *that same day* and an adverb like *the day after*, which introduces a new DREF into the discourse context

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[7] Note that some researchers have posited axioms that entail that the OCCASION relation is inferred by default (see Lascarides & Asher 1993). While this would potentially explain why there is narrative progression in (6), one would still have say why—given our knowledge of the world—the default is not overridden. Moreover, one would have to explain the infelicity of discourses like (ii) below (cf. Moens & Steedman 1988, Kamp & Reyle 1993).

(ii)   #Harry fell asleep next to Dawn at 5. She sat down. He took off her coat. She walked in.

[8] See e.g. Hobbs 1979; 1990, Mann & Thompson 1988, Lascarides & Asher 1993, Knott 1996; Knott & Mellish 1996, Kehler 2002, Webber *et al*. 2003, among many others.

[9] As noted by Jerry Hobbs (p.c.), another possibility is to say that 'and', which rarely has the meaning of simple conjunction, is responsible for the narrative progression in (6). Such a view, however, would not explain the narrative progression in discourses like (iii).

(iii)   Sue cleaned our house on May 12, 1984. That same day, Lev hired her.

[10] Note that this is different from saying that we need a theory in which *that same day* triggers a particular ordering of events.

and is only 'once-anaphoric'. A nice result of the analysis is that it is easy to implement with a more general theory of temporal interpretation, i.e. without any significant changes to well-known approaches to the meaning of tense and aspect.

I conclude the paper by arguing that the adverb *currently* is like *that same day* in constraining the temporal location of a described event relative to a salient time DREF previously introduced into the discourse context. *Currently* differs from *that same day*, however, in its ability to have a deictic interpretation (in addition to an anaphoric one), viz. *on Sunday*. Moreover, unlike other temporal adverbials, *currently* is typologically bizarre in having an affinity for stative VPs. I briefly discuss what this observation may mean for the interface between aspectual and adverbial meaning.

2　The framework

This section briefly outlines Muskens' (1995) CDRT that underlies the analysis proposed in this paper. This framework is chosen over, e.g. classic DRT proposed by Hans Kamp and colleagues (Kamp 1981, Kamp & Reyle 1993), in order to provide dynamic meanings of temporal expressions as terms in a typed λ–calculus. Moreover, while other compositional presentations of DRT exist[11], I find Muskens' presentation especially straightforward.

CDRT treats the syntax of DRT—i.e. the language of *Discourse Representation Structures* (DRSs)—as an abbreviation for more elaborate terms. Muskens starts from the assumption that DRSs constitute a binary relation between input and output assignments (embeddings in DRT terms). This relation is responsible for the dynamic nature of DRT. Assignments are functions from the set of DREFs to the domain. A DRS K is a pair of a set of DREFs $\delta,\ldots,\delta'$ (i.e. the universe of K) and a set of conditions $C,\ldots,C'$. As illustrated below, in (10), the meaning of a DRS K is the set of pairs of assignments $\langle f, g \rangle$ such that g differs from f at most with respect to the values that they assign to the DREFs in the universe of K, written $f[\delta,\ldots, \delta']g$, and g makes the conditions of K true (cf. Groenendijk and Stokhof 1991).

(10)　a.　　$[\![[\delta,\ldots,\delta' \mid C,\ldots,C']]\!]^{\mathfrak{M}} =$

　　　b.　　$\{ \langle f, g \rangle \mid f[\delta,\ldots, \delta']g \,\&\, g \in [\![C]\!]^{\mathfrak{M}} \cap \ldots \cap [\![C']\!]^{\mathfrak{M}} \}$

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[11] Cf. λ-DRT of Latecki and Pinkal (1990), Groenendijk and Stokhof's (1990; 1991) DPL, Asher's (1993) bottom-up DRT and the compositional version of DRT proposed by van Eijck and Kamp (1996). These other proposals could be adapted along similar lines to what is presented here.

CDRT mimics the dynamic nature of DRT in type logic by adopting assignments in the object language. In particular, the set of primitive types—i.e. one that includes individuals (type **e**), intervals of time (type **i**), eventualities (type **ε**), possible worlds (type **ω**) and truth-values (type **t**)—is enriched with type **s** for *environments*, which behave like assignments[12]; they "…are very much like the program states that theoretical computer scientists talk about, which are lists of the current values of all variables in a given program at some stage of its execution" (Muskens 1996: 11). In this paper, I assume the set of primitive types below, which differs from Muskens 1995 only in that I disregard possible worlds in the ontology. This is done for the sake of simplicity.

DEFINITION 1 (Types)
- e, i, ε, t, s ∈ Typ
- $(\mu\alpha) \in$ Typ, if $\mu, \alpha \in$ Typ

To see how environments are made part of the object language, consider (11). The DRS in (11a) serves as an abbreviation for the type s(st) expression in (11b), where *i* and *j* are variables over environments. Unlike in DRT, drefs in CDRT are functions that take an environment as an argument and return an object in that environment. Assuming that this object can be of any type, drefs are type sα, where $\alpha \in$ Typ. Moreover, conditions are treated as predicates of environments, i.e. expressions of type st.

(11)   a. $[\delta_{s\alpha},\ldots,\delta'_{s\alpha}|\ C_{st},\ldots,C'_{st}]$:=
       b. $\lambda i\lambda j.i[\delta,\ldots,\delta']j \wedge Cj \wedge\ldots\wedge C'j$

Unlike (10a), (11a) no longer gets a direct interpretation. Rather, the form that it abbreviates, namely (11b), gets assigned an interpretation. The meaning of a sentence φ is a relation that holds between environments *i* and *j* just in case *j* is an environment that might result from the interpretation of φ in environment *i*.
     Below, I provide examples of expressions of various types that are found in the analysis that follows.

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[12] The term *environment* comes from Stone 1997; Muskens uses the loaded notion *state* instead.

DEFINITION 2 (Constants and variables)

For any type $\alpha \in$ Typ, there is a denumerable set of α-constants Con$_\alpha$ and a denumerably infinite set of α-variables Var$_\alpha$, including the following sets:

- Con$_e$ = {sue,…}
- Con$_i$ = {may.12.1984,…}
- Con$_{et}$ = {house,…,jacket,…}
- Con$_{it}$ = {day,…,week,…}   • Var$_{(si(s(st)))}$ = {Q, Q',…}
- Con$_{(e(\varepsilon t))}$ = {enter,...,clean.our.house,…}   • Var$_{(s\varepsilon(s(st)))}$ = {P, P',…}
- Con$_{(e(e(\varepsilon t)))}$ = {hire,…read,…}   • Var$_s$ = {i, i',…j, j',…,k, k'}
- Con$_{se}$ = {u$_1$, u$_2$,…,u'$_1$, u'$_2$,…,u}   • Var$_{se}$ = {x, x',…}
- Con$_{si}$ = {t$_1$, t$_2$,… ,t'$_1$, t'$_2$,…,t}   • Var$_{si}$ = {t, t',…}
- Con$_{s\varepsilon}$ = {e$_1$, e$_2$,…,e'$_1$, e'$_2$,…,e}   • Var$_{s\varepsilon}$ = {e, e',…}

Let us now consider abbreviations that are relevant to the analysis proposed in this paper. Def. 3 expresses that *i* differs from *j* at most with respect to the values that they assign to δ. Note that ST is a predicate that is true of drefs, i.e. it stands for the predicate "is a DREF of type (sα)." This predicate is used by Muskens to ensure that DREFs and environments behave as variables and assignments respectively (see AX1-AX3 in Muskens 1995: 6-7).

DEFINITION 3

If δ is term of type sα, where $\alpha \in$ Typ, then *i*[δ]*j* abbreviates the conjunction of:

(i) $\forall \delta'_{s\alpha}[[ST_{(s\alpha)t}(\delta') \wedge \delta' \neq \delta] \rightarrow \delta'(j) = \delta'(i)]$ and

(ii)   the conjunction of $\forall \delta'_{s\beta}[ST_{(s\beta)t}(\delta') \rightarrow \delta'(j) = \delta'(i)]$ for all $\beta \in$ Typ $- \{\alpha\}$

Def. 4 provides abbreviations for DRS conditions which are used in the proposed meanings (Muskens 1995: 10). I refer the reader to Muskens 1995 for the semantics of the expressions below.

DEFINITION 4 (DRT abbreviations)

i. $\Re\{\delta_{s\alpha},…, \delta'_{s\alpha}\}$:= $\lambda i.\Re(\delta i,…,\delta' i)$ e.g. man{u$_1$} := λi.man(u$_1 i$)

        $\delta_{s\alpha} = \delta'_{s\alpha}$:= $\lambda i.\delta i = \delta' i$ e.g. t$_1$ = t$_2$:= λi.t$_1 i$ = t$_2 i$

        $\alpha_\alpha°$:= $\lambda i.\alpha$ e.g. sue° := λi.sue

ii.   C$_{st}$, C'$_{st}$:= λi.C$i \wedge$ C'i (conjoined condition)

iii.   K$_{sst}$; K'$_{sst}$:= $\lambda i\lambda j.\exists k[Kik \wedge Kkj]$ (sequencing)

iv.   [| C$_{st}$,…,C'$_{st}$]   := $\lambda i\lambda j.\ i = j \wedge$ C$j \wedge…\wedge$ C'j (text box)

v.   [$\delta_{s\alpha}$,…,$\delta'_{s\alpha}$ | C$_{st}$,…,C'$_{st}$] := $\lambda i\lambda j.i[\delta,…,\delta']j \wedge$ C$j \wedge…\wedge$ C'j (update & test)

vi.   K$_{sst}$ $\Rightarrow$ K'$_{sst}$:= $\lambda i.\forall j[Kij \rightarrow \exists k[K'jk]]$ (DRT implication)

vii. $\neg$K$_{sst}$:= $\lambda i.\neg\exists j[Kij]$ (DRT negation)

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Let us now consider in more detail the proposed temporal ontology. As mentioned above, I assume an ontology consisting of time intervals and eventualities of type i and ε respectively. Accordingly, the basic domains D_i and D_ε are sets of time intervals and eventualities respectively. Following Muskens 1995, I assume that D_i is ordered by the *complete precedence* relation $<$, which is a constant of type (i(it)). This relation is then used to define the inclusion relation $\subseteq$ (cf. van Benthem 1983).

DEFINITION 5
$$t \leq t' \quad := \quad t < t' \vee t = t'$$
$$t \subseteq t' \quad := \quad \forall t'' [t' < t'' \rightarrow t < t''] \wedge \forall t''[t'' < t' \rightarrow t'' < t]$$

Moreover, I assume that D_ε is ordered by the part-of relation $\sqsubseteq$, which is subject to the constraint in Def. 6.[13] I assume that the domains of eventualities and time intervals are linked through a temporal trace function τ, which takes an eventuality and returns its run time (Link 1987). That is, τ is a constant of type εi.

DEFINITION 6
For all eventualities e and $e' \in D_\varepsilon$: if $e \sqsubseteq e'$ then $\tau(e) \subseteq \tau(e')$

Given the temporal trace function τ, each eventuality inherits the relations in Def. 5. In what follows, I will write the more concise formula $t < e$ to abbreviate $t < \tau(e)$. Similarly, I will write $e \subseteq t$ for $\tau(e) \subseteq t$.

3   The solution

In this section, I would like propose an analysis for the discourse in (12)—a simplified version of (6)—using the framework outlined in the previous section.

(12)   a.   Sue cleaned our house on May 12, 1984.
       b.   That same day, Lev hired her.

To begin with, I propose to treat (12) as arising from the syntactic representation in (13).

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[13] For sake of simplicity, I assume that the domains of eventualities are domains of singular eventualities. If plurality is added to the theory, a Boolean structure needs to be imposed on top of the structures introduced here (Hinrichs 1985, Krifka 1989).

(13) a. $[_{TP} [_{AdvP}$ on May 12th 1984^{t_1}]$[_{TP}$ PST $[_{AspP}$ PFV^{e_2,t_2} $[_{VP}$ Sue^{u_3} clean our house]]]]
   b. $[_{TP} [_{AdvP}$ that same day$_{t_1,t_2}$]$[_{TP}$ PST $[_{AspP}$ PFV^{e_4,t_4} $[_{VP}$ Lev^{u_5} hire her$_{u_3}$]]]]

I assume that anaphoric relationships are indicated in the syntax.[14] I follow Barwise 1987, Muskens 1995 and others in indexing antecedents with superscripts and anaphoric expressions with subscripts, further requiring that (i) no two superscripts be the same and (ii) for each subscript n, where $0 < n$, there be a corresponding superscript n. Moreover, I assume that the speech time can serve as an antecedent even though it is not introduced into the discourse context, i.e. the speech time is always accessible (van Eijck & Kamp 1996). I will use t_0 to describe a constant function (of type si) from environments to the speech time.

   With regard to the assumed phrase structure in (13), note that I will not provide meanings of VP-internal expressions because the proposed analysis is not concerned with meanings of nominal expressions.[15] Moreover, I will treat all temporal adverbial expressions as syntactically on a par, i.e. as adverbial phrases, without providing the internal structure of such expressions. This is a gross idealization since an expression like *currently* surely has a different syntax from *on May 12th, 1984* and *the day after*. For the current purposes, however, all that matters is that these expressions are of the same semantic type. Finally, I make the standard assumption that English sentences in the 'simple past' have a covert aspectual operator in the head of AspP. Following Kratzer 1998, Szabó 2004, Landman 2008 and others, I assume that eventive sentences, viz. (12a,b), have a covert perfective operator (PFV) whose overt counterpart is found in many of the world's languages.

   Let us now proceed to derive the meaning of the discourse in (12) using the framework introduced in the previous section. Working bottom up, (14) provides the meaning of the VP in (13a), which is an abbreviation for the expression in (15) of type (sε(sst))—i.e. it is a function of the following kind: it takes a function from an environment to an event that has the property of being a house cleaning in that environment and returns a relation that holds between two environments i and j if (i) they differ maximally in the dref u_4 and (ii) the value of u_4 in the second environment j is Sue, who cleans our house.

(14) $[_{VP}$ Sue^{u_3} clean our house] $\leadsto \lambda e.[u_3 \mid u_3 = sue°$, clean.our.house$\{u_3, e\}]$
(15) $\lambda e \lambda i \lambda j.i[u_3]j \wedge u_3 j = sue \wedge$ clean.our.house$(u_3 j, ej)$

   The meaning of the VP combines with PFV, whose meaning is provided in (16) and (17). As is standard in work on aspect, PFV requires the introduced event

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[14] See Beaver 1999 for persuasive arguments against such an approach. I adopt it here for the sake of simplicity; space constraints do not permit me to deal with anaphora resolution explicitly.
[15] See Muskens 1996 and Brasoveanu 2007 for an analysis of nominal expressions within CDRT.

e_2 to be contained within a time argument t, which (as we will see) is supplied by adverbials and serves as the REFERENCE TIME for the described event (Kamp & Rohrer 1983, Klein 1994, von Stechow 1995, Kratzer 1998, Bary 2009).[16]

(16) $[_{Asp} PFV^{e_2, t_2}] \rightsquigarrow \lambda P \lambda t.[e_2, t_2 \mid e_2 \subseteq t, e_2 < t_2] ; P(e_2)$

(17) $\lambda P \lambda s \lambda t \lambda i \lambda j. \exists k(i[e_2, t_2]k \wedge e_2 k \subseteq tk \wedge e_2 k < t_2 k \wedge P(e_2)kj)$

Another key property of PFV is that it introduces a time t_2 that follows the described event e_2 (cf. Partee 1984). This time may (though need not) serve as an antecedent in subsequent discourse.[17] This is especially apparent when we consider (18), which combines of the meaning in (15) and the meaning in (17).

(18) $\lambda t \lambda i \lambda j. \exists k(i[e_2, t_2]k \wedge e_2 k \subseteq tk \wedge e_2 k < t_2 k \wedge k[u_3]j \wedge u_3 j = sue \wedge$
$\qquad\qquad clean.our.house(u_3 j, e_2 j))$

According to (18), there is an environment k in which the value of t_2 is after an event in k. We know that this time is available for anaphoric pick-up because the output environment that is passed on for the interpretation of subsequent discourse is j, which differs from k only in the value that it assigns to u_4 (and crucially not in value assigned to t_2). Whether the time is actually picked up as an antecedent depends on independent rules of anaphora resolution, which I do not address here.[18]

Let us now move on to consider the meaning of the past tense operator. As illustrated in (19)-(20), PST denotes a text box; it does not introduce a new DREF, but merely checks that the time argument precedes the speech time.

(19) $[_T PST] \rightsquigarrow \lambda Q \lambda t. [\mid t < t_0] ; Q(t)$

(20) $\lambda Q \lambda i \lambda j. \exists k(i = k \wedge tk < t_0 k \wedge Q(t)kj)$

As the final step to deriving the meaning of (13a), consider the meaning of the adverbial phrase *on May 12th 1984* in (21)-(22):

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[16] Note that PFV does not really introduce an event, but rather a function from an environment to an event in that environment. I will continue to say 'event' for simplicity of exposition.

[17] In this way, I depart from Partee's (1984) deterministic REFERENCE TIME update.

[18] The idea that I adopt in related work (Altshuler, forthcoming) is that anaphora resolution reduces to satisfaction of constraints imposed by coherence relations: it can look at many anaphors at once and can appeal to world knowledge, especially when there is a lot of content available (Hobbs 1979; 1990).

(21) $[_{\text{AdvP}}$ on May 12$^{\text{th}}$ 1984^{t_1}] $\rightsquigarrow$ $\lambda Q[t_1 \mid t_1 = \text{may}.12.1984°]$; $Q(t_1)$

(22) $\lambda Q \lambda i \lambda j.\exists k(i[t_1]k \wedge t_1 k = \text{may}.12.1984 \wedge Q(t_1)kj)$

Here we see that *May 12th 1984* introduces a time that names May 12, 1984. In this way, it is semantically on a par with the proper name *Sue*, cf. (14)-(15). As we shall see shortly, *that same day* differs from *May 12th, 1984* in (i) not introducing a new time DREF and (ii) retrieving two salient DREFs previously introduced into the discourse context.

When we combine the meanings in (14), (16), (19) and (21), we get the meaning in (23), which is an abbreviation for the expression in (24) of type sst. Note that I will henceforth use the convention of putting conditions that contain antecedents for subsequent discourse, viz. $e_2 < t_2$, at the end of the formula.

(23) $[_{\text{TP}} [_{\text{AdvP}}$ on May 12$^{\text{th}}$ 1984^{t_1}]$[_{\text{TP}}$ PST $[_{\text{AspP}}$ PFV^{e_2,t_2} Sue^{u_3} clean our house]]] $\rightsquigarrow$
$[t_1, e_2, t_2, u_3 \mid t_1 = \text{may}.12.1984°, t_1 < t_0, e_2 \subseteq t_1, \ u_3 = \text{sue}°,$
clean.our.house$\{u_3, e_2\}, e_2 < t_2]$

(24) $\lambda i \lambda j.i[t_1, e_2, t_2, u_2]j \wedge t_1 j = \text{may}.12.1983 \wedge t_1 j < t_0 j \wedge e_2 j \subseteq t_1 j \wedge u_3 j = \text{sue}$
$\wedge$ clean.our.house$(u_3 j, e_2 j) \wedge e_2 j < t_2 j)$

According to the meanings above, there is a time interval before the speech event that is May 12th, 1984. A house-cleaning event took place within this interval. Moreover, a time after this event is introduced and, as will be seen shortly, serves as an antecedent for the hiring event described later in the discourse.

To finish the derivation of the entire discourse in (12), I will concentrate on the meaning of *that same day* in (12b). I disregard the meanings of the other expressions in (12b) because they are on a par with those in (12a). As illustrated in (25) *that same* requires: (i) a salient time antecedent t_1 that has the property of being a day and (ii) t_1 to have taken place throughout an already established REFERENCE TIME t_2, within which the described event takes place.[19]

(25) $[_{\text{AdvP}}$ that same day$_{t_1,t_2}$] $\rightsquigarrow$ $\lambda Q.[\mid \text{day}\{t_1\}, t_2 \subseteq t_1]$; $Q(t_2)$

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[19] As noted by Muffy Siegal (p.c.), discourses like (iv) present a challenge for the proposed analysis. This discourse is felicitous even though it does not (explicitly) describe a day that could serve as an antecedent for *that same day*. The view advocated here is that in such instances, one accommodates an antecedent of the right kind, i.e. one that has the property of being a day. For example, in (iv), one accommodates a day three weeks ago.

(iv) Three weeks ago, Sue gave Fido a bath and cleaned our house. **That same day,** my wife hired her and gave her a check for one month in advance.

Relating (25) to the discourse at hand, notice that t_1 and t_2 are co-indexed with the drefs introduced by *on May 12th, 1984* and PFV respectively. As is reflected in the meaning of (12) below, in (27), the former co-indexation allows us to capture the inference that Lev's hiring of Sue took place on May 12, 1984. The latter co-indexation allows us to capture the inference that Lev's hiring of Sue took place *after* she cleaned his house.[20]

(26) $[t_1, e_2, t_2, u_3, e_4, t_4, u_5 \mid$

   a. $t_1 = \text{may.12.1984}°, t_1 < t_0, e_2 \subseteq t_1, u_3 = \text{sue}°,$

   $\text{clean.our.house}\{u_3, e_2\}, e_2 < t_2,$

   b. $\text{day}\{t_1\}, t_2 \subseteq t_1, t_1 < t_0, e_4 \subseteq t_2, u_5 = \text{lev}°, \text{hire}\{u_5, u_3, e_4\}, e_4 < t_4]$

The formula in (26a) corresponds to the aforementioned truth-conditions for (12a). The formula in (26b) corresponds to the truth-conditions for (12b). It says that a hiring event took place some time within May 12th, 1984 as well as within a time after the house-cleaning event. This is the desired result.

In sum, this section has provided an analysis of the discourse in (12). The key idea was that *that same day* is 'twice' anaphoric: it encodes two anaphoric drefs that need to be resolved. One of these drefs serves to locate the described event within a salient day previously mentioned in the discourse. The other dref serves to locate the described event within a previously mentioned REFERENCE TIME. In (12), this REFERENCE TIME is introduced by the perfective aspect, which explains why we have narrative progression; this aspect moves the REFERENCE TIME forward.

By allowing a previously established REFERENCE TIME to play such a crucial role without introducing a REFERENCE TIME of its own, *that same day* differs from the other adverbs discussed at the outset of the paper. This difference is captured by the meanings below, in (27)-(28), and summarized in Fig. 2.[21]

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[20] Note that nothing in the meaning of *that same day* requires t_2 to be coindexed with the DREF introduced by PFV. This is what we want because although *that same day* is transparent to narrative progression, it is not a narrative progression trigger, viz. (8), where *that same day* occurs in a context where a PARALLEL coherence relation is inferred. In such a context, t_2 would be coindexed with a DREF introduced by an expression other than PFV.

[21] I do not provide a meaning for *on Sunday* because it is quite complicated and deserves a paper of its own. See Kamp & Reyle 1993: 621 for a construction rule that illustrates the complexity and Altshuler 2010 for a CDRT analysis that incorporates Kamp and Reyle's insight.

	Retrieve a time anaphorically from the discourse context?	*Make reference to the context of utterance?*	*Introduce a new time dref?*
May 12, 1984	No	No	Yes
yesterday	No	Yes	Yes
the day after	Yes	No	Yes
that same day	Yes	No	No
on Sunday	Yes	Yes	Yes

Figure 2   Typology of adverbs (to be revised)

(27) $[_{\text{AdvP}} \text{yesterday}^{t_n}] \rightsquigarrow$
    $\lambda Q.[t_n \mid \text{day}\{t_n\}, t_n < \text{day.of}\{t_0\}, [t \mid t_n < t < t_0] \Rightarrow [\mid \neg [\text{day}\{t\}]]\,;\, Q(t_n)$

(28) $[_{\text{AdvP}} \text{the day after}^{t_n}{}_{t_m}] \rightsquigarrow$
    $\lambda Q.[t_n \mid \text{day}\{t_n\}, t_n < \text{day.of}\{t_m\}, [t \mid t_n < t < t_m] \Rightarrow [\mid \neg [\text{day}\{t\}]]\,;\, Q(t_n)$

According to (27), *yesterday* introduces a new DREF t_n such that: (i) t_n must have the property of being a day, (ii) t_n must precede the day of the speech time, and (iii) t_n must be the closest day to the speech time (i.e. if there is a time t that is closer to the speech time than t_n, then t does not have the property of being a day).

According to (28), *the day after* is exactly like *yesterday* except that the time that the introduced DREF must follow (rather than precede) is some salient day (rather than the day of the speech time).

4   Conclusion

In this paper I argued that a temporal adverbial need not introduce a new time DREF into the discourse context. That is, in addition to being +/- deictic and +/- anaphoric, a core property of adverbial meaning is whether an adverb is +/- in its ability to introduce a new time DREF. My argument was based on *that same day* and its transparency to narrative progression. I proposed that *that same day* retrieves two salient times from the input context, i.e. it is 'twice-anaphoric'. This is what I proposed to be the crucial difference between *that same day* and an

adverb like *the day after*, which introduces a new DREF into the discourse context and is only 'once-anaphoric'. One question that comes up is whether there are any other temporal adverbials that also fail to introduce a new time DREF into the discourse context. In conclusion of this paper, I would like to suggest that *currently* is such an adverb.

There is a particular use of *currently* where it co-occurs with the past tense and is anaphoric on a previously mentioned time.[22] The discourse in (29) exemplifies such a usage, where *currently* refers to the time of the interview described in (29a).

(29) a.   Carol was thirty-six at the time of the interview.
     b.   She had dropped out of high school after becoming pregnant and married at seventeen.
     c.   **<u>Currently</u>** she was divorced and raising her son on her own with her work as a hairdresser (Press 1991).

The idea that *currently* is a time-seeking anaphor is supported by the observation that (29) is no good without *currently* in (29c):

(30) a.   Carol was thirty-six at the time of the interview.
     b.   She had dropped out of high school after becoming pregnant and married at seventeen.
     c.   #She was divorced and raising her son on her own with her work as a hairdresser.

Here, we are led to the inference that Carol was both married and divorced. In other words, *currently* is needed because it serves to locate the events described in (29c) at the time of the interview described in (29a).

A challenge for the anaphoric analysis of *currently* comes from Kamp's (1971) example in (31), which contains the related adverb *now*.[23] This example was used to argue that *now* always refers to the context of utterance, which would explain why (31) entails that an earthquake is taking place at the speech time (even though there is no present tense in the sentence); such an entailment disappears without *now*. The same point can be made about *currently*, viz. (32).

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[22] Corpora reveal that *currently* occurs more frequently with the past tense than the present tense (see Lee 2010 for similar results with *now* using the British National Corpus).
[23] *Currently*, rather than *now*, is discussed in this section because *now* introduces various complexities that would take us too far a field (e.g. *now* is arguably ambiguous; see Lee & Choi 2009, Altshuler 2009; 2010 for more discussion).

(31) I learned last week that there would **<u>now</u>** be an earthquake (Kamp 1971: 299).

(32) I learned last week that there would **<u>currently</u>** be an earthquake.

I would like to suggest the following reanalysis: *currently* (as well as *now*) requires a salient time antecedent and the speech time must chosen in (32) because it is compatible with the semantics of *would* and there is no other possible antecedent; the learning event described by the matrix clause is ruled out because *would* requires the earthquake to follow this event.

Evidence for this view comes from (33), which is like (32) except that it is embedded within a story and has a possible antecedent, namely Victoria beginning to look nervous. Consequently, *currently* no longer refers to the speech time.

(33) …Victoria began to look nervous, thought Jenya. She was shaking and paced back and forth. Apparently, she learned last week that there would **<u>currently</u>** be an earthquake.

In sum, the data above suggests that *currently* is an anaphoric expression: it requires a salient time antecedent that could be in the present or past and—if no grammatical elements (viz. the present tense) indicate otherwise—independent rules of anaphora resolution determine which one is chosen. In (32), these rules determine that the speech time is chosen; in (33) these rules determine that the onset of looking nervous is chosen.

Another key property of *currently* is illustrated by the discourses in (34) and (35), which suggest that this adverb is incompatible with eventive sentences.[24]

(34) In messages on 3 December, the British and French Governments noted that an effective United Nations Force {**<u>#currently arrived/</u>** [OK]**<u>was currently ready to arrive/</u>**[OK]**<u>was currently arriving</u>**}.[25]

(35) He developed the Boston Road projects for CVS, Big Y and Red Robin, and {**<u>#currently built/</u>** [OK]**<u>was currently building</u>**} a Hampton Inn and Suites at Founders Plaza.[26]

The data above are important for several reasons. To begin with, it goes against Katz's (2003) descriptive claim that some adverbs "select against stative verbs

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[24] cf. similar claims about *now* in Kamp & Reyle 1993, Lee & Choi 2009 and Altshuler 2009.
[25] http://www.un.org/en/peacekeeping/missions/past/unef1backgr2.html
[26] http://articles.courant.com/keyword/hampden/recent/2

	Retrieve a time anaphorically from the discourse context?	*Make reference to the context of utterance?*	*Introduce a new time dref?*
May 12, 1984	No	No	Yes
Yesterday	No	Yes	Yes
the day after	Yes	No	Yes
on Sunday	Yes	Yes	Yes
that same day	Yes	No	No
currently	Yes	Yes	No

Figure 3   Typology of adverbs (final version)

and for eventive verbs", but "there do not seem to be adverbs that select for stative verbs and against eventive verbs." Katz calls this generalization the "Stative Adverb Gap" which (if it were correct) would be unexpected on most analyses of temporal adverbials and certainly on the analysis of temporal adverbials proposed in this paper.

On the other hand, the fact that there are, in fact, adverbs that "select for stative verbs and against eventive verbs", viz. *currently*, raises non-trivial questions about the meaning of these adverbs and, more generally, the interface between adverbial and aspectual meaning. Space limitations prevent me from addressing these questions in detail here. However, a good starting point is to say that *currently* is like *that same day* in not introducing a new time DREF but rather retrieving a salient time previously mentioned in the discourse (see Fig. 3 above). In particular, one could extend Altshuler's 2009 analysis of *now* to *currently* and say that this adverbial has both an explicitly temporal component and perspective shifting discourse component. These components conspire to impose the following two requirements: (i) search for a salient time that serves as the 'current perspective' and (ii) describe what took place throughout this topical time. The first requirement would capture *currently*'s anaphoric nature, while the second leads to a contradiction with eventive, but not stative VPs. More specifically, the idea would be that aspectual constraints on narrative progression imposed by eventive (but not stative) VPs contradict the narrative progressive constraints imposed by *currently*. The hope is that further research will make this idea precise within the theory of temporal interpretation proposed here.

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