

De re tenses and trace conversion*

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Abstract I suggest a quantificational account for tenses in which the seemingly peculiar behavior of tenses that are interpreted *de re* (most notably the double access reading of English present-under-past sentences) falls out from a general Trace Conversion rule that applies to moved quantifiers, as in Fox 2002. I propose that *de re* tenses involve movement (following Ogihara 1989), and that the first argument of tenses is a property of times which characterizes the set of times that include the local evaluation time, such that the application of Trace Conversion to moved tenses yields an inclusion requirement with respect to the local evaluation time of the base position. Unlike previous analyses (Ogihara 1989; Abusch 1997), the current analysis predicts that a *de re* interpretation of a tense (past or present) involves inclusion of the attitude time. This is supported by the availability of simultaneous readings for past-under-past sentences in non-SOT languages such as Hebrew, and the unavailability of ‘mixed’ (simultaneous and backward-shifted) readings for past-under-past constructions under universal quantification.

Keywords: semantics of tense, quantification, trace conversion, *de re*, sequence of tense, double access, Hebrew

1 Introduction

Cases where embedded tenses seem to be interpreted *de re*, namely indexically, are puzzling from the point of view of the semantics of tenses. The problem has been mostly noted for the *double access* reading of English present-under-past sentences like (1): Whenever a tense is interpreted as indexical, it seems that it also contributes a relative meaning, as if it were both an indexical and a relative tense at the same time. Intuitively, the embedded tense in (1) says something both about the speaker’s

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“now”, the utterance time, hence *indexical* meaning; and about John’s “now”, the attitude time, hence *relative* meaning. However, there has been disagreement about the nature of that relative meaning.

- (1) John thought that Mary is pregnant.

This paper aims to argue that under close scrutiny it can be seen that the relative component that *de re* tenses contribute is a kind of present. That is, *de re* tenses contribute a relative meaning of inclusion of the attitude time. A further claim that will be made here is that this puzzling behavior teaches us something about the semantics of tenses: that they are quantificational, and that they quantify over the set of times that include the local evaluation time. Together with an independently needed Trace Conversion rule for the syntax-semantics interface (following Fox 2002), this enables us to predict that whenever a tense moves, its lower copy is interpreted as a definite description which presupposes inclusion of its local evaluation time. And since *de re* readings of tenses will be analyzed (following Ogihara 1989) as involving movement, the relative meaning of inclusion for *de re* tenses will be predicted.

The paper is structured as follows: In Section 2 I present the problem with the analysis of *double access*, and the idea that it is an instance of *de re* interpretation of tenses. In Section 3 I present my analysis which is based on Trace Conversion. In Section 4 I argue that the current proposal fares better than previous *de re* analyses of tenses, in light of *de re* interpretations of past-under-past sentences. I show that the proposed analysis predicts that every *de re* tense contributes a relative meaning of inclusion of the attitude time (Section 4.1), and support this prediction by the availability of simultaneous readings for past-under-past sentences in non-SOT languages such as Modern Hebrew (Section 4.2), and the unavailability of ‘mixed’ (simultaneous and backward-shifted) readings for past-under-past structures under universal quantification (Section 4.3). Section 5 summarizes and discusses some problems and an alternative analysis.

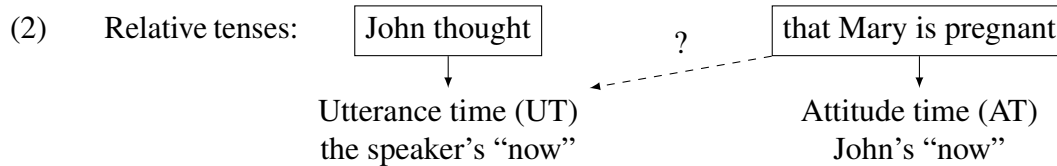
2 Double access

2.1 Data

A present complement clause embedded under a past attitude verb in English, as in (1), has only the *double access* reading (DAR). DAR requires the embedded event not only to hold at the attitude time (AT = the local evaluation time of the embedded clause, John’s “now” in (1)) but to encompass the utterance time (UT = the local evaluation time of the matrix clause, the speaker’s “now” in (1)) too.¹

¹ This is not an exact characterization of DAR, but it suffices for the discussion. For detailed discussions about the nature of DAR see Ogihara 1989; Abusch 1997; Bary & Altshuler 2015; Klecha 2014.

Starting out from the assumption that tenses are always relative — namely that they are evaluated with respect to the local evaluation time of the clause in which they appear — this is surprising: Why would the event in the embedded clause ‘care’ about the utterance time at all? This is illustrated in (2).

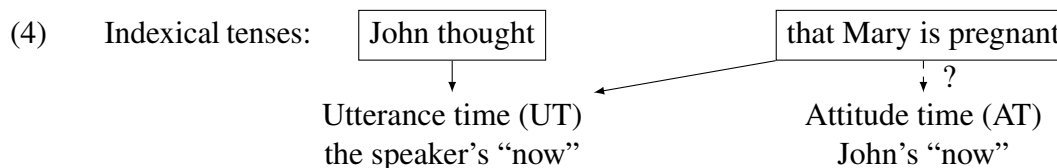


In order to see that the utterance time plays a crucial role in the interpretation of sentences such as (1), consider the following well-observed contrast:

- (3) Double access:
- a. Yesterday, John thought that Mary is pregnant.
 - b. #Two years ago, John thought that Mary is pregnant.

Presumably, (3b) is infelicitous since it posits a requirement on the time of which John believed Mary’s pregnancy to hold that clashes with our world knowledge in which human pregnancies cannot last two years.

If so, assuming that the embedded present in (1) is simply relative we are not able to explain how the utterance time becomes relevant to the running time of the embedded event. On the other hand, assuming that it is indexical, namely evaluated with respect to the utterance time, won’t be enough either. We would just replace the question of how the utterance time is relevant for the embedded event with the question of how the attitude time is relevant for it.



That the attitude time cannot be ignored in the interpretation of (1) can be seen in that (1) has no reading along the lines of (5).

- (5) John thought that Mary would be pregnant now.

On the face of it, there are two ways to treat the embedded present in (1), as indexical or as relative, but neither is adequate on its own. That is, in order to account for the DAR of present-under-past sentences like (1), two things should be derived: (i) an indexical component for DAR, namely sensitivity of the embedded event to UT, and (ii) a relative component for DAR, namely sensitivity of the embedded event to AT.

2.2 *De re* approaches

A common approach to facing this problem, mainly due to Ogihara (1989) and Abusch (1997), is that the embedded present in (1) is interpreted *de re*.² Put simply, it is an indexical tense. However, as we have seen this only gives us the means to provide an indexical component for DAR. But what about a relative component?

Two main answers were given to this question within *de re* analyses of DAR: one by Abusch (1997), and the other by Ogihara (1989). For now I will only briefly describe their answers, and in Section 4 I will discuss them in somewhat more detail.

Abusch's answer is that there is a general restriction on the interpretation of tenses which she calls the Upper Limit Constraint (ULC). Following Heim's (1994) implementation, it prohibits assigning to a tense node a time that is later than its local evaluation time.

Assuming that the embedded present in (1) is a *de re* tense, the ULC entails effectively that (1) can only be felicitous if John thought of Mary's pregnancy time as being before or including his "now", i.e., if it is not interpreted as being after AT.

However, the ULC-based approach faces some conceptual as well as empirical problems. One empirical problem will be discussed in Section 4.3. For now I will only point out the conceptual problems it raises. First, the ULC is an ad hoc constraint. Even though it provides a relative component for *de re* tenses, it is not clear what other motivation this kind of formal constraint might have. Second, the ULC forces us to treat future as something different than present and past — i.e., not as a tense — since future gives us a time that is later than the local evaluation time, which is what the ULC prevents. Even though saying that future is not a tense might not be such a bad idea, the ULC leaves us no other option and as such it limits our theoretical possibilities.

Escaping these kinds of problems and not utilizing the dubious ULC, Ogihara's (1989) Copy-based approach suggests the DAR is the result of tense movement that leaves a copy, which is in line with the Copy theory of movement.

Following Ogihara (1989), I will suggest that *de re* tenses are the result of movement that leaves a copy in the embedded clause. The higher copy of the tense provides an indexical component, and the lower copy is responsible for a relative component for *de re* tenses.

The claim that I put forward in this paper is that the lower copy of *de re* tenses provides a relative component which requires the embedded event to include the attitude time. This generalizes to any *de re* interpretation of tenses, even *de re* past tense. The generalization is in (6).

² I set aside the question of what makes the *de re* interpretation of the embedded present in (1) obligatory, which seems to be a mystery. See Abusch 1997 and Klecha 2014.

- (6) INCLUSION GENERALIZATION:
A *de re* tense is interpreted as *including* the local evaluation time of its base position (AT).

Section 3 presents an analysis that predicts (6). Section 4 adduces evidence in favor of (6).

3 Proposal: A Trace-Conversion-based approach

We have seen that *de re* approaches suggest that the embedded present in present-under-past sentences is interpreted *de re*, and that Ogihara suggested that this interpretation comes about by movement, such that the higher copy provides an indexical component and the lower copy is responsible for a relative component. The goal of this section is to motivate and provide an analysis in which the interpretation of the lower copy of *de re* tenses is always the same: They are interpreted as a definite description that presupposes inclusion of the attitude time, thus conforming to (6).

3.1 Trace Conversion for quantificational tenses

As a first step towards an analysis, I want to present an interpretability problem that arises if we assume that tenses are quantificational, that they may be interpreted *de re*, and that *de re* tenses involve copy movement as in Ogihara's Copy-based approach. Then I present my analysis that solves that problem using Trace Conversion and the assumption that tenses quantify over the set of times that include the local evaluation time. Later I show that the proposed analysis also predicts (6).

There is a long standing debate whether tenses are to be analyzed as quantificational or as pronominal, namely as referring expressions. Partee (1973) has claimed that tenses should be treated as pronominal since they behave as if they refer to times. However, Stalnaker (as cited by von Stechow & Heim 2011), and later Ogihara (1989) proposed that tenses are still quantificational and that similarly to other quantifiers they quantify over a contextually provided domain of times.³

Let us assume a quantificational semantics for tenses. The question that this section discusses is this: Given this assumption, and the assumption that tenses can move and leave a copy behind as in Ogihara's Copy-based approach, then what is the interpretation of a tense, i.e., a temporal quantifier, that has copies in two different places in a single LF?

Specifically, take the LF of (1) in which the embedded present has moved to get a *de re* interpretation. In the Copy-based approach, a copy is left behind as in (7).

³ In the following discussion I neglect the contextual restriction, which does not play a crucial role here.

What is the interpretation of such an LF?

(7) $\text{PRES}_3 \lambda 7 \text{ PAST}_1$ John think PRES_7 Mary be-pregnant

This relates to a general problem with the interpretation of quantifiers that move within the Copy theory of movement: If we want to account for the reading of (8) where *every girl* takes higher scope than *a boy* we would want to move *every girl* up as in (8a). But leaving a full copy of a quantifier phrase of type $\langle et, t \rangle$ in two places in the structure yields an uninterpretable structure. The Trace Conversion rule suggested by Fox (2002), in (9), is designed to solve such problems. It converts the lower copy into a definite description of type e , as in (8b).

(8) A boy kissed every girl.

- a. $\lambda \text{every girl } \lambda 1$ a boy kissed [every girl]₁
- b. $\text{every girl } \lambda 1$ a boy kissed [the girl 1]

(9) TRACE CONVERSION:

- a. Variable Insertion (VI): $(\text{Det}) \text{ Pred} \rightarrow (\text{Det}) [\text{Pred } \lambda y(y = x)]$
- b. Determiner Replacement (DR):
 $(\text{Det}) [\text{Pred } \lambda y(y = x)] \rightarrow \text{the} [\text{Pred } \lambda y(y = x)]$ (Fox 2002: 67)

The exact same problem with the interpretation of (8a) would apply to structures such as in (7), if tenses are quantifiers, that is, if the type of PRES_7 is $\langle it, t \rangle$.⁴ A natural move is to apply Trace Conversion to (7) too. Unfortunately, it turns out that the Trace Conversion rule cannot be applied to quantificational tenses as usually defined. Consider a simple quantificational tense semantics as in (10).

- (10) a. $\llbracket \text{PRES} \rrbracket(t_i)(P_{\langle i, t \rangle}) = 1$ iff $\exists t' [t' \supseteq t \wedge P(t') = 1]$
 b. $\llbracket \text{PAST} \rrbracket(t_i)(P_{\langle i, t \rangle}) = 1$ iff $\exists t' [t' < t \wedge P(t') = 1]$

An immediate problem arises: The first argument of tenses in (10) is a time and not a property of times, unlike nominal quantifiers. Applying the Trace Conversion rule in such a case wouldn't do any good: The converted quantifier would end up meaning something like "the today", since the argument of *the* would be a time rather than a property of times.

The question can be asked as follows: If tenses are quantifiers, just as nominal quantifiers, why do they take a time and not a property of times? What is the reason

4 In Ogihara 1989 this problem is avoided by assuming that quantification is not part of the core semantics of tenses, but rather tenses are properties of times/states, and existential closure is done higher up. Additionally, his proposal is based on a Davidsonian approach with reference to states, which he claims provides the right results for capturing the tricky DAR associated with present-under-past sentences. To keep the presentation traceable I only use his Copy movement idea, similarly to what has been done in Ogihara & Sharvit 2012.

that nominal quantifiers are of type $\langle et, \langle et, t \rangle \rangle$ whereas temporal quantifiers are of type $\langle i, \langle it, t \rangle \rangle$ rather than $\langle it, \langle it, t \rangle \rangle$?

Therefore, I submit that tenses are indeed of type $\langle it, \langle it, t \rangle \rangle$, similarly to nominal quantifiers. What should be the property they quantify over? There are a few possibilities here. I suggest that this is the property of including the local evaluation time, since that property would let us predict (6).

I use a predicate \mathcal{T} , a function of type $\langle i, it \rangle$, which is defined as follows.

$$(11) \quad \llbracket \mathcal{T} \rrbracket = \lambda t. \lambda t'. t' \supseteq t$$

\mathcal{T} takes the local evaluation time as its argument. Given a local evaluation time t , $\llbracket \mathcal{T} \rrbracket(t)$ is the characteristic function of the set of all times that include t .

$$(12) \quad \llbracket \mathcal{T} \rrbracket(t) = \lambda t'. t' \supseteq t$$

The kind of function given by $\llbracket \mathcal{T} \rrbracket(t)$ is a suitable candidate for a predicate to be taken by the temporal quantifier. What the quantifiers take is a predicate of type $\langle i, t \rangle$: a property of times, which is the property of including the evaluation time.

Before we discuss the way in which the semantics of tenses should be amended in order to work with this kind of argument, note that the application of Trace Conversion to tenses is now possible. Since all tenses take the property of including the evaluation time as their argument — that is, an argument which very much resembles a present tense — the application of Trace Conversion would strip them of their inherent meanings and leave intact only the ‘presentness’ of their argument.

Assume that we have a structure with a present tense, the first argument of which is $[\mathcal{T} t^*]$, namely the set of times that include the utterance time, as in (13a). After QRing it as in (13b), we can apply Trace Conversion in (13c) and (13d), to derive the meaning of the lower copy, which is now of type i , as in (13e).

- | | | |
|------|----------------------------------------------------------------------------------------------------------------|----|
| (13) | a. ... [ϕ PRES [$\mathcal{T} t^*$]] ... | |
| | b. [PRES [$\mathcal{T} t^*$]] λx ... [ϕ PRES [$\mathcal{T} t^*$]] ... | QR |
| | c. [PRES [$\mathcal{T} t^*$]] λx ... [ϕ PRES [[$\mathcal{T} t^*$] $\lambda y(y = x)$]] ... | VI |
| | d. [PRES [$\mathcal{T} t^*$]] λx ... [ϕ the [[$\mathcal{T} t^*$] $\lambda y(y = x)$]] ... | DR |
| | e. $\llbracket \phi \rrbracket =$ the t s.t. $t \supseteq t^*$ and $t = x$ | |

The meaning we get for the lower Copy after Trace Conversion in (13e) is independent of whether it was a past or a present to begin with: Since Trace Conversion replaces the tense with *the*, the same result of inclusion would be achieved if it were a past tense. This seemingly strange result is what lets us predict (6), and it will become crucial later, when we discuss past-under-past sentences (Section 4).

I suggest the semantics of tenses in (14).

- (14) a. $\llbracket \text{PRES} \rrbracket (T_{\langle i,t \rangle})(P_{\langle i,t \rangle}) = 1$ iff $\exists t [T(t) \wedge P(t) = 1]$
 b. $\llbracket \text{PAST} \rrbracket (T_{\langle i,t \rangle})(P_{\langle i,t \rangle}) = 1$ iff $\exists t [\exists t' [T(t') \wedge t < t'] \wedge P(t) = 1]$

I assume that tenses are relative: \mathcal{T} takes the local evaluation time as its argument, and the result of applying \mathcal{T} to the local evaluation time, namely the set of times that include the local evaluation time, is what tenses take as their first argument (T in (14)).⁵

Given the set of times that include the local evaluation time, the definition of PRES in (14a) is simple: It yields truth in case there is a time which is within this set and the given proposition is true at that time. The definition of PAST in (14b), given such a set, is more complex: It yields truth in case there is a time (t) which is before some time (t') within this set, and the proposition is true at that time (t).⁶

Before deriving the puzzling DAR of (1), let us see how this works in simple cases. I assume a system in which world and time variables are represented in the syntax, and predicates and clauses are of type $\langle s, it \rangle$ (cf. Percus 2000; Kusumoto 2005). Truth for utterances is defined as in (15), following von Stechow & Heim's (2011: 104) definition, modified to incorporate times:⁷

- (15) An utterance of a sentence ϕ in world w at time t is true iff $\llbracket \phi \rrbracket (w)(t) = 1$.

A tenseless clause such as “Mary be-pregnant” has the representation in (16).

- (16) $\lambda w_1 \lambda t_1$ Mary be-pregnant _{w_1, t_1}

Not having tenses, the world and time arguments taken by the predicate *be-pregnant*

⁵ For any evaluation time t_i there is a unique function T_i such that $T_i = \llbracket \mathcal{T} \rrbracket (t_i)$, which is the argument of tenses whenever they appear in a position where t_i is the local evaluation time. Therefore in simple cases (i.e., when no movement is involved) the definitions of tenses in (14) give equivalent results to the standard definitions in (10), since the equivalences in (i) hold:

- (i) Given a local evaluation time t_i and the function T_i s.t. $T_i = \llbracket \mathcal{T} \rrbracket (t_i)$:
 a. $\exists t [T_i(t) \wedge P(t)] \Leftrightarrow \exists t [t \supseteq t_i \wedge P(t)]$
 b. $\exists t [\exists t' [T_i(t') \wedge t < t'] \wedge P(t)] \Leftrightarrow \exists t' [t' < t_i \wedge P(t')]$

⁶ This definition of PAST renders it a non-conservative quantifier. See Section 5.

⁷ I choose such a system mainly for convenience. The desired results can be derived otherwise, for example utilizing a distinguished variable 0 for the local evaluation time, as in Heim 1994. This requires some modifications, see footnote 8.

Additionally, the semantics I assume for *think* is in (ii).

- (ii) $\llbracket \text{think} \rrbracket (w)(t)(P_{\langle s, it \rangle})(x) = 1$ iff $\forall \langle w', t' \rangle \in \text{Dox}_x(w, t) : P(w')(t') = 1$
 Where $\text{Dox}_x(w, t)$ is the set of doxastic alternatives of x in w at t .

are bound by the local evaluation world and time — w_1 and t_1 .

A tensed clause as in (17a) has the structure in (17b) and the truth conditions (given the actual world w^* and the utterance time t^*) in (18).

- (17) a. Mary was pregnant.
 b. $\lambda w_1 \lambda t_1 [\text{PAST} [\mathcal{S} t_1]] \lambda t_3 \text{Mary be-pregnant}_{w_1, t_3}$
- (18) $\llbracket (17b) \rrbracket (w^*)(t^*) = 1$ iff
 $\exists t [\exists t' [t' \supseteq t^* \wedge t < t'] \wedge \text{Mary be-pregnant in } w^* \text{ at } t]$ iff
 $\exists t [t < t^* \wedge \text{Mary be-pregnant in } w^* \text{ at } t]$

3.2 Application — *de re* tenses in present-under-past sentences

We can now show how the DAR can be derived for (1). First, the embedded PRES together with its first argument undergo QR, as in (19a). Since they appear in the scope of two different local evaluation times, the two copies are not completely identical: In the lower copy the argument of \mathcal{S} is t_3 which corresponds to AT, whereas in the higher copy the argument of \mathcal{S} is t_1 which corresponds to UT.⁸

Second, the application of Trace Conversion to the lower copy yields the interpretable structure in (19b). The truth conditions of (19b) given the actual world and the utterance time are in (19c).

- (1) John thought that Mary is pregnant.
- (19) a. QR:
 $\lambda w_1 \lambda t_1 [\text{PRES} [\mathcal{S} t_1]] \lambda t_7 [\text{PAST} [\mathcal{S} t_1]] \lambda t_2 \text{John think}_{w_1, t_2}$
 $\lambda w_3 \lambda t_3 [\text{PRES} [\mathcal{S} t_3]] \lambda t_4 \text{Mary be-pregnant}_{w_3, t_4}$
- b. Trace Conversion:
 $\lambda w_1 \lambda t_1 [\text{PRES} [\mathcal{S} t_1]] \lambda t_7 [\text{PAST} [\mathcal{S} t_1]] \lambda t_2 \text{John think}_{w_1, t_2}$
 $\lambda w_3 \lambda t_3 [\text{the} [\llbracket \mathcal{S} t_3 \rrbracket \lambda y. y = t_7]] \lambda t_4 \text{Mary be-pregnant}_{w_3, t_4}$
- c. $\llbracket (19b) \rrbracket (w^*)(t^*) = 1$ iff
 $\exists t'' [t'' \supseteq t^* \wedge \exists t' [t' < t^* \wedge \forall \langle w, t \rangle \in \text{Dox}_{\text{John}}(w^*)(t') :$
 $\text{Mary be-pregnant in } w \text{ at the } t''' \text{ s.t. } t''' \supseteq t \text{ and } t''' = t'']]$

The LF in (19a) corresponds to the desired double access meaning. The relative

⁸ A potential advantage of using the distinguished variable 0 for the local evaluation time (see footnote 7), is that there would be no need to assume copies which are not identical as in (19), a situation which has no equivalent in the nominal domain. This requires replacing the first argument of tenses with \mathcal{S}_0 , where $\llbracket \mathcal{S}_0 \rrbracket = \lambda t. t \supseteq t_0$: Both copies would be $[\text{PRES } \mathcal{S}_0]$, and 0 would get different assignments depending on the clause in which it appears. Such a move requires the further assumption that the local evaluation time has a special status, i.e., that λ -abstraction over it is not created by QR. This is what is assumed by von Stechow's (1995) QR CONVENTION: "The movement index created by QR is always different from the distinguished index 0". I thank Uli Sauerland for highlighting this issue.

component of DAR is the result of the converted copy downstairs, because of which the pregnancy time believed by John is presupposed to include AT, i.e., John’s “now”; and the indexical component of DAR is asserted by the higher copy: The time of which John believed Mary to be pregnant is extensionally required to include UT.⁹

Just like in Ogihara’s original Copy-based approach, both the indexical component and the relative component of DAR encode inclusion. In the next section, which is dedicated to a comparison of the current proposal to previous ones in light of past-under-past sentences, we will see that the two approaches can be teased apart when considering such sentences.

4 Substantiation for the analysis: Comparison with previous *de re* accounts

In this section I consider how the current proposal fares with respect to other *de re* accounts. Past-under-past sentences are added to the picture as a way to differentiate the predictions of the various accounts, and to claim that (6) is the right prediction.

4.1 Setting the scene: Predictions for *de re* past-under-past sentences

It has been long observed (Jespersen 1924; Ogihara 1989; Abusch 1997; a.o.) that a past complement clause embedded under a past attitude verb (past-under-past as in (20)) in English can have either a backward-shifted reading as in (20a) or a simultaneous reading as in (20b). This is known as Sequence of Tense (SOT).

- (20) John thought that Mary was pregnant.
- a. John thought: “Mary was pregnant”. Backward-shifted reading
 - b. John thought: “Mary is pregnant”. Simultaneous reading

I do not deal here directly with explaining the existence of these two readings. Instead, I focus on the predictions of the various *de re* analyses for tenses as to the *de re* interpretation of past-under-past sentences. First I will go over the prediction of the current proposal, and then compare it to the predictions of previous analyses.

Recall that the meaning we get for the lower copy in (19) after Trace Conversion is independent of whether it was PAST or PRES to begin with: Since Trace Conversion replaces the tense with *the*, the same result of inclusion for the lower copy would be achieved if it were a past tense. This is the case in (21) which is the *de re* LF of (20).

⁹ An anonymous reviewer claims that as it stands, the truth conditions in (19) are not quite right: Since t_7 appears within the attitude context and bound from outside, it yields a belief of John about a time that includes the utterance time. However, it is clear that the attitude holder should not have any belief directly about the utterance time. I hope this can be solved using a concept-generator mechanism as in Percus & Sauerland 2003 and Charlow & Sharvit 2014 and applying it to the lower copy, such that the belief is about a time concept applied to t_7 rather than about t_7 itself.

- (21) a. QR:
 $\lambda w_1 \lambda t_1 [\text{PAST } [\mathcal{S} t_1]] \lambda t_7 [\text{PAST } [\mathcal{S} t_1]] \lambda t_2 \text{ John think}_{w_1, t_2}$
 $\lambda w_3 \lambda t_3 [\text{PAST } [\mathcal{S} t_3]] \lambda t_4 \text{ Mary be-pregnant}_{w_3, t_4}$
- b. Trace Conversion:
 $\lambda w_1 \lambda t_1 [\text{PAST } [\mathcal{S} t_1]] \lambda t_7 [\text{PAST } [\mathcal{S} t_1]] \lambda t_2 \text{ John think}_{w_1, t_2}$
 $\lambda w_3 \lambda t_3 [\text{the } [[\mathcal{S} t_3] \lambda y.y = t_7]] \lambda t_4 \text{ Mary be-pregnant}_{w_3, t_4}$
- c. $\llbracket (21b) \rrbracket (w^*)(t^*) = 1$ iff
 $\underline{\underline{\exists t'' [t'' < t^* \wedge \exists t' [t' < t^* \wedge \forall \langle w, t \rangle \in \text{Dox}_{John}(w^*)(t')] : \text{Mary be-pregnant in } w \text{ at the } t''' \text{ s.t. } t''' \supseteq t \text{ and } t''' = t'']}]}$

Crucially, the only place where there is a difference between the truth conditions in (19c) and (21c) is the doubly-underlined $t'' < t^*$ in (21c) which replaces the $t'' \supseteq t^*$ in (19c). The current proposal thus predicts that the truth conditions of the *de re* structures of (20) and (1) would be identical except for the temporal relation with respect to UT, namely the indexical component. On the other hand, the relative component in both *de re* past-under-past and *de re* present-under-past requires inclusion. This is exactly what is required for predicting (6), repeated here:

- (6) INCLUSION GENERALIZATION:
 A *de re* tense is interpreted as *including* the local evaluation time of its base position (AT).

This result comes about given our assumptions: (i) that tenses quantify over the set of times that include their local evaluation time, (ii) that *de re* interpretations of tenses are the result of movement that leaves a copy in the embedded clause, and (iii) that Trace Conversion applies to that copy, turning it to mean “the time that is within the set of times that include the local evaluation time (which is identical to the index created by movement)”.

Let us now compare (6) to the predictions of previous approaches.

Abusch’s ULC-based approach derives a relative component for DAR from the ULC, which prevents a tense node from being assigned a time that is later than its local evaluation time. Therefore, the relative component of *de re* present and that of *de re* past would be the same. The ULC-based approach thus predicts (22).

- (22) UPPER LIMIT GENERALIZATION:
 A *de re* tense is interpreted as *preceding or including* the local evaluation time of its base position (AT).

In 4.3 I will argue that (22) is too permissive based on cases where a past-under-past construction is embedded under universal quantification, and that (6) is preferred.

Ogihara's Copy-based approach suggests that *de re* readings of tenses are the result of movement that leaves a copy downstairs, which is in line with the Copy theory of movement. Since the semantics of the lower copy is what determines the contribution of the relative component (see footnote 4), the relative component of *de re* past would require the embedded event to precede AT. Ogihara's Copy-based approach then predicts the following:

- (23) TEMPORAL DIRECTIONALITY GENERALIZATION:
A *de re* tense is interpreted as:
- a. *preceding* the local evaluation time of its base position if it's PAST.
 - b. *including* the local evaluation time of its base position if it's PRES.

In 4.2 I will argue that (23a) does not allow for simultaneous readings of past-under-past in non-SOT languages, whereas given (6) they are naturally explained.

4.2 Simultaneous readings of past-under-past in Hebrew

To test whether *de re* past contributes a relative component of precedence as in (23a) or one of inclusion as in (6) we would want to check what happens with past-under-past sentences: If we could find evidence that *de re* interpretations of tenses give rise to simultaneous readings, we could have an argument for (6).

Could we argue that the simultaneous reading in (20b) is an instance of a *de re* past? The answer is no. Many analyses¹⁰ assume that the embedded past in (20) can be a zero tense, explaining its simultaneous reading through some kind of deletion or SOT rules (see Comrie 1986; Stowell 1995, 2007; Kratzer 1998; Schlenker 1999, 2004 and Grønn & von Stechow 2010). Abusch (1997) suggests the simultaneous reading of *were having* in (24) as a motivation for such an explanation:

- (24) John decided a week ago that in ten days at breakfast he would say to his mother that they *were having* their last meal together. (Abusch 1997: 18)¹¹

The time of having-last-meal in (24) is normally understood to be simultaneous with the time of having-breakfast and the time of saying, and not to precede any other time we can think of in this sentence: neither the utterance time nor the decision-time. This leads to the conclusion that no treatment of this occurrence of past tense as a real past tense can work, and therefore we need to posit deletion rules for English.

If so, English would be the wrong language to look at when we want to see if *de re* past tenses give rise to simultaneous readings, since having deletion rules we might get such readings in another way. What we should do then is consider

¹⁰ Though not all; see e.g., Altshuler & Schwarzschild 2012.

¹¹ The example was originally presented in French in a paper by Kamp and Rohrer.

languages in which there are no deletion rules, such as Hebrew.

As has been shown by [Ogihara & Sharvit \(2012\)](#), the fact that Hebrew has no deletion rules is evident in the following Hebrew equivalent to (24), in which the past on *axlu* ('ate') can only be interpreted as backward-shifted:

- (25) Yoni hexlit lifney šavua lehagid le-ima šelo beod asara yamim
 Yoni decided before week to.tell to-mother his in.more ten days
 be-aruxat boker še-hem *axlu* et ha-aruxa ha-axrona šelahem
 in-meal morning that-they ate ACC the-meal the-last their
 yaxad.
 together

The fact that there is no simultaneous reading available for (26) in the context in (26a) is expected. Surprisingly, however, when the context is as in (26b), a simultaneous reading for (26) is quite natural.

- (26) yadati še-Rina hayta be-herayon!
 Knew.1sg that-Rina was in-pregnancy!
 'I knew that Rina was pregnant!'
- a. Context: yesterday I saw Rina with a swollen belly. Sim.: ✗
 b. Context: two years ago I saw Rina with a swollen belly. Sim.: ✓

But if Hebrew has no deletion rules, what could make any simultaneous reading possible? Our only candidate is a *de re* account. The simultaneous reading of (26) in the context in (26b) could be explained with a *de re* LF, if we assume (6). But as [Ogihara & Sharvit \(2012\)](#) pointed out, within the Copy-based approach we cannot derive simultaneous readings for *de re* past because of (23a), thus it cannot explain simultaneous readings of past-under-past in non-SOT languages such as Hebrew.

Moreover, (26) shows that a *de re* analysis of tenses is needed.¹² First, what determines the availability of a simultaneous reading for (26) is the distance from the utterance time, which already points at the direction of an interpretation that involves indexicality, which is what a *de re* interpretation would yield. Second, consider the well-observed contrast in (3), repeated here:

- (3) Double access:
 a. Yesterday, John thought that Mary is pregnant.
 b. #Two years ago, John thought that Mary is pregnant.

¹² See [Ogihara & Sharvit 2012](#) for another instance of a simultaneous reading of past-under-past in Hebrew that involves a mistake of the attitude holder regarding the time he is in, which also points at the direction of a *de re* analysis.

There is a clear correlation between (26) and (3): A simultaneous reading for past-under-past in Hebrew requires a setup in which an English present-under-past wouldn't be accepted, and vice versa: English present-under-past requires a setup in which a simultaneous reading for past-under-past in Hebrew wouldn't be accepted.

This is reminiscent of the correlation between past and present in matrix clauses: *Mary was pregnant* isn't normally accepted when *Mary is pregnant* is true.

Assuming that both DAR and simultaneous readings of past-under-past in Hebrew are instances of a *de re* interpretation of a tense, the correlation between (26) and (3) is expected.¹³ But if one wants to deny the need for *de re* tenses and explain the DAR using an involved semantics for English present which incorporates both an indexical component and a relative component (as in Gennari 2003; Altshuler & Schwarzschild 2013 and Bary & Altshuler 2015), one would have to say something similar about Hebrew past to account for that correlation. However, there is no evidence that Hebrew past should have an indexical component in its semantics.

4.3 Functional readings of tenses

The prediction of the ULC-based approach in (22) is compatible with simultaneous readings for *de re* past, so it can explain the Hebrew data in (26). But (22) predicts also backward-shifted readings for *de re* past, against which I argue in this section.

Before I argue against (22), a word about time concepts is in order. Abusch (1997) utilizes Lewis' *acquaintance relations* for tenses, or in Heim's (1994) terminology: *time concepts*. The idea is that a *de re* interpretation of a tense involves reference to some time, and a time concept by which the attitude holder (John in our examples) can describe this time to himself. Time concepts can be "yesterday", "now", "tomorrow", "this year", or "last time the lights went out". Given, for example, the time concept "yesterday", the *de re* interpretation of (20) is roughly (27) (where (27a) represents an indexical component and (27b) a relative component):

- (27) The time of which John believed Mary to be pregnant is such that:
- a. From the speaker's perspective it *precedes* the "now". Indexical c.
 - b. From John's perspective it's "yesterday". Relative c.

The ULC-based approach then rules out using time concepts such as "tomorrow" or "a year from now", because they would lead to a violation of the ULC.¹⁴

Consider now the example in (28), in which a past-under-past construction is

¹³ The exact mechanism by which this correlation should be derived is left to be spelled out. Hopefully, this would fall out from an analysis of why a PAST- ϕ sentence has a non-PRES- ϕ inference. See Altshuler & Schwarzschild 2012 and references therein.

¹⁴ An interesting question arises regarding temporally neutral time concepts such as "on Bill's 40th birthday". Following Heim (1994: fn. 28), Bary & Altshuler (2015) discuss the scenario in (iii):

embedded under universal quantification over individuals. Just like any other past-under-past sentence in English, it has two readings: a backward-shifted reading as in (28a) and a simultaneous reading as in (28b). Importantly, (28a) is a reading of (28) even with a *functional* meaning, i.e., if every doctor had another past-time in mind. However, there is no ‘mixed’ functional reading for (28) in which for some doctors it was a past-time and for some doctors it was a present-time, as in (28c).¹⁵

- (28) Every doctor thought Mary was pregnant.
- a. Every doctor thought: “Mary was pregnant”. Backward-shifted
 - b. Every doctor thought: “Mary is pregnant”. Simultaneous
 - c. *Some doctors thought: “Mary was pregnant”, and
Some doctors thought: “Mary is pregnant”. Mixed

Recall that the ULC rules out time concepts that involve future reference, such as “tomorrow”. On the face of it, then, the time concept in (29) should be allowed.

- (29) At the time I am Mary’s doctor, be it now or before.

Suppose that Mary was seriously injured, and after being brought to the hospital, the doctors at the E.R., Sue and Sally, were consulting each other. Sue was Mary’s doctor at that time, and Sally was Mary’s doctor two years before that. For some reason, it was relevant for Mary’s treatment whether she had been pregnant at any time in her life. Sue thought: “Sure, she is pregnant now”, and Sally thought: “She was pregnant when I was her doctor, two years ago”. Following the ULC-based approach, the functional *de re* reading of (28) using the time concept in (29) should give rise to the

- (iii) John thinks Bill’s 40th birthday is in the past and that Mary was pregnant on that day. Bill’s 40th birthday is in fact the day of John’s thinking, which is today.

In this context, (1) is infelicitous. However, the ULC-based approach predicts it to be felicitous: The indexical component of DAR requires inclusion of UT (in reality), and the time of Bill’s 40th birthday does include the utterance time; the relative component provided by the ULC requires Bill’s 40th birthday not to be later than AT (in John’s mind), and it isn’t.

Heim (1994) therefore suggests that there is a prohibition on temporally neutral time concepts. However, Bary & Altshuler (2015) show that once the relative component of DAR requires that the time of Mary’s pregnancy *include* AT rather than *include or precede* it, this prohibition is redundant and temporally neutral time concepts become harmless. Note that this is in line with (6).

¹⁵ I thank Danny Fox for pointing out the relevance of such examples. The same argumentation can be done with quantification over times as in (iv) and with ellipsis as in (v).

- (iv) In the last few years, every time I met John he told me that he was sick.
- (v) Yesterday I met John and Mary. She told me she was sick, and he did too.

reading in (28c) in this scenario. However, no such reading is available.¹⁶

In other words, this situation is compatible with the predicted functional *de re* reading for (28) given the time concept in (29), which can be described as follows:

- (30) For each doctor, the time of which she believed Mary to be pregnant is s.t.:
- a. From the speaker's perspective it *precedes* the "now". Indexical c.
 - b. From that doctor's perspective it's the time of her being Mary's doctor (which is not later than her "now"). Relative c.

Given (6) no mixed reading is predicted: Since a *de re* past yields no backward-shifted reading, it yields no mixed simultaneous and backward-shifted one as well.

Can we maintain the ULC and rule out (28c)? A few ideas may come to mind:

- i. Functional readings are not possible for tenses interpreted *de re*. That is, the *de re* past cannot be bound by the universal quantification. This would indeed solve the problem, but it is not clear why that would be the case: what would allow such binding for non-*de re* tenses and prevent it for *de re* tenses?
- ii. Temporally neutral time concepts are ruled out, as suggested by Heim (1994: fn. 28). First, for that to help here we would have to say that the time concept in (29) counts as temporally neutral even though it does encode at least some temporal relation. Second, as Bary & Altshuler (2015) show, ruling out temporally neutral time concepts is not necessary if the relative component of DAR requires inclusion (see footnote 14).

These are indeed possible refutations of the argument presented here, but as I have shown none of them is trivial. Combined with the stipulative nature of the ULC, the data presented here might be a good-enough reason to rethink it.

5 Concluding remarks

To conclude, the current proposal has several advantages over previous *de re* analyses. First, the ULC assumed by Abusch (1997) can be dispensed with, as in Ogiwara

¹⁶ It should be noted that the data here are problematic for pragmatic accounts of SOT phenomena such as Gennari 2003. According to Gennari, simultaneous readings of past-under-past in English do not require a different representation than backward-shifted readings, but result from a real embedded past tense and a "superinterval property" of stative predicates which allows a past state to stretch up to the present. Since the backward-shifted reading and the simultaneous reading are derived from the same LF in this analysis, it is not clear why that LF would not admit a mixed reading of the two, as in (28c). Even though Altshuler & Schwarzschild (2013) also assume only one representation for English past-under-past sentences, their analysis differs from Gennari's in important respects. Because of that, the question of the vulnerability of Altshuler & Schwarzschild's analysis to this argument is more subtle and requires another discussion, which I will not pursue here.

1989. Second, simultaneous readings of past-under-past in Hebrew and the DAR of present-under-past in English are both accounted for as instances of a *de re* interpretation of tenses, in contrast with Ogiwara’s Copy-based approach. Third, the unavailability of mixed functional readings of past-under-past sentences is naturally accounted for, unlike in Abusch’s ULC-based approach.

As has been shown in the last section, these advantages result from the fact that the current proposal predicts (6) whereas previous analyses do not.

One may ask what alternatives we have, if we are convinced that a *de re* analysis of tenses is needed and that the Inclusion Generalization in (6) is correct. For example, my analysis relies heavily on the assumptions that tenses are quantificational and that they can move: The interplay between the inner structure of the quantificational tenses and the application of Trace Conversion to moved tenses enabled me to predict (6). Is there a way to do without these assumptions?

For now, I can only think of one possible alternative, which assumes no tense movement. Suppose that tenses are pronominal and have the following semantics (I discuss here only PAST tenses for brevity, but this also extends naturally to PRES).

(31) $\llbracket \text{PAST}_{i,j} \rrbracket^g$ is defined only if $g(i) < g(j)$. When defined, $\llbracket \text{PAST}_{i,j} \rrbracket^g = g(i)$

When the second index of tenses is locally bound, i.e., when they are evaluated with respect to the local evaluation time, nothing special needs to be said.

(32) λt_1 John $\text{PAST}_{2,1}$ think that λt_3 Mary $\text{PAST}_{4,3}$ be-pregnant

The problem begins where the second index of a tense is non-locally bound, namely if instead of $\text{PAST}_{4,3}$ in (32) we would have $\text{PAST}_{4,1}$. Let us adopt a concept-generator mechanism as in Percus & Sauerland 2003 and Charlow & Sharvit 2014, and assume that tenses that are non-locally bound are interpreted through the application of a concept generator which is syntactically realized, as in (33).

(33) λt_1 John $\text{PAST}_{2,1}$ think that $\lambda G_8 \lambda t_3$ Mary [$G_8 \text{PAST}_{4,1}$] be-pregnant

G_8 provides a suitable acquaintance relation between John and the time $g(4)$. Now, what if we assumed that acquaintance relations about times are so restricted that any acquaintance relation which does not involve presentness is ruled out? In other words, the only time with which we are sufficiently acquainted is our “now”. With both the past and the future we are not sufficiently acquainted. So “today” and “this month” are fine descriptions, but “yesterday” and “tomorrow” are not.

In a sense, this would be both an Upper Limit and a Lower Limit constraint. But differently from Abusch’s (1997) ULC, it will not be done by constraining the assignments of tense nodes, but rather by constraining acquaintance relations. Therefore it will not affect cases of tenses that are locally bound in which no

acquaintance relations are involved, but only *de re* tenses. However, similarly to the ULC, such a restriction on acquaintance relations seems unmotivated.

One possible motivation to prefer this kind of analysis over the one I suggested in Section 3 is that the way PAST is defined in (14b) is problematic. This definition of PAST renders it a non-conservative quantifier, i.e., (34a) and (34b) are not equivalent. (34b) is in fact contradictory: t should be both in T and at the same time before some time in T . Given that T is the set of times that include the evaluation time, there is no time in T which precedes another time in T , so this yields a contradiction.

- (34) a. $\llbracket \text{PAST} \rrbracket(T)(P) = 1$ iff $\exists t[\exists t'[T(t') \wedge t < t'] \wedge P(t) = 1]$
 b. $\llbracket \text{PAST} \rrbracket(T)(T \cap P) = 1$ iff $\exists t[\exists t'[T(t') \wedge t < t'] \wedge T(t) \wedge P(t) = 1]$

This is problematic for local movements of PAST: In cases where two copies of PAST appear in the scope of the same local evaluation time, the result would be a fatal presupposition failure: The lower copy will presuppose inclusion of the evaluation time whereas the higher copy will assert precedence with respect to it.

It has been suggested (Fox 2002: fn. 8, a.o.) that conservativity of natural language determiners follows from the Copy theory of movement: Given the Copy theory, non-conservative quantifiers would lead to trivial meanings. It has been noted by Sportiche (2005), Hallman (2012) and Romoli (2015), that once we allow two copies to be evaluated with respect to two different worlds, this connection breaks down and non-conservative quantifiers may give rise to non-trivial meanings. This is essentially what is assumed here: The two copies of PAST must be interpreted with respect to different times, otherwise they would lead to trivial meanings.

Relatedly, it is assumed here that two copies can have two different binders: One copy can be bound by the matrix local evaluation time and the other by the embedded one. One may ask whether this is natural, and if we could find anything like that in the nominal domain. I have no good answers to these questions. I thank Danny Fox and Uli Sauerland for pointing that out, and leave it for further discussion.

Finally, the motivation of Ogihara (1989) for his Temporal Directionality Isomorphism, represented here in (23), is data from Japanese in which there are no simultaneous readings for past-under-past. The solution Ogihara & Sharvit (2012) suggest involves making the question of whether movement leaves a Copy behind subject to crosslinguistic variation, a route which I tried to avoid.

To the extent that there are indeed no such readings in Japanese, in the view adopted here it means that the structure where past has QRed is blocked. Note that for Hebrew there is anyway still a need for an account of when the QRed structure is available for past-uner-past sentences, namely the conditions under which a simultaneous reading is available (see footnote 13); and for English too, the unavailability of a present-under-past in-situ needs to be explained (see footnote 2).

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