Since ~~since~~

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Abstract   The compositional analysis of sentences like "Tony has been happy since he's been taking Prozac" becomes feasible through a combination of a maximal informativeness semantics for definite descriptions and an elided second "since" inside the "since"-clause.

1 The Larger Context

This paper appears anti-chronologically: it is, in a way, the middle of three papers, each of which also appeared in an off-chronological way.

The actual sequence is the following: A manuscript that circulated initially as Iatridou (2001) but was published as Iatridou (2014) raised a question it could not solve. A manuscript that circulated initially as von Fintel and Iatridou (2002) attempted to solve that problem by appealing to a solution which was later generalized in a manuscript that was initially circulated as von Fintel, Fox, & Iatridou (2006) and was published as von Fintel et al. (2014).[1]

The current paper is an enrichment of the middle of the three papers, namely, von Fintel and Iatridou (2002). The reason we chose this as our contribution to Roger's volume is that Roger and Kai discussed this paper over coffee many years ago in

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[1] Some more archaeology reveals that Sabine's work on temporal existentials existed well before 1999, as it is mentioned in von Fintel (1999). The current work was first presented under the title "Simultaneous readings" at *Sinn und Bedeutung* in Osnabrück in 2001 and at a 2003 colloquium at Rutgers, where feedback was given by Roger.

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Highland Park and Roger's remarks led to the proposal developed in that early version of the paper. So any errors in this proposal are hereby attributed to Roger.

The paper is structured as follows. First, we will start with a discussion and analysis of the Perfect. Then we will present a puzzle for that analysis, which has to do with the occurrence of the Perfect in *since*-clauses. Then we will present a solution for that puzzle. At the end, we will formulate some questions for future research.

If you would like to steel yourself for the puzzle ahead, here's the gist: what makes it so that (1a) has the interpretation in (1b)?

(1)   a.   Tony has been happy since he's been taking Prozac.
      b.   Tony has been happy since the time since which he's been taking Prozac.

And what do those sentences mean in the first place? It will take some work to see that these sentences are puzzling, but we promise that you will.

2   Varia on the Perfect (Old and New)

2.1   The Basics of the Existential Perfect and Universal Perfect

We will start out with a compositional implementation of the analysis of the Perfect developed in Iatridou, Anagnostopolou, & Izvorski (2001) (IAI). According to IAI, the Perfect introduces a time interval: the "perfect time span" (PTS).[2,3] Like all intervals, the PTS is defined by its boundaries:

- The Right Boundary (RB) of the PTS is set by Tense, sometimes in concert with adverbials (such as *by Monday*).
- The Left Boundary (LB) of the PTS may be set by "perfect-level adverbials".

The lower predicate (which characterizes an event) is predicated of the PTS. This predication is mediated by various devices, most notably operators associated with the Perfective or Imperfective.

Let's go through an example:

(2)   I have visited Cape Cod three times since 1990.

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[2]In our formal implementation, we associate the Perfect with an existential quantifier introducing the PTS. One could set up an alternative, "referential" theory, but we won't explore this here. We do not believe that this affects our puzzle.

[3]As IAI state, their analysis is in the spirit of the "extended now" theory of McCoard (1978).

According to IAI, the following hold of (2):

- the Right Boundary of the PTS is the time of utterance, because the sentence is in the Present Perfect,
- the Left Boundary of the PTS is (some time in) 1990, and
- in the PTS there are three subintervals at which it is true that I visit Cape Cod.

The time line can be represented as follows:

(3)
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   LB                                                              RB
    |..............X....................X....................X......|
   1990              (the Perfect Time Span/PTS)                   UT
```
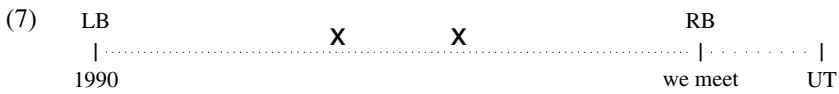
Or in logical representation[4]:

(4) $\exists t : RB(NOW, t)$ and $LB(1990, t)$ and $\exists t', t'', t''' \subseteq t$: I visit Cape Cod at t', t'', t'''

In general, the LB of the PTS can be set by an adverb, as in (2), or contextually:

(5) I have visited Cape Cod three times.   ($\approx$ since the beginning of my life)

On the other hand, the RB is manipulated by Tense. For (2), given that the sentence is in the Present Perfect, the RB is the utterance time. In the Past Perfect, the RB is before the utterance time:

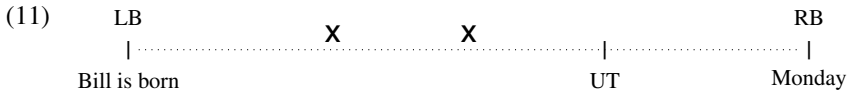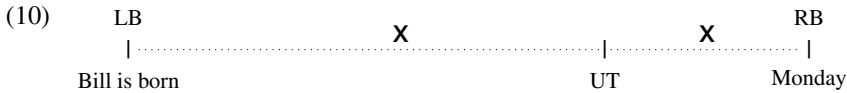(6) When we met, I had visited Cape Cod two times since 1990.

(7)
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   LB                                       RB
    |...................X.......X............|........|
   1990                                    we meet   UT
```

(8) $\exists t \prec u$: we meet at t and $\exists t' : RB(t, t')$ and $LB(1990, t')$ and
$$\exists t'', t''' \subseteq t' : \text{I visit Cape Cod at } t'', t'''$$

In the Future Perfect, the RB follows the utterance time:

(9) By next Monday, Bill will have visited the Cape 2 times.

In the Future Perfect, it again becomes clear that all the Perfect does is place the event(s) inside the PTS. It does not place the event(s) on the timeline with respect to the utterance time. For (9), all we know is that the RB is in the future. The events themselves can be before or after the utterance time. The following are all verifying instances of (9):

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[4] We leave implicit the condition that t', t'', t''' have to be distinct.

(10)   LB   X   X   RB
       |·································|················|
       Bill is born   UT   Monday

(11)   LB   X   X   RB
       |·································|················|
       Bill is born   UT   Monday

(12)   LB   X   X   RB
       |·································|················|
       Bill is born   UT   Monday

This is why one can also say things like (13), in a model like (11):

(13)   She is a very good student. She will have written her essay by next Monday
       for sure. For all I know, she has written it already.

What we have seen so far are examples of the "Existential Perfect" (or "E-Perfect"). This name reflects the presence of existential quantification over subintervals of the PTS. There is also the "Universal Perfect" (or "U-Perfect"), whose name reflects the presence of (apparent) universal quantification over subintervals of the PTS. Consider (14):

(14)   a. She has been living on Cape Cod since 1990.
       b. $\exists t\colon RB(NOW, t)$ & $LB(1990, t)$ & $\forall t' \subseteq t\colon$ she lives on Cape Cod at t'[5]

Its truth-conditions schematically are:

- there is a time span (the Perfect Time Span/PTS),
- the Right Boundary of the PTS is the time of utterance,
- the Left Boundary of the PTS is (some time in) 1990, and
- for every subinterval of the PTS, it is true that she lives on Cape Cod.

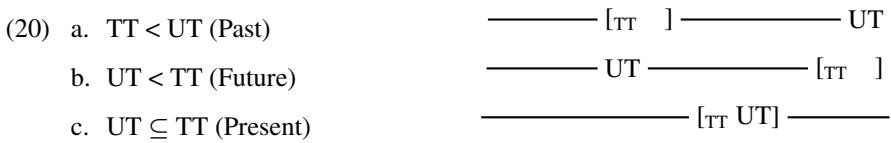Consider the Existential versus Universal Perfect at a glance:

(15)   She has visited Cape Cod twice since 1990.

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[5]We note that this somewhat impressionistic way of stating the truth-conditions is only directly appropriate for predicates with the subinterval property. Later on, we will give a more precise analysis, which, in fact, will not have a universal quantifier but state an inclusion relation of the PTS within the interval at which the lower predicate holds. Cf. example (41) and our analysis in (42b).

(16) **(X)** LB   X   X   RB
         |· ·|
         1990   UT

(17) She has been living on Cape Code since 1990.

(18) (∿∿∿) LB ∿∿∿∿∿∿∿∿∿∿∿∿∿∿∿∿∿∿∿∿∿∿∿∿∿∿∿ RB
         |· ·|
         1990   UT

The difference between the two can be seen in (15)/(17): in the E-perfect (15) there are distinct events within the PTS, whereas in the U-perfect (17) there is a sustained situation throughout the PTS. There are also similarities, which include that nothing is said about what happens outside of the PTS. For example, in both, there could be another occurrence/part of the event before the LB, as indicated in (16)/(18).

Before we turn to a compositional implementation of these meanings for the E-Perfect and U-Perfect, two remarks are in order: 1. As we just hinted, Perfect sentences do not make a claim about what happens outside the PTS and thus are truth-conditionally compatible with the core event/state being true outside the PTS as well. Even if she has visited Cape Cod twice since 1990, she may well have done so before 1990. And if she's been living on Cape Cod since 1990, that may well have started before 1990. Of course, implicatures might enrich the meaning of a Perfect sentence. 2. When we speak of *the* Right/Left Boundary of the PTS, we mean the precise start/end of the interval. But the linguistic means for characterizing the LB, in particular, are often not expressions of pinpoint accuracy. *Since 1990* basically just conveys that the LB is some time in 1990.[6]

2.2 The Structure

We will assume and indirectly argue, that in the presence of the Perfect, the clausal spine looks as follows:

(19) Tense > Perfect > Imperfective/Perfective[7] > vP

In this section, we will lay out how we think (19) composes, following IAI in the position that the E-Perfect versus U-Perfect distinction is the result of the aspectual operators (Imperfective/Perfective) in (19).

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[6]Our formal definitions in (36) and (37b) will reflect this.

[7]The reader should remember that the terms "Perfect" and "Perfective", though they sound alike in English, refer to two very different things.

Expressions are evaluated relative to two times: the utterance time (UT) and the current evaluation time or Topic Time (TT). The "times" that we will be using are intervals with time points as a limiting case. Times/intervals can be thought of as sets of contiguous time points. One interval containing another can be thought of as a subset-superset relation. We also talk of intervals preceding and succeeding each other. We assume that the utterance time is conceived of as a time point. We keep track of the utterance time throughout the compositional derivation, so that deeply embedded occurrences of adverbials like *now* or embedded occurrences of Present Tense can refer to the utterance time. The other time parameter, the evaluation time, is manipulated by temporal/aspectual operators as we move downward in a tree. In what follows, we go into more details.

We will use two types of notation for this purpose, so that the readers can choose which one is more appropriate for their purposes. One notation is in the spirit of Klein (1994), the other in the spirit of Priorean tense semantics (cf. von Stechow 2015).

In a tradition that goes back to Reichenbach, but here in the terms of Klein 1994, we will call Tense the relationship between Topic Time and Utterance Time:

(20) a. $TT < UT$ (Past)   ——————— $[_{TT}$ $]$ ——————— UT

     b. $UT < TT$ (Future)   ——————— UT ——————— $[_{TT}$ $]$

     c. $UT \subseteq TT$ (Present) ——————— $[_{TT}$ UT$]$ ———————

What we see in (20a) is that in the Past Tense, the Topic Time (or evaluation time) precedes the Utterance Time UT. The reverse relationship holds in the Future, in (20b). In the Present, TT contains UT, as in (20c). As already said above, it is inherent in this system (as well as the alternative notation that we will be using) that Tense is not a relationship between UT and the time of the event ("Situation Time", ST). For arguments for this by now fairly uncontroversial position, see Klein (1994) and many others. The relationship between UT and ST is derived indirectly, via the mediation of Aspect, to which we will return shortly.[8]

We will also present a more formally explicit denotational semantics. For that, we will work within an intensional framework. We write the utterance time as a superscript on the left interpretation bracket and the evaluation time as a superscript on the right. Initially, the evaluation time is set to be identical to the utterance time by the following pragmatic principle:

(21) An utterance of a sentence ϕ at a time u is true iff $^{u}[[\phi]]^{u} = 1$.

Present tense (re)sets the evaluation time to be identical to the utterance time. Past tense is interpreted as claiming that there is a time before the previous evaluation time of which the rest of the tree is true. The Future says that there is a time after

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[8]There are, of course, alternative views, which we will not discuss in this paper. We do not think that they would help with our puzzle. But for the curious, see Chapter 6 of Altshuler (2016).

the previous evaluation time of which the rest of the tree is true (we are putting aside here the question of whether the Future is a modal or a tense).

(22)   a. $^u[\![\text{PRES } \phi]\!]^t = 1$ iff $^u[\![\phi]\!]^u = 1$.
       b. $^u[\![\text{PAST } \phi]\!]^t = 1$ iff $\exists t' \prec t \colon {^u[\![\phi]\!]}^{t'} = 1$.
       c. $^u[\![\text{FUT } \phi]\!]^t = 1$ iff $\exists t' \succ t \colon {^u[\![\phi]\!]}^{t'} = 1$.

Languages also encode the relationship between Topic Time and Situation Time. This relationship is called "Aspect". In short, Tense and Aspect together result in placing (part of) ST on the timeline with respect to UT. The two most commonly described aspectual relationships are the Perfective and the Imperfective[9]:

(23)   a.   ST $\subseteq$ TT (Perfective aspect) $[_{TT} \dots [_{ST} \dots] \dots]$
       b.   TT $\subseteq$ ST (Imperfective[10]) $[_{ST} \dots [_{TT} \dots] \dots]$

Alternatively:

(24)   a. $^u[\![\text{PRF } \phi]\!]^t = 1$ iff $\exists t' \subseteq t \colon {^u[\![\phi]\!]}^{t'} = 1$.
       b. $^u[\![\text{IMP } \phi]\!]^t = 1$ iff $\exists t' \supseteq t \colon {^u[\![\phi]\!]}^{t'} = 1$.

The meaning of PRF is that the VP is true at some interval t' which is a subinterval of the time of evaluation t. Conversely, the meaning of IMP is that the VP is true at an interval t' which is a superinterval of t.

   Let us go through some examples before we introduce the Perfect into the equation. Sentence (25) is an example of a Past Perfective and (26) an example of a Past Imperfective.

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[9]We follow Kratzer (1998) and others in using the non-proper sub/superset relations to implement the Kleinian aspect meanings. The anonymous reviewer points out that this predicts that one and the same sentence can be used both in the perfective and in the imperfective if the TT and the ST happen to coincide. We have nothing to say about this here, but see Footnote 15.

[10]Even though there is some confusion, there is also a convention about when to use the term "Imperfective" and when the term "Progressive". The latter is used when the morpheme describes events in progress and has the semantics in (23b) or (24b). The term "Imperfective" is used when the morpheme in question appears in sentences describing events in progress as well as in generic and habitual sentences. (The question of why it should be so often one and the same morpheme which expresses events in progress and habitual/generic statements has received a fair amount of attention.) So strictly speaking, the semantics we gave in (23b)/(24b) would justify us using the term "Progressive" and not the term "Imperfective". In fact, this can be seen in the Perfect of the habitual/generic uses of the English simple Past (which in episodic sentences is interpreted as perfective): *I have worked at MIT since 1997*. However, we will keep using the term "Imperfective" because the Perfect of the habitual/generic use of the imperfective also yields the U-Perfect, a crucial component of what this paper is about. So the gap in our exposition will be not the wrong use of a term, but the fact that we do not give a semantics for genericity/habituality and show that the Perfect of that imperfective category also yields the U-Perfect.

(25) a. Bill insulted Tony.

   b. [$_{TP}$ PAST [$_{AspP}$ PRF [$_{vP}$ Bill insult Tony]]]

   c. $\exists t \prec u \colon \exists t' \subseteq t \colon$ Bill insult Tony at t'.

   d. _____[$_{TT}$ …[$_{ST}$ …] …] _____ UT

(26) a. Bill was insulting Tony.

   b. [$_{TP}$ PAST [$_{AspP}$ IMP [$_{vP}$ Bill insult Tony]]]

   c. $\exists t \prec u \colon \exists t' \supseteq t \colon$ Bill insult Tony at t'.

   d. _____[$_{ST}$ …[$_{TT}$ …] …] _____ UT

Now let us introduce the Perfect. IAI argued that the choice of Imperfective versus Perfective determines which type of Perfect we will end up with. Specifically, the Imperfective is required for a U-Perfect. On a non-stative predicate, the Perfective under the Perfect yields an Existential Perfect and the Imperfective under the Perfect yields (mostly[11]) a Universal Perfect.

(27) *Perfect of the Perfective: E-Perfect*
I have read two books since last Monday.

(28) *Perfect of the Imperfective: U-Perfect*
I have been reading two books since last Monday.[12]

Stative predicates in English yield ambiguities:

(29) I have been sick since 2014.

The U-Perfect reading of (29) is easily accessible. It conveys that I started being sick (at least) sometime in 2014 and have been continuously sick since then, including now. But the E-Perfect reading can be brought out as well. Consider the context in (30) and the utterance in (31) in that context:

(30) *The insurance company will reimburse you $500 if you have been sick in the period between January 1, 2014 and now.*

(31) I have been sick since January 1, 2014. I was sick for 3 weeks in the fall of 2015.

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[11]The Perfect of the Imperfective can also yield an E-Perfect, as in Comrie's *Have you ever been watching television when the tube exploded?* (Comrie 1976: 62). But such sentences are not encountered frequently, possibly because in addition to meeting the requirements of the Perfect, the use of the progressive needs to be justified by an anchoring adverbial. This in turn means that there should be an additional operator, of the Perfective type, to get all the right relationships in place. Possibly this is what makes this type of sentence rare, also in corpora.

[12]A reviewer points out that with activities like *read books*, the subinterval property needs to be understood in a way that allows for temporal gaps, such as bathroom breaks. See Landman (2012) for discussion.

This ambiguity is expected, given that the (morphologically unmarked) English statives can be read as TT ⊆ ST or ST ⊆ TT. That is, (32a), depending on the choice of (32b) or (32c), can be read as him being sick throughout yesterday, or him being sick at some time properly included in yesterday.

(32) a. Yesterday he was sick.
      b. yesterday ⊆ his disease
      c. his disease ⊆ yesterday

As IAI argued, the choice of Aspect determines whether we have an E-Perfect or a U-Perfect. The reason for the effect of Aspect on the interpretation of the Perfect is that the PTS functions as the Topic Time in its interaction with Aspect. Recall that the Perfective signals the relationship $ST \subseteq TT$. This means that the Perfect of the Perfective signals the relationship $ST \subseteq PTS$, which is the E-Perfect:

(33) [$_{\text{TT/PTS}}$ …[$_{\text{ST}}$ …] …]

On the other hand, the Perfect of the Imperfective signals the relationship TT ⊆ ST, which means that the Perfect of the Imperfective conveys $PTS \subseteq ST$, which is the U-Perfect[13]:

(34) [$_{\text{ST}}$ …[$_{\text{TT/PTS}}$ …] …]

Let us put this together in our other notation as well. We already know that the Perfect introduces an interval (PTS). The PTS takes the TT it receives from the higher Tense as its Right Boundary and stretches backward in time. This PTS is then fed downward as the new TT to the rest of the tree, which then interacts via the (Im)Perfective with the ST (expressed by the vP). Here is the PTS:

(35) $^u[\![\text{PERF } \phi]\!]^t = 1$ iff $\exists t'$: $RB(t, t')$ and $^u[\![\phi]\!]^{t'} = 1$.

Its RB, as we already saw, is determined by Tense. We define the *RB*-relation as follows[14]:

(36) $RB(t, t')$ — t is or contains the Right Boundary of t' — iff
      $t \cap t' \neq \emptyset$ and $\forall t'' \succ t$: $t'' \succ t'$.

The LB of the PTS can be determined by "Perfect-Level adverbials", which appear between the Perfect operator and the (Im)Perfective. For example, *since 1990*:

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[13]Modulo Footnote 11.

[14]Note that the definitions in (36) and (37b) make it possible to talk about a large interval like 1990 to characterize the left boundary of a PTS: what that means is that the start of the PTS is somewhere in 1990. So, the *LB* relation between intervals in (37b) says that one interval contains the start of another. We thank a reviewer for suggesting an improvement in the way we defined RB and LB.

(37) a. $^u[\![\text{since 1990 } \phi]\!]^t = 1$ iff $LB(1990, t)$ and $^u[\![\phi]\!]^t = 1$.

b. $LB(t, t')$ — t is or contains the Left Boundary of t' — iff $t \cap t' \neq \emptyset$ and $\forall t'' \prec t: t'' \prec t'$.

There are two things to note:

- According to our analysis, an interval that *since 1990* is true of is one that starts *some time in* 1990. 1990 is a Left Boundary of the PTS iff the PTS starts some time in 1990. This seems correct: our example sentence *Tony has been living on Cape Cod since 1990* leaves it open exactly when in 1990 he started living there.
- This treatment does not by itself predict that *since*-adverbials are perfect-level adverbials. For example, as it stands, they could be used to modify the interval introduced by tense. That is, they could say of some kind of extended Present that it stretches back to 1990 and the same might occur with a simple Past. In fact, there are such uses of the German *seit*-adverbials and the Greek *apo*-adverbials, as we will see later. For English, we will need to introduce a stipulation. We do not explore here how to do that.

So now we are ready to compose the E-Perfect:

(38) Tony has visited Cape Cod since 1990.

(39) [TP PRES [PERF since 1990 [ASP PRF [VP Tony visit Cape Cod]]]]

(40) a. $\exists t: RB(u, t)$ and $LB(1990, t)$ and $\exists t' \subseteq t:$ Tony visit Cape Cod at t'.

b.

LB   **X**   RB
|·· · ··· |
1990   UT

Here, the PTS between now and (some time in) 1990 is claimed to contain an interval at which Tony visits Cape Cod.[15]

Of course, we can compose the U-Perfect as well:

(41) Tony has been living on Cape Cod since 1990.

(42) a. [TP PRES [PERF since 1990 [ASP IMP [VP Tony live on Cape Cod]]]]

b. $\exists t: RB(u,t)$ and $LB(1990,t)$ and $\exists t' \supseteq t:$ Tony live on Cape Cod at t'.

c. (~~~) LB ~~~~~~~~~~~~~~~~~~~~~~~~~ RB
|·· ·· |
1990   UT

This claims that there is an interval stretching backward from now (the utterance time) to some time in 1990, which is part of a potentially larger interval at which Tony lives on Cape Cod. Now, if Tony lives on Cape Cod at a particular interval

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[15] As it stands, our meaning does not exclude that the visit is ongoing at the utterance time. In fact, though, it seems one would have to say *Tony has been visiting Cape Cod (ever) since 1990* or even *Tony has been on a visit to Cape Cod since 1990*. If we wanted to exclude such a reading for (38), we could explore making PRF introduce a *proper* subinterval of the previous evaluation time.

that means, in fact, that he lives there *throughout* that interval, since *live* has the subinterval property.

This concludes our overview of the analysis of the Perfect that we will be assuming. We realize that we have glossed over many issues and ignored many alternatives. We think that the puzzle we explore in the following arises in any reasonable analysis of the Perfect and should be of interest therefore even to people who have doubts about our assumptions. Before we turn to the puzzle, we need to introduce one more set of preliminary data.

2.3 **since-*Clauses***

Since at least McCoard ([1978](#)), it has been known that English *since*-clauses[16] are compatible with the Perfect and not the Past tense:

(43)   She *(has) visited the Cape twice since 1990.

This section concentrates more on the properties of this adverbial.

The examples that we have seen so far include *1990* as the argument of *since*. That is, in those cases, the argument of *since* is (the name of) an interval. In fact, *since* is in general very good with definite descriptions of events as its argument[17]: *since the World Cup*, *since Miranda's graduation ceremony*. For such cases, we assume that there is a mediating function from events to the time interval they occupy. This gets inserted into the logical structure to provide *since* with the kind of argument it needs.[18]

But *since* can also take clausal arguments:

(44)   a.   since we last met
       b.   since Bill insulted Tony

The puzzle we introduce in the next section has to do with clausal *since*.

Iatridou ([2014](#)) argues that the *since*-adverbial contains a definite description of an event and its associated time interval.[19] In brief, there is an existential and uniqueness presupposition in the *since*-clause. The existential presupposition can be seen in (45–46), where the inference that the cat has died survives negation and questioning:

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[16]We are ignoring here the causal uses of *since*.

[17]For indefinite arguments of *since*, see Iatridou ([2014](#)): fn. 17.

[18]A function taking an event to its run time or temporal trace was introduced and employed by Krifka ([1989](#)). Of course, one could also say that *since* is slightly ambiguous. One homonym would be the one we defined and the other would take an event as its argument and return the same result as its relative would have if it had been applied to the time interval the event occupies. Take your pick.

[19]Actually, Iatridou ([2014](#)) talks about definite event descriptions, not just definite time intervals, but this distinction is not relevant for us here.

(45)   He hasn't visited Cape Cod since his cat died. $\longrightarrow$ the cat died

(46)   Has he visited Cape Cod since his cat died? $\longrightarrow$ the cat died

Correspondingly, one would not be surprised to find (47a) on a car-insurance questionnaire, but (47b) would raise certain eyebrows:

(47)   a.   Have you been convicted of drunk driving in the last 10 years?
       b.   Has it been 10 years since you were convicted of drunk driving?

The uniqueness presupposition (actually unique salience presupposition) can be seen in (48), where the use of the *since*-clause is infelicitous in the presence of multiple events that are equally salient:

(48)   a.   Bill insulted Tony several times: once in 1990, once in 1993 and then again in 1997…
       b.   #And Tony has been living on Cape Cod since Bill insulted him.
       c.   #Tony has visited Cape Cod two times since Bill insulted him.

If modifiers like *for the first/second/last time*, etc. are added then we can rescue (48b–c) by making one particular occurrence salient.

In a well-formed sentence with a *since*-clause, Iatridou (2014) argues that the PTS is empty of the type of event described in the *since*-clause. In other words, in (49), there is no event of Bill insulting Tony between LB and RB:

(49)   a.   Tony has visited Cape Cod two times since Bill insulted him.
       b.   Tony has been living on Cape Cod since Bill insulted him.

But saying that there is a covert *for the last time* inside the *since*-clause would give the wrong results:

(50)   a.   Tony has visited Cape Cod two times since his cat died.
       b.   #Tony has visited Cape Cod two times since his cat died for the last time.

That is, there is no meaning of *last* in the *since*-clause. The *since*-clause is used felicitously only if there is a single event. If there is a single event and that event is at LB, it follows that the PTS is empty of events of the relevant sort.[20]

What *since* operates on when it gets a clausal argument is a definite singular description of an event. However, Iatridou (2014) did not discuss in detail how the definite description in clausal *since* comes about. One possibility to achieve this result could be an operator that takes us from a predicate of times (a proposition) to *the*
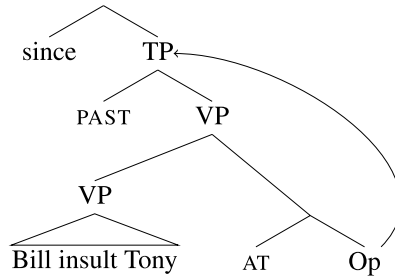
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[20]Iatridou (2014) shows that the effect of the empty PTS is derived only when the LB is a single event. When the definite description refers to the only *salient* event (as definite descriptions are expected to be able to refer to salient individuals, in the presence of non-salient ones), then the effect of the empty PTS is correctly predicted to not necessarily come about.

time it is true of. But this won't work: the times that "Bill insulted Tony" describes are times in the past of which Bill insulted Tony. That is not what *since* takes as its argument. What we want the argument of *since* to be, is the time *at* which Bill insulted Tony. So let's do exactly that. We will say that the definite operator originates as the argument to a silent temporal preposition AT, which has the meaning in (51):

(51) $^u[\![\phi \ \text{AT} \ i]\!]^t = 1$ iff $^u[\![\phi]\!]^t = 1$ and $^u[\![i]\!]^t = t$.

The operator does not have the correct type to stay in the argument of AT and so it moves to just below *since*:

(52) a.

```
          since       TP←
                    /    \
                 PAST     VP
                        /    \
                      VP       \
                    /    \      \
            Bill insult Tony   AT   Op
```

b. since Op λt [$_{\text{TP}}$ PAST [$_{\text{VP}}$ [$_{\text{VP}}$ Bill insult Tony] [AT t]]].

The operator delivers the time t such that Bill insulted Tony at t. In other words, the operator is a function from predicates of times to the unique time they are true of. In essence, the interpretation of the operator is *the time at which*.

The movement of the operator is semantically motivated but we can see it in the syntax as well, through the existence of lower readings of the kind associated with movement of operators (Geis 1970; Larson 1990, and many others). For example, (53a) can mean (53b):

(52) a. He has been to the Cape twice since Sue believes that Bill insulted him.

 b. He has been to the Cape twice since the time at which, according to Sue, Bill insulted him.

Predictably, the movement cannot cross an island. (54a) cannot mean (54b):

(53) a. He has been to the Cape twice since Sue heard the rumor that Bill insulted him.

 b. He has been to the Cape twice since the time at which, according to the rumor that Sue heard, Bill insulted him.

In the cases that we have seen so far, the predicate in the clausal argument of the *since*-clause is a non-stative in the Past Perfective (*since Bill insulted him, since his cat died*). In these cases, it was more or less clear what *the time at which Bill insulted him, the time at which his cat died* referred to. But the clausal complement to *since* can also contain a predicate with the subinterval property.

(54)   Tony has been happy since he lived on Cape Cod.

This raises a complication: what is "the" time at which Tony lived on Cape Cod? If Tony ever lived on Cape Cod, there are many past intervals at which he lived there: all the subintervals of the maximal stretch of time throughout which he lived on Cape Cod. So, how can the definite reference succeed? We suggest (for now) that the definite here picks out the maximal interval of which the property holds. This is not unheard of for definite operators, but we will come to change it later.

3   The Puzzle

3.1   The Profile

Consider sentence (56):

(55)   Tony has been happy since he has been taking Prozac.

Interpret (56) as a U-Perfect, which means that Tony's happiness extends throughout the PTS. How is the PTS determined here? It is easy to decide what the RB is. Since (56) is a Present Perfect, RB is at UT. But what is its LB? The intuition is quite clear: Tony's happiness started when he started taking Prozac and it has lasted ever since then.[21] That is, we understand (56) as conveying that Tony started being happy when he started taking Prozac and the time of his being happy and his taking Prozac extend up until and including UT.

   What our theory predicts is also clear: the LB should be provided by the complement of *since*. But here is the problem: the complement of *since* is *he has been taking Prozac*. And *he has been taking Prozac* does not mean *he started taking Prozac*.

   The question is how (56) yields the assertion that the period in which he has been taking Prozac is (possibly properly) included in the period in which he has been happy. We will call this the "simultaneous reading" and the rest of the paper is about the right way to analyze the simultaneous reading, as well as the consequences of said analysis for linguistic theory at large.
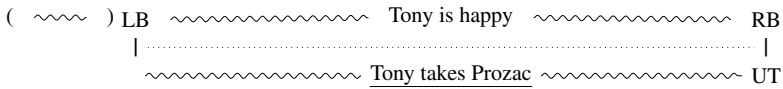
   Let us start by looking schematically at (57) and (58), which differ only in the content of the *since*-clause: (57) contains a Past Perfective, while (58) contains a Present Perfect of the Imperfective:

---

[21]Though recall that we saw in the context of (16)/(18) that it is not impossible that the eventuality started before the PTS:

(i)   Tony has been happy at least since he has been taking Prozac, and possibly longer.

(57) Tony has been happy since <u>he insulted Bill</u>.

   (～～～) LB ～～～～～～～～ Tony is happy ～～～～～～～～ RB
           | .... |
         <u>Tony insults Bill</u>   UT

(58) Tony has been happy since <u>he has been taking Prozac</u>.

   (～～～) LB ～～～～～～～～ Tony is happy ～～～～～～～～ RB
           | .... |
   ～～～～～～～～～ Tony takes Prozac ～～～～～～～～ UT

The matrix clause in both (57, 58) is the same. Let us interpret it as a U-Perfect in both sentences. This means that in both (57) and (58), Tony's happiness holds for all subintervals of the PTS, as can be seen in the schema. Also, in both (57) and (58), RB is at UT, since the matrix predicate is in the Present Perfect. The LB of (57) is the time at which Tony insults Bill. As per the discussion of Iatridou (2014) above, the PTS in (57) is empty of events of Tony insulting Bill. That is, in (57), the PTS is empty of events of the sort described in the *since*-clause. On the other hand, in (58), the PTS is not just not empty of events of the sort described in the *since*-clause, the predicate of the *since*-clause holds at *all* subintervals of the PTS. Hence, the term "simultaneous reading" (or "SR"): it looks as if in the SR, the matrix event and the *since*-event are simultaneous.

But actually, this simultaneity is derivative. What the *since*-event is simultaneous with is the matrix PTS, not the matrix event. The derived simultaneity between the *since*-event and matrix event comes about as follows:

a. Because *Tony has been happy* is a U-Perfect, the matrix event fills out the matrix PTS.
b. The *since*-event is simultaneous with the matrix PTS.
c. Hence, the *since*-event is simultaneous with the matrix event.

And this can be verified, by changing step (a). That is, we look at what happens when we are dealing with an E-Perfect in the matrix clause:

(59) Tony has been to the Cape two times since he has been taking Prozac.

  LB   ×   ×   RB
   | .... |
  ～～～～～～～～～ Tony takes Prozac ～～～～～～～～ UT

In (59), the *since*-event is simultaneous with the PTS, and not with the matrix event(s). This means that we were right that in (58) the simultaneity between the *since*-event and the matrix event was only the result of the *since*-event and the PTS being simultaneous, plus the sentence being a U-Perfect.

In other words, we can have an SR regardless of whether the matrix Perfect is a U-Perfect, as in (58), or an E-Perfect, as in (59).

Moreover, there is an additional argument that it is not the matrix event and the *since*-event that are simultaneous, but the PTS and the *since*-event. Consider (60) and recall that it is possible that part of the matrix event occurs before the PTS (i.e., before its LB):

(60)   Tony has been happy since he has been taking Prozac and possibly longer.

(~~~) LB ~~~~~~~~~~~~ Tony is happy ~~~~~~~~~~ RB
        | .... |
        ~~~~~~~~~~~~ Tony takes Prozac ~~~~~~~~~~ UT

If the matrix event extends to the left of the LB, the *since*-event does not extend to the left as well. The *since*-event stretches back only to the LB of the PTS. Hence, it is not the matrix event and the *since*-event that are simultaneous, but the PTS and the *since*-event. And as we will see, we will improve on this further soon.

3.2   Inside the since-*Clause in the SR*

The contrast between (59) and (60) reveals, in effect, that to obtain the SR, there are no morphosyntactic requirements on the matrix predicate other than it being a Perfect. As long as it is a Perfect, any Perfect, whether an E-Perfect or a U-Perfect, will do to yield the SR.

The next question is whether there are requirements on the predicate inside the *since*-clause. Our SR sentences so far all had a Perfect inside the *since*-clause as well:

(61)   Tony has been happy [since he has been taking Prozac].

(62)   Tony has been to the Cape two times [since he has been taking Prozac].

In fact, a Perfect inside the *since*-adverbial is not just possible but necessary for SR. Consider the following sentences that differ among each other but have in common that there is no Perfect inside the *since*-clause. Not all of them are grammatical, but the grammatical ones all lack the SR reading.

(63)   Past tense on a non-stative predicate inside the *since*-clause:

   a. Tony has been happy [since he took Prozac].
   b. Tony has been to the Cape twice [since he took Prozac].

(64)   Past tense on a stative predicate inside the *since*-clause:

   a. Tony has been to the Cape twice [since he was in the hospital].
   b. Tony has been happy [since he was in the hospital].

(65) Present Tense on the predicate inside the *since*-clause:

      a. *Tony has been to the Cape twice [since he is in the hospital].

      b. *Tony has been happy [since he is in the hospital].

So in order to obtain the SR reading, we need a Perfect inside the *since*-clause as well. Moreover, what we see in our SR cases is that the Perfect inside the *since*-clause has the morphosyntactic setup of a U-Perfect:

(66) Tony has been happy [since he has been taking Prozac].

(67) Tony has been to the Cape two times [since he has been taking Prozac].

This raises the question of whether the SR reading is possible with an E-Perfect inside the *since*-clause. We will return to this question in Sect. 5. Given that for the SR, the *since*-adverbial must contain a Perfect, it follows that there is another PTS involved, namely, the PTS of the Perfect in the adverbial. So in the SR, we have two PTSs: one PTS corresponding to the matrix perfect (boxed) and one to the perfect in the *since*-clause PTS (underlined):

(68) Tony $\boxed{\text{has been happy}}$ [since he has been taking Prozac].

(69) Tony $\boxed{\text{has been to the Cape two times}}$ [since he has been taking Prozac]

    And once we realize that there are two PTSs involved, we can now proceed to the most appropriate description of the SR:

(70) In the SR, it is the two PTSs (the matrix PTS and the *since*-internal PTS) that are simultaneous.

We said earlier that in the SR, it is the matrix PTS, not the time of the matrix event that is involved. Now we see that it is the *since*-PTS that is involved, not the time of the *since*-event.

    But because there is a U-Perfect in the *since*-clause, its predicate holds throughout the *since*-PTS. Hence, the illusion that simultaneity holds between the matrix PTS and the time of the adverbial's predicate. From now on, we will consider (70) to be the truth of the matter with respect to the question of what the simultaneity holds between in the SR.

    With (70) under our belt, we can now also proceed to the most appropriate paraphrase of the SR, which we argue is (71):

(71) What our sentence means:

      a. Tony has been happy since he has been taking Prozac. =

      b. Tony has been happy since the time since which he has been taking Prozac.

The paraphrase in (71b) captures the fact that intuitively, as we already saw, (71a) conveys that the start of the happiness dates back to the time that Tony started Prozac. The form in (71b) captures the essence of (70): in the SR, there is a PTS inside the *since*-clause. We make this PTS more explicit by spelling out its LB with another *since*-clause.

Now the task is to connect the paraphrase to the form. How do we find (71b) in (71a)?

4   Deriving the SR Reading

4.1   *Something That Does Not Work*

We could ignore (70b) and try something we anyway did in a different context in Sect. 2.3, namely, postulate a covert definite operator that starts out as the complement of a covert AT inside the *since*-clause.

(72)   Tony has been happy since he has been taking Prozac.

(73)   since $\underline{\text{Op }\lambda\, t}$ [$_{TP}$ $\boxed{\text{Pres [Perf}}$ [$_{AspP}$ $\boxed{\text{IMP}}$ [$_{VP}$ [$_{VP}$ $\boxed{\text{he take Prozac}}$] [AT t]]]]].

Or, in a longer paraphrase, according to (73), the *since*-clause of (72) would say this (the markings show the corresponding parts between (72) and (73)):

(74)   since the time t such that there is a PTS stretching backwards from now such that this PTS is included in a time t' which is a time at which Tony takes Prozac and which is identical to t

As before, the definite operator tries to find the maximal time that satisfies the description. In other words, it delivers the interval between now and when Tony started taking Prozac. But there are two problems with this way of doing things.

The first problem can be appreciated by looking at (75a) and its paraphrase in (75b):

(75)   a.   He has been sick since 1990.

        b.   He has been sick since some time in 1990.

We know that "*since 1990*" means "*since some time in 1990*". By that token, if we use the *since*-clause of (73)/(74) then "*since the interval between now and when Tony started taking Prozac*" would mean "since some time in the interval between now and when Tony started taking Prozac." So, it would be true if he started being happy yesterday while he started taking Prozac last year. We don't want this.

And there is a further reason to reject (73)/(74). According to that proposal, *since* is taking as argument an interval that reaches all the way to now. It seems that this is

not possible. Imagine that Tony has been taking Prozac since the beginning of this week. By (73)/(74), *since* should be able to take *this week* as complement. But it cannot:

(76)   #Tony has been happy since this week.

But of course, this is exactly what would be happening in the SR reading of (72) according to (73)/(74). We thus have two good reasons to reject (73)/(74) as the analysis of (72).[22]

4.2   *What Does Work: Take the Paraphrase Seriously*

Recall (71), repeated here as (77):

(77)   a.   Tony has been happy <u>since he has been taking Prozac.</u> =
         b.   Tony has been happy <u>since the time since which he has been taking Prozac.</u>

According to (77b), the clausal complement of *since* in (77a) contains its own *since*-clause. Recall that if we can find (77b) in (77a), we will have solved all the problems that the interpretation of (77a) raises, including why it must contain Perfect morphosyntax in its *since*-clause.

However, how to find (77b) in (77a) is not that transparent: if there are two *since*s in the semantics, why do we pronounce just one? Why don't we say (78) instead of (72)?

(78)   *Tony has been happy since he has been taking Prozac since.

Might there be a silent *since* in (72)? Such a solution is not very inspired, plus it would make the wrong predictions. For example, we could place silent *since* in (79a) and expect it to mean (79b), which it does not.

(79)   a.   *I met him after he has been taking Prozac. ≠
         b.   I met him after the time since which he has been taking Prozac.

We argue that the answer to the question of the missing *since* can be found in Larson ([1987]), who considers the following pair of sentences, which differ only in a preposition that has gone missing in (80b):

(80)   a.   By 1999, I will have lived in every city that John has lived in.
         b.   By 1999, I will have lived in every city that John has lived.

---

[22]The reader may wonder why (i) is better than (76). We will provide an answer to this once we have laid out our proposal.

(i) Tony has been happy since he was in the hospital.

Larson attributes the elided preposition to an instance of Antecedent Contained Deletion, or ACD. Let us give a quick introduction to ACD. In general, in VP-ellipsis, the elided VP (VPe) is interpreted as having the same meaning as its antecedent (VPa):

(81) a. Miranda [petted the dog]$_{VPa}$ and Lena did _____$_{VPe}$ too.
     b. Miranda petted the dog and Lena petted the dog too.

ACD is a case of VP-ellipsis but with an added twist: the elided VP is contained inside the antecedent VP (hence the name!):

(82) John [suspected everyone Mary did _____$_{VPe}$]$_{VPa}$

The issue with ACD can be described as follows: If we fill in VPe at LF by copying in VPa, we get a problem. Specifically, we get a problem of infinite regress:

(83) a. John suspected everyone Mary [suspected everyone Mary did _____]
     b. John suspected everyone Mary [suspected everyone Mary suspected everyone Mary did _____]
     c. John suspected everyone Mary [suspected everyone Mary suspected everyone Mary suspected every one Mary did _____]
        etc.

A solution to the aforementioned problem of ACD was proposed in Sag (1976) and May (1985): the DP head of the relative clause containing the ellipsis undergoes QR:

(84) a. John [suspected everyone Mary did [e]$_{VPe}$]$_{VPa}$
     b. [[everyone Mary did [e]$_{VPe}$]$_k$ [John [suspected t$_k$]$_{VPa}$]

Subsequent replacing of VPe by VPa does not face the infinite regress problem:

(85) [[everyone Mary did [suspected t$_k$]$_{VPe}$]]$_k$ [John [suspected t$_k$]$_{VPa}$]

This solution to the ACD problem (QR preceding replacement of VPe by VPa) is considered the right one by many researchers working on the topic. Larson (1987) argues that there is ACD not just in VP-ellipsis but also with PP ellipsis. First of all, it is clear that there is non-ACD PP-ellipsis (Larson p.c.):

(86) a. Squirrels left paw prints [on the porch]$_{PPa}$ and birds left claw marks [e]$_{PPe}$
     b. John got a bicycle [for his birthday]$_{PPa}$ and Bill got a skateboard [e]$_{PPe}$
     c. John gives his money [to MIT]$_{PPa}$ and Mary gives her time [e]$_{PPe}$

Now consider (87):

(87) By 1999, I will have lived in every city John has lived.

There is a missing preposition. Both instances of *lived* require a preposition:

(88)   *John has lived that city.

Larson analyzes (87) as a case of PP ACD. Consider (89), a more detailed version of (87):

(89)   By 1999, I will have lived [in [every city [that John has lived [e]$_{PPe}$]]]$_{PPa}$

QR applies to the DP "[every city [that John has lived [e]$_{PPe}$]]":

(90)   [[every city [that John has lived [e]$_{PPe}$]] [by 1999, I will have lived [in t$_k$]$_{PPa}$]]

Subsequently, we replace PPe by PPa:

(91)   [[every city [that John has lived [in t$_k$]$_{PPe}$]]
                                                   [by 1999, I will have lived [in t$_k$]$_{PPa}$]]

This is how Larson "finds" the missing preposition in (87). He argues it is missing in the overt string due to PP ACD.

Next we apply Larson's reasoning to find our missing *since*. (92b) is an extended version of (92a):

(92)   a. Tony has been happy since he has been taking Prozac.
       b. Tony has been happy [since Op [he has been taking Prozac [e]$_{PPe}$]]$_{PPa}$

Subsequently, there is QR:

(93)   [Op [he has been taking Prozac [e]$_{PPe}$]$_k$ [Tony has been happy [since t$_k$]$_{PPa}$]]

Finally, PPe is replaced by PPa:

(94)   [Op [he has been taking Prozac [since t$_k$]$_{PPa}$]$_k$
                                      [Tony has been happy [since t$_k$]$_{PPa}$]][23]

So our missing *since* went to the same place as Larson's missing *in*. They are both elided under ACD. However, there is one difference with the Larson case: missing *since* is obligatorily missing, unlike in Larson's cases. Compare (95) to (96):

(95)   By 1999, I will have lived in every city John has lived (in).

(96)   Tony has been happy since he has been taking Prozac (*since).

Possibly this difference is due to *since* simply not being able to strand and so only the ACD option is available:

(97)   ??When have you been living here since?

Of course, we do not know why some prepositions strand and others do not.

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[23]This is the "LF-fill in" version of ellipsis, which is the way Larson has it; the "PF-deletion" will yield the same results.

4.3   Now Some Semantics

In the previous section, we worked out a syntax that is close to the paraphrase (98b) for (98a):

(98)   a.   Tony has been happy since he has been taking Prozac.
      b.   Tony has been happy since the time since which he has been taking Prozac.

Specifically, we accounted for why (98a) has only one *since* but (98b) has two.

But we are not done. We need to understand what interval is picked out by "the time since which Tony has been taking Prozac". Imagine that Tony started taking Prozac at 3 p.m. on October 28, 2008. Then any superinterval of that time will be an interval in which Tony started taking Prozac: October 28, the week of October 28, the month of October 2008, the year 2008, etc. That means that in the scenario above, we can truthfully say all of the following:

(99)   a.   Tony has been taking Prozac since October 28, 2008.
      b.   Tony has been taking Prozac since October 2008.
      c.   Tony has been taking Prozac since 2008.

You might say: "That's not a problem! Just have 'the time since which Tony has been taking Prozac' refer to the <u>smallest</u> interval! (i.e., exclude reference to any of the superintervals)". But that won't solve our problem either, because there is no unique shortest interval either (because of the *at least* component of the meaning of *since*). If Tony started taking Prozac on October 28, 2008, the following are also true (among many others)[24]:

(100)   a.   Tony has been taking Prozac since May 1, 2010.
       b.   Tony has been taking Prozac since early morning June 5, 2012.
       c.   Tony has been taking Prozac since summer 2014.

Because of the presence of these intervals, there won't even be a smallest interval in the set of intervals that the operator operates on.

So it should be clear by now that we have a set of intervals since which Tony has been taking Prozac. We propose that the operator finds in the set of intervals that interval from whose presence in the set we can deduce the presence of all the others in the set. Intuitively, the operator finds "the most informative" interval in the set.

Imagine that Tony started taking Prozac in October 2008. Then "the time since which he has been taking Prozac" will pick out that time such that all the other times at which he takes Prozac follow. The choice of any other interval will not deliver all the right entailments.

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[24]Of course, while they are true, actually asserting them would bring with it implicatures that would be extremely misleading. Appealing to implicatures will not, however, alleviate the semantic problem for the analysis of definites.

Let's say that Tony started taking Prozac in 2008. Then, 2008 is the most informative interval because all the intervals to the right are entailed to be in the set of intervals since which he has been taking Prozac. On the other hand, the interval 2011, for example, is not the most informative interval because there are no entailments about the intervals to its left, which, however, are included in the set of intervals since which he has been taking Prozac. Since 2011 is not the most informative interval, it will not be picked out by "the time since which Tony has been taking Prozac".

So, the operator picks the smallest leftmost interval among the set of intervals since which he has been taking Prozac. This is so because from that one interval the presence of all the other intervals in the set of intervals since which he has been taking Prozac is entailed.

Note that we need this same rationale for questions:

(101)   Since when has Tony been taking Prozac?

The question in (101) is answered by 2008, and not by any of the other intervals. The reasoning is the same as above: it is 2008 from which it follows that all the intervals to its right are included in the set of intervals since which he has been taking Prozac.[25]

4.4   Definiteness

Let us start this section with summarizing where we are. Following Iatridou (2014), we assumed that the *since*-clause provides a definite description. So far in the paper, we argued that this definite description should be interpreted as picking out the most informative interval, rather than the unique or the largest interval. Those two positions may not be obviously compatible, if one has in mind a common semantics for the definite determiner *the*, such as the one explored by Link (1983):

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[25]We can now also return to the question raised in Footnote 23, namely, the contrast in (i–ii). In the main text in Sect. 4.1, we explained why (i)(=76) is out. In this footnote, we explain the status of (ii).

(i) #Tony has been happy since this week.

(ii) Tony has been happy since he was in the hospital.

In our analysis, (ii) claims that Tony has been happy since the most informative interval t such that there is a time t' before now such that there is a time t'' that includes t' and that is a time at which Tony is in the hospital and that is $= t$.

What if he's not anymore in the hospital? Then, the most informative interval will be the entire time interval at which he was in the hospital. That is OK.

What if he's still in the hospital? Then, the most informative interval will be the entire time interval at which he is in the hospital from its start and until now. Then, the sentence will have a meaning that is as trivial as (i).

We don't hear this meaning; instead, we hear that Tony's hospital stay was in the past. It seems that the fact that there would be a trivial reading if he were still in the hospital serves to help the hearer to exclude that possibility.

(102)   a. *The ϕ* is defined only if there is a maximal object x s.t. $\phi(x)$.

      b. When defined, *the ϕ* refers to the maximal object x s.t. $\phi(x)$.

We saw above that in the SR, an analysis along the lines of (101) for the definite description in a *since*-clause will bring about a presupposition failure, as there is no unique maximal (or minimal, for that matter) interval that will fit. One possible path would be to say then, that it is incorrect that the *since*-clause yields a definite description.

One could also take the opposite path. One could argue that (102) is not the correct characterization of the definite determiner and that the semantics of the latter should be molded along the lines that we suggested for the definite description in the *since*-clause.

von Fintel, Fox, & Iatridou (2014) argue exactly this; namely, that the definite description in a *since*-clause showcases exactly the canonical meaning of *the*, which is in (103):

(103)   a. *The ϕ* is defined only if there is a unique individual x such $\phi(x)$ is a maximally informative proposition among the true propositions of the form $\phi(\ldots)$.

      b. When defined, *The ϕ* refers to the individual x st. $\phi(x)$ is the maximally informative true proposition of the form $\phi(\ldots)$.

von Fintel, Fox and Iatridou refer to (103) as the Maximal Informativeness semantics of *the*, henceforth MI.

For many cases, a Link-style semantics and MI predict the same results, but there are some cases where the predictions are different. Take, for example, (104):

(104)   The number of Greek soldiers who together can destroy the Trojan army

According to a Link-style semantics, the NP in (104) is undefined: there is no maximal number of soldiers that can defeat the Trojan army. If a number of soldiers s can do it, any number larger than s can do it too. In fact, what we are picking out in (104) is the minimal number of Greek soldiers.

According to MI, however, the article *the* is defined because it picks out the smallest number of soldiers. It does this exactly because the most informative number is the smallest number of soldiers in (104). Let's say again that s is the smallest number of soldiers that can defeat the Trojan army. All the sentences containing amounts that are larger than s are asymmetrically entailed. If we had picked as reference of (104) an m larger than s then the proposition containing m would not have entailed the propositions with r, where $s < r < m$. See von Fintel, Fox, & Iatridou (2014) for more cases.

So, after all, the definite description that we find in *since*-clauses, following our exploration of the SR, is a well-behaved definite description. It's just that definites work in a way that was previously not appreciated.

5 Back to the Simultaneous Reading

Finally, we come to a question that we brought up earlier but which we have not yet addressed. We said that to have an SR, we need a Perfect inside the *since*-clause, and the *since*-Perfect that we have been using in all our examples so far has been a U-Perfect:

(105) a. Tony has been happy since he has been taking Prozac.

  b. Tony has been to the Cape two times since he has been taking Prozac.

We find the same phenomenon in other languages. Interestingly, but also predictably, we find it in languages where the U-Perfect reading is conveyed without a Perfect morphosyntax (indicated as "U-meaning" instead of "U-Perfect"). In some languages, including Greek and German, the meaning that English conveys with U-Perfect morphosyntax is expressed with simple (imperfective) tenses:

(106) Tony nimmt seit   1990 Prozac.
    Tony takes   since 1990 Prozac

  'Tony has been taking Prozac since 1990.'

(107) o Tony perni   Prozac apo to 1990.
    the Tony takes.IMP Prozac from the 1990

  'Tony has been taking Prozac since 1990.'

Putting aside the question of how a simple (imperfective) tense can convey the same meaning as a U-Perfect in English, we see that the same facts hold regarding SR: if the *since*-clause contains material that can yield a PTS, the SR (i.e., simultaneous PTSs) is possible with any construction that can yield a PTS in the matrix. We give the relevant sentences first in German and then in Greek:

(108) matrix U-meaning:
    Tony ist glücklich seit   er Prozac nimmt.
    Tony is happy   since he Prozac takes

  'Tony has been happy since he has been taking Prozac.'

(109) matrix E-perfect:
    Tony hat Cape Cod zweimal besucht seit   er Prozac einnimmt.
    Tony has Cape Cod twice   visited since he Prozac in-takes

  'Tony has visited Cape Cod twice since he has been taking Prozac.'

(110) o Tony ine eftichismenos apo tote pu perni Prozac.
    the Tony is happy   from then that takes Prozac

  'Tony has been happy since he has been taking Prozac.'

(111) o   Tony echi pai   sto   Cape Cod thio fores apo   tote pu   perni
        the Tony has   gone to-the Cape Cod two times from then that takes
          Prozac.
          Prozac

        'Tony has gone to Cape Cod twice since he has been taking Prozac.'

The question that we raised but did not address earlier is whether an SR is possible
with an E-Perfect in the *since*-clause. Nothing in our analysis makes it necessary
that the Perfect in the *since*-clause be a U-Perfect. In principle, everything that we
have said should work with an E-Perfect as well. That is, all we would need from the
since-clause is material that would yield a PTS, so either a U-Perfect or an E-Perfect
should do. But this does not appear to be the case. For many speakers, an E-Perfect
inside the *since*-clause is ungrammatical.

(112) *Tony has been happy since he has visited Cape Cod.

Why should this be? Recall our LF for the SR reading:

(113) [Op [he has been taking Prozac [since t_k] $_{PPe}$]$_k$
                                          [Tony has been happy [since t_k] $_{PPa}$]]

Earlier, we gave the derivation that yields (113) in the LF-fill-in view of ellipsis,
because that is what Larson (1987) did. Now we give the same derivation but in the
PF-deletion view of ellipsis, because it may illustrate the point we want to make a
bit more easily.

    We start with (114):

(114) Tony has been happy [$_{PP}$ since Op [he has been taking Prozac [$_{PP}$ since e]]]

    Then QR applies:

(115) [Op [he has been taking Pr. [$_{PP}$ since e]]$_k$
                                          [Tony has been happy [$_{PP}$ since t_k]]]

Finally, PF deletion under identity:

(116) [[**Op**$_i$ [he has been taking P. [$_{PP}$ since **t**$_i$]]] $_k$
                                          [Tony has been happy [$_{PP}$ since t_k]]]

In (116), there are two movement chains: QR for ACD resolution (boxed) and the
movement of the Operator (bold). Both these movements would also happen in the
ungrammatical (117):

(117) *[[**Op**$_i$ [he has visited Cape Cod [$_{PP}$ since **t**$_i$]]] $_k$
                                          [Tony has been happy [$_{PP}$ since t_k]]]

We argue that the problem with (117) lies with the movement of the operator. To keep things simple, we will undo the QR movement for ACD resolution:

(118)   *Tony has been happy [$_{PP}$ since **Op**$_i$ [he has visited Cape Cod [$_{PP}$ since **t**$_i$]]]

The problem is, as we will see, that this movement of this operator is not possible because inside the *since*-clause, there is an existential Perfect.

The movement of the operator strands the preposition in (118). Another option would be pied-piping. So in principle, the operator movement would look like (119a) or (119b):

(119)   a.   Op$_i$ [he has visited Cape Cod [$_{PP}$ since t$_i$]]
         b.   [Since Op]$_i$ [he has visited Cape Cod t$_i$]

But both of these are out in the E-Perfect:

(120)   a.   *When have you visited Cape Cod (twice) since?
         b.   *Since when have you visited Cape Cod (twice)?[26]

On the other hand, this movement is possible in U-perfects:

(121)   Since when have you been living on Cape Cod?[27]

So compare the two derivations that are required to yield SR in the two cases:

(122)   Tony has been happy [$_{PP}$ since Op [he has been taking Prozac [$_{PP}$ since e]]]

(123)   *Tony has been happy [$_{PP}$ since Op [he has visited Cape Cod [$_{PP}$ since e]]]

In (122), there is a U-Perfect and extraction of the operator is fine. In (123), there is an E-Perfect and the movement chain is illicit. In other words, a crucial ingredient that is necessary to derive the SR is independently not possible in the case of the E-Perfect.

So let us take stock of where we are. We have an analysis for how the SR is derived. What is needed is a PTS inside the *since*-clause. Then the matrix and *since*-PTSs can be coextensive. If all we need from the *since*-clause to obtain SR is a PTS, that is, a Perfect inside it, in principle any Perfect should do. However, we saw that an E-Perfect inside the *since*-clause yields ungrammaticality. We connected this ungrammaticality to the inability to extract the *since*-clause in an E-Perfect. But why should there be such an inability?

What would (124) mean, if it were grammatical?

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[26]This sentence should be read in the temporal sense and not the adversial sense, which does not even require a Perfect:

(i) Oh yeah? Since when are you an expert on butterflies?

[27]We have already seen that stranding of *since* is not possible. In fact, we used this to explain the obligatoriness of ACD à la (Larson 1987) in the case of the missing *since*.

(124)   *Since when have you visited Cape Cod twice?

Given everything we have said, (124) should mean *What is the time since which you have been to Cape Cod twice?* What is wrong with this meaning? Fox and Hackl (2006) discuss this impossible extraction from an E-Perfect as reported in a previous version of the current paper. They argue that its unacceptability is due to the fact that it is not possible to satisfy the presupposition of the definite description in the *since*-clause. The reason is that the domain of time is dense. As a result, it is not possible to find "the time since which an event happened". On the other hand, with a U-Perfect this extraction is fine because the definite description picks out the time at which the living on the Cape started.

    Regardless of whether Fox and Hackl (2006) is correct or not in their explanation of (124), the fact is that (124) is ungrammatical, and its LF version is a necessary ingredient for the derivation of the SR. It follows that an SR is not obtainable with an E-Perfect in the *since*-clause.

6 Is This Paper Perfect?

No. There is at least one problem. We extended the analysis of Larson (1987) to the temporal preposition *since*. So Larson and we predict that other temporal prepositions should be able to undergo PP ACD, so that a sentence with one overt preposition could in principle be hiding a second identical one. This means that (125a) should be able to mean (125b), which, unfortunately, it does not. According to (125a), Mary will sing until Bill starts singing. On the other hand, according to (125b), Mary's and Bill's singing will cease at the same time.

(125)   a. Mary will sing until Bill sings.
         b. Mary will sing until the time until which Bill sings.

    The derivation would proceed as follows:

(126)   Mary will sing [$_{PP}$ until Op [Bill sings [$_{PP}$ until e]]]

Then QR applies:

(127)   [Op [Bill sings [$_{PP}$ until e]]$_k$ [Mary sings [$_{PP}$until t$_k$]]]

Finally, PF deletion under identity:

(128)   [**Op**$_i$ [Bill sings [$_{PP}$ until **t**$_i$]]$_k$ [Mary sings [$_{PP}$ until t$_k$]]]

Something must be wrong with this derivation; otherwise, (125a) should be able to mean (125b). But what is it? We do not know, but we promise to solve it in time for Roger's 70th birthday festschrift.

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