Resolving similarity in embedded contexts

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1 Introduction

It is widely accepted that in evaluating counterfactual conditionals we consider what happens in circumstances that are similar to the actual world. In this paper I discuss evidence in favor of an analysis of counterfactuals that links the resolution of similarity to the interpretation of tense.

(Arregui, 2005, 2007a, 2008) presented an analysis of counterfactuals that characterized them as predicates of past features of the world (predicates of a past *situation*). It was argued that only similarity with respect to the relevant past features counts. Since counterfactuals were characterized as a case of modal predication about a (past) part of the world, I will refer to this as the *de re* analysis.

The *de re* analysis links the resolution of similarity directly to the interpretation of tense. My objective in this paper is to discuss novel data that shows that the interpretation of tense in counterfactuals affects our evaluation of similarity. We will compare the evaluation of counterfactuals embedded in relative clauses (in which the embedded tense is free) with counterfactuals embedded in the complement of propositional attitude verbs (in which the embedded tense is bound). As we will see, the free vs. bound distinction has consequences for the evaluation of similarity. We will use examples with quantified subjects to detect variation in the resolution of similarity.

The paper is structured as follows. In Section 2, I will present the *de re* analysis of counterfactuals. My goal is to spell out the main ideas, and prepare the ground for the discussion of embedded contexts. Readers are referred to (Arregui, 2005, 2007a, 2008) for further details and justification. According to the *de re* analysis, the interpretation of counterfactuals only requires that we worry about similarity with respect to *certain* features of the actual world. Instead of global similarity, as sponsored by the classical Lewis-Stalnaker style analysis, the *de re* analysis favors local similarity, and ties it to the resolution of tense. This paper is concerned with the latter claim. The argument will be constructed as follows. In Section 3 we will examine examples originating in the sequence of tense literature in which the interpretation of embedded tenses has been claimed to vary: relative clauses vs. complement clauses. In Section 4 we will observe that different options are available for the interpretation of embedded counterfactuals, depending on whether tense is interpreted as free or bound. That is, similarity in counterfactuals is evaluated differently depending on whether they are embedded in relative clauses or in the complement of propositional attitude verbs. The correlation between the interpretation of tense and the resolution of similarity will be taken as evidence in favor of a semantics that ties the resolution of similarity to tense, and thus in

favor of the *de re* analysis.

2   A *de re* analysis

In (Arregui, 2005, 2007a, 2008) I proposed an analysis according to which counterfactuals are interpreted as making *de re* predications about past features of the world. In this section I will (briefly) present the proposal, and some of my basic assumptions. This will serve as the basis for the argumentation in Section 4.

   As a preliminary clarification, let me note that my interest here is with the interpretation of past tense morphology in counterfactuals, and I will not discuss the differences between simple *would* and *would have* counterfactuals. For a discussion of the role of *have*, the reader is referred to (Arregui, 2005, 2007b), as well as (Ippolito, 2003, 2006; Condoravdi, 2002; Iatridou, 2000; Ogihara, 2000), among others.

2.1   Structural preliminaries

In this section, I will present some of my basic assumptions. For the sake of concreteness, I will adopt a simplified syntactic structure for counterfactuals, as well as simplified assumptions regarding the interaction between the if-clause and the matrix clause. I will treat counterfactuals as modal claims c-commanded by a past tense. The modal itself takes two arguments: the if-clause serves as restrictor, and the main clause as nuclear scope (for a more thorough discussion of syntactic matters, the reader is referred to Bhatt and Pancheva (2006); Iatridou (2000), etc; for accounts that address the dynamic nature of the interaction between the if-clause and the matrix, the reader is referred to Kratzer (1991); Fintel (1994), among others):

   (1)   Structure for *would*-conditionals:
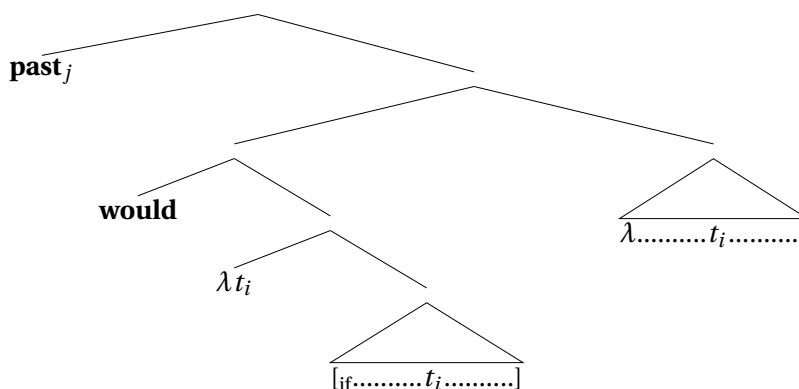
   I would like to highlight the following points: (a) In (1) a past tense c-commands the entire counterfactual construction, regardless of whether we are dealing with simple *would* or *would-have* counterfactuals (see Arregui, 2005, 2007b, for discussion). The idea that (some) counterfactuals are conditionals in the scope of a past tense can be traced back to the work of Thomason and Gupta (1980), and similar ideas have been examined in more recent literature (among others Iatridou, 2000; Ogihara, 2000; Condoravdi, 2002; Ippolito, 2003). It has been observed that the tense morphology we observe in the antecedent clause of counterfactuals (the *if-clause*) is often incompatible with a

deictic interpretation (among others Dudman, 1984). The structure in (1) provides an explanation for the apparent disparity, since the structure predicts that a sequence of tense interpretation will be available for tense in this context. Given (1), the past morphology in the if-clause can be analyzed as indicating agreement with the higher past tense and need not carry deictic past information. A snap-shot of the relevant details is provided in (2), and the mechanisms of sequence of tense will be discussed more generally in Section 3 (following Kratzer, 1998).

(2)

a variable tense
(tense morphology is not interpreted)
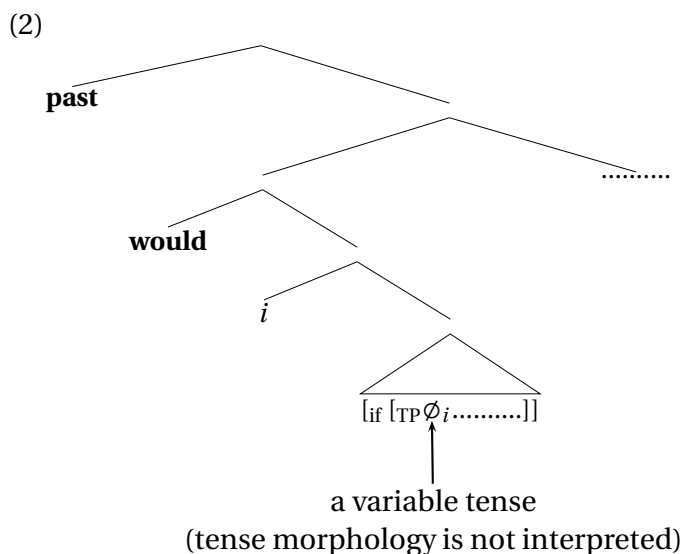
(b) The modal combines with two properties of times, one corresponding to the matrix clause, and the other to the if-clause. In the analysis that will be discussed here, the modal will be responsible for fixing the temporal parameter of its arguments (for views according to which modals are responsible for shifting the evaluation time of their embedded clauses away from the speech time, the reader is referred to Enç (1996); Condoravdi (2002), among others).

2.2 A *de re* proposal in the framework of situation semantics

The proposal examined in this paper assigns a crucial role to tense in managing similarity in counterfactuals. Theories of tense often deal with issues related to temporal interpretation without making specific ontological commitments (they are not necessary). However, in assigning tense a role in the evaluation of similarity, we will adopt a particular view regarding the ontology underlying its interpretation. In the proposal examined here, tenses will be treated as referential expressions (following a tradition that includes (Partee, 1973; Abusch, 1988, 1996; Heim, 1994; Kratzer, 1998)) and they will be taken to refer in the domain of possible situations (as presented in (Kratzer, 1989, 2002, 2006)).

In a Kratzer-style situations framework, situations are parts of worlds (where worlds themselves are characterized as 'maximal situations'). Given a Lewis-style perspective on possible worlds, situations are at most part of one world. The 'mereological' part-of relation will be indicated with the symbol $<_k$. With a 'situations treatment' of referential tenses, tenses have both a temporal and a modal dimension: they identify parts within a world (in other words, features of a world). Under a situations analysis, a (real)

deictic past tense has the interpretation below (analyzing tense features as presupposition triggers, along the lines of Heim (1994)):

(3) $[\![\mathbf{past}_i]\!]^g = g(i) = s_i$, where s_i is presupposed to precede the speech event.

The analysis of counterfactuals that will be examined here appeals not only to the part-of relation described above $<_k$, but also to a *modal* part of relation (represented here with $<$). Having adopted a referential analysis of tense, it will be necessary to identify the situation referent of past tense in counterfactuals within situations and worlds different from the actual world. Given a Lewis-style perspective, cross-world identification of situations (and indeed, any individual!) take place via counterparts. Appealing to counterparts, we can say that a situation in the actual world is part-of (in the modal sense) of another world (or of a situation in another world) iff the actual world situation has a counterpart in the other world:

(4) $s < s'$ iff s has a counterpart in s' (Arregui, 2007a, 2008)
     (where counterpart relations are established via contextually salient parameters of similarity)

With these ideas in place, we can now proceed to discuss the interpretation of the modal, but we'll take a preliminary step. In the analysis examined here, the modal is responsible both for shifting the reference time of its argument clauses, and for quantifying over antecedent situations. For the sake of simplicity, I will spell out the temporal shift separately:

(5) Where $[\![\textit{if-clause}]\!]$ = a property of situations p, the future shifted proposition p^* identified by the modal to serve as the antecedent proposition will be:
     $p^* = \lambda s \exists s' : s' < s \wedge s' \text{is non-past} \wedge p(s') = 1$.

Having established this background, we can now turn to the *de re* analysis of the modal. According to the proposal in (6) (Arregui, 2007a, 2008), the arguments of the modal include two propositions and a situation. The situation is the denotation of the matrix past tense, and functions as the *res* of the counterfactual predicate:

(6) Given two propositions p^* and q^* and a past situation s in w,
     $[\![\mathbf{would}_L]\!]^{w,g}(p^*)(q^*)(s) = 1$ iff
     $\{s'_L : s < s'_L \wedge p^*(s'_L) = 1\} \subseteq \{s'_L : \exists s''_L : s'_L < s''_L \wedge q^*(s''_L) = 1\}$,
     where s_L is a situation that satisfies the set of laws L salient in the context.

Before discussing (6) in detail, let us make one observation about the laws (*L*) (I simply note this point here, it is discussed more extensively in (Arregui, 2007a)). The truth value of counterfactuals is usually resolved on the basis of both facts in the actual world and laws in the actual world (see for example (Lewis, 1979) for an early discussion of their relative importance). The analysis in (6) treats the modal as introducing a free resource variable responsible for invoking relevant laws (making use of ideas in (Fintel, 1994)), thus ensuring that quantification is restricted by whatever subset of the laws is contextually relevant. The proposal examined here thus separates the two factors that traditionally have played a role in resolving similarity: the *modal* is responsible for appealing to the salient (relevant) laws, and *past tense* is responsible for invoking the facts.

According to the proposal in (6), *would* takes as arguments two propositions and a past situation. In the structure in (1), past tense contributes the past situation that is the *res* of predication. The counterfactual is about that past situation. Given (6), the counterfactual will be true iff all (law-like) situations that contain a counterpart of that past actual world situation in which the antecedent is true can be extended (modally) to situations in which the consequent is true.

The proposal in (6), together with the structure in (1), gives past tense an important role to play. Past tense is responsible for identifying the features of the world that matter for evaluating similarity. In other words, past tense identifies the situation that is the *res* of predication (the situation that supports the truth of the counterfactual). We can see the proposal in (6) at work by examining an example:

(7)   *An example*
   ⟦If it had rained, I would have gotten wet⟧^{w,g} = 1 iff
   $\{s'_L : s < s'_L \land \text{it has rained in} s_L\} \subseteq \{s'_L : \exists s''_L : s'_L < s''_L \land \text{I have gotten wet in} s''_L\}$

We will first worry about the antecedent proposition. As we saw in (5), *would* in (7) sets the temporal parameter of the antecedent clause to some non-past time. But if we set the result state introduced by the perfect *had rained* at some non-past time (for example, the utterance time), we will allow the raining event to be located before the speech time (thus giving the impression that the antecedent clause is set in the past!) (for a discussion of the temporal effects of the perfect in antecedent clauses, the reader is referred to (Arregui, 2007b; Ippolito, 2003, 2006, , among others)).

Let us now consider the *res* situation in (7). Suppose that I was in an open field, and had no umbrella or protective cover. In such circumstances we might be willing to grant that (7) is true. And the *de re* semantics makes correct predictions: suppose that past tense refers to the past situation of me being unprotected in the field, it will be the case that all lawlike situations that include a counterpart of this situation in which it has rained will have lawlike modal extensions in which I have gotten wet.

We will make correct predictions for (7) when tense refers to the situation that I was uncovered in the open field. But we might worry. What if tense had referred to another situation (the situation of there being a big cow next to me, for example)? Then the counterfactual would have come out false (there is no law-like link between cows, it raining, and me getting wet). The only response to this concern is to say that when we interpret a counterfactual, we try to resolve the denotation of past tense in a way that makes the sentence true. This is a general strategy for referential expressions, and is part of our cooperative attitude when talking to each other.

The analysis in (6) locates the relevance of actual world features in the resolution of tense. A counterfactual will come out as true or false depending on the interpretation of tense (and the laws). In the next section we will take a short detour to consider examples showing that we have intuitions about the situations that support the truth of counterfactuals (the situations that are the *res* of counterfactual predicates). This is encouraging, as it lends plausibility to the *de re* analysis. The examples in question will be sentences in which counterfactuals are embedded under the verb *to know* (this matter is discussed also in (Arregui, 2007a, 2008)).

2.3   Motivating the view: intuitions on 'aboutness' in counterfactuals.

In this section we will be concerned with the conditions in which we are ready to claim that somebody *knows* a counterfactual. We will be interested in the analysis of knowledge put forward in Kratzer (2002). Kratzer characterizes knowledge as justified true belief, and avoids the well-know problem posed by Gettier-examples by requiring that belief be *de re* about facts (the pertinent situations in the world). Since in Kratzer's proposal knowledge of a proposition requires acquaintance with situations that support the truth of the proposition, knowledge contexts will provide good settings to test our intuitions regarding the situations that support the truth of counterfactuals.

Here is Kratzer's characterization of *know*:

(8)   *S knows p* iff   (Kratzer 2002)

   a.   There is a fact f that exemplifies p
   b.   S believes p *de re* of f, and
   c.   S can rule out relevant possible alternatives of f that do not exemplify p.

The requirement that knowledge include *de re* belief of the world-features responsible for the truth of the embedded proposition avoids the problems posed by *Gettier*-scenarios. To see how this works, consider the example in (9):

(9)   Smith knows that either Jones owns a Ford or Brown is in Barcelona.

As Gettier famously pointed out, examples like (9) can prove challenging for an analysis of knowledge as justified true belief. Suppose that Smith knows that Jones used to own a Ford, and has recently seen Jones driving around in a Ford, and so justifiably believes that Jones owns a Ford. Suppose also that Smith has no idea as to where Brown is. Smith's belief state is such that he believes that *either Jones owns a Ford or Brown is in Barcelona*. Now, in Gettier's story, it turns out that Jones had sold his Ford, and was driving around in a friend's car, and accidentally Brown happens to be in Barcelona. So Smith believes a true proposition, and is justified in believing that proposition. However, we would not accept, in this context, that Smith *knows* the proposition.

Kratzer's analysis of *know* avoids the problem posed by Gettier contexts by requiring that knowledge include *de re* belief about a situation that supports the truth of the believed proposition.[1] Our judgments regarding knowledge attribution are thus expected to be sensitive to the situations that support the truth of propositions, and we can now use Gettier contexts to test our intuitions for the case of counterfactuals. Consider (10) in a Gettier context (11):

(10)   Smith knows that if Nixon had pushed the button, there would have been a nuclear holocaust.

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[1] Kratzer requires *de re* belief about facts, where facts are characterized as follows: *If s is a possible situation and p is a proposition, then s is a fact exemplifying p iff for all s′ such that s′ < s and p is not true in s′, there is an s″ such that s′ < s″ < s and s″ is a minimal situation in which p is true. (A minimal situation in which p is true is a situation that has no proper parts in which p is true.)* (Kratzer, 2002, : 660)

(11) *Gettier context:* at some point in the past, the button had been connected to an A-set of missiles, and if those had been launched, there would have been a nuclear holocaust. Smith knew this. But at some later point, there was a change of strategy, and the button was disconnected from the A-missiles and connected to a B-set of missiles. If those had been launched, there would have been a nuclear holocaust. Smith never found out that the wiring had been changed.

In the scenario described in (11), we would be unwilling to grant that Smith knows that if Nixon had pushed the button, there would have been a nuclear holocaust. We can explain this with Kratzer's proposal by showing that in this context Smith is not properly acquainted with the features of the world that support the truth of the embedded clause (i.e. Smith is not acquainted *de re* with the relevant situation). The example allows us to see that we have clear intuitions about what features of the world are responsible for the truth of the counterfactual, and lends plausibility to a view according to which tense makes reference to such features.

The observation that we have intuitions about the situations that support the truth of counterfactuals is encouraging, but does not in itself justify a *de re* analysis. The fact that there are situations that support the truth of counterfactuals does not itself guarantee that we make reference to such situations when uttering a counterfactual. To argue that tense makes reference to such situations, I will present examples in which differences in the interpretation of tense correlate with differences in the interpretation of counterfactuals. We will begin by examining the various interpretations available to tense.

3 Deictic vs. bound variable tenses: evidence from sequence of tense literature

In this paper I have adopted a referential theory of tense. A referential approach to tense was originally defended by Partee (1973), who noted that tenses could function a lot like pronouns, and receive free referential interpretations, anaphoric interpretations and bound variable interpretations. Various presentations of this view can be found in the literature (Heim, 1994; Kratzer, 1998; von Stechow, 1995; Kusumoto, 2005, etc.). Here I will follow Kratzer (1998) in distinguishing between deictic tenses and variable tenses. Illustrations are provided in (12):

(12) *A referential theory of tense*
   a. $[\![past]\!]^{g,c}$ is only defined if c provides an interval t that precedes t_0.
      If defined, then $[\![past]\!]^{g,c} = t$.
   b. $[\![\varnothing_n]\!]^{g,c} = g(\varnothing_n)$ (Kratzer, 1998)

According to Kratzer (1998) (and Heim, 1994), a deictic past tense carries the presupposition that the temporal entity it refers to is past (12a). A variable tense carries no presuppositions, and will be interpreted simply in reference to a variable assignment (12b). With this analysis, deictic past tenses (tenses in which morphological features carry semantic information) refer to salient past entities. Variable tenses can be interpreted either as free or bound. If free, they will refer to salient entities. If bound, they will give rise to the bound-variable reading of tense.

Kratzer's proposal for the interpretation of tense is set within a larger framework designed to provide an account for sequence of tense phenomena and *de se* beliefs, in parallelism with the interpretation of pronouns (we have simplified the presentation here). 'Sequence of tense' is a descriptive terms used in the literature to identify cases in which tense morphology appears to be semantically vacuous, lacking the temporal information associated with real, deictic past tenses (we will examine examples in Sections 3.1 and 3.2). Various analysis of sequence of tense phenomena have been provided (Abusch, 1988; Ogihara, 1989; von Stechow, 1995; Kusumoto, 2005, among others). According to Kratzer (and others), sequence of tense phenomena arise because not all instances of past tense morphology correspond to deictic past tenses. In the right environment, past tense morphology can show up as an instance of *agreement*, and carry no semantic import. In such contexts, we will find a variable tense.

Kratzer's analysis of sequence of tense phenomena makes use of both free and bound variable interpretations for variable tenses. Kratzer shows that we can understand the restrictions on the temporal interpretations available to tenses in different types of embedded clauses by observing that some of those tenses are free and others are bound. This will be discussed in the next two sections.

3.1   Tenses in relative clauses

It has been observed that tenses in relative clauses can be interpreted independently (Ogihara, 1989, , etc.). An illustration is provided in (13):

(13)   He married a woman who went to Harvard.   (Ogihara, 1989)

The sentence in (13) does not impose an order between the time of the marriage and the time at which the woman studies in Harvard. This can be captured in a referential theory of tense with an analysis in which the relative clause tense (RC-tense) is a deictic past tense, and is simply ordered with respect to the speech time. If both tenses are deictic, they are only ordered with respect to the speech time, and no order is impose amongst them.

Given the aspectual classes involved in (13), it is difficult to imagine that the RC-tense could be interpreted as a variable tense, coindexed with the matrix. It is easier to access this option with stative relative clauses, as in (14). Here, the RC-tense could easily correspond to a variable tense that picks up a salient referent from the context, and thus ends up being anaphoric to the matrix tense:

(14)   John bought a fish that was still alive.   (Ogihara, 1989)

As a variable tense, the RC-tense pronoun carries no restrictions. It surfaces with past tense morphology because it agrees with the matrix past tense. A variable tense in the relative clause would make (14) an example of a sequence of tense phenomena. Alternatively, the RC-tense could be a real deictic tense. As such, it could co-refer with the matrix past or be independent.

The alternative interpretations for the RC-tense discussed above are presented below, as conceived by Kratzer (1998):

(15)   a. $[_{TP}$ past$_1$ [John buys a fish that$_2$ $[_{TP}$ $\emptyset_1$ [t_2 be still alive]]]].

b. [$_{\text{TP}}$ past$_1$ [John buys a fish that$_2$ [$_{\text{TP}}$ past$_{1/3}$ [t_2 be still alive]]]]. (Kratzer, 1998)

In (15a), the RC-tense in (14) is analyzed as a variable. It is interpreted by the variable assignment, and is anaphoric to the salient matrix past tense. In (15b), the RC-tense in (14) is analyzed as a deictic past tense. The referent picked out by the tense pronoun must precede the speech time, and can be co-referential with the matrix past tense, or not.

To see another illustration of the variable tense (clearly) at work, consider (16):

(16)   John said he would buy a fish that was still alive. (Kratzer, 1998)

In (16) the RC-tense picks out a temporal entity that is future with respect to the speech time. This tense carries no deictic past features. Yet, it surfaces with past morphology because of agreement with a higher past tense.

The important conclusion to be drawn from this section is that tenses in relative clauses are not bound. Whether they are deictic or variable tenses, they are interpreted referentially, picking out temporal entities.

3.2   Tenses in complement clauses

Tenses in complement clauses also exhibit sequence of tense phenomena. An illustration is provided in (17):

(17)   John decided a week ago that in ten days he would say to his mother that they were having their last meal together. (Abusch, 1988)

Even though there is past tense morphology in the most deeply embedded tense, the time corresponding to the meal is understood to follow the speech time. Past morphology on the VP *were having their last meal together* is semantically vacuous. In this example, tense on *was* can only be a variable tense, surfacing with past morphology as a consequence of agreement.

Though tenses in the complement clause of attitude verbs can be interpreted as variable tenses, they cannot be interpreted independently of the matrix tense (that is, they cannot be *free* variable tenses). To see this, consider (18):

(18)   John thought that the fish was still alive.

The interpretation of the embedded tense in (18) is restricted. The sentence can only mean that John thought in the past that the fish was still alive at that past time when he was thinking (or at an earlier time). (18) cannot report a past thought about a future state of the fish. This restriction on the interpretation of the embedded tense has been targeted by Abusch's upper limit constraint (presented by Kratzer as in (19)):

(19)   *Abusch's Constraint* ('Upper Limit' Constraint)
       In attitude contexts, the highest tense is controlled by the matrix tense.

If we think of the upper limit constraint as a descriptive generalization, it simply claims that the interpretation of tenses in the complement clause of attitude verbs are 'bounded' by the time of the matrix event.

The proposal in (Kratzer, 1998) provides an account of the semantics of complement clauses that allows us to make sense of Abusch's generalization. Making use of observations and proposals by Cresswell and von Stechow (1982) and von Stechow (1995), Kratzer generalizes a *de se* account of beliefs to temporal cases. Under a temporal *de se* analysis, the complement clauses of propositional attitude verbs denote properties of times. In the example in (20a), this will be the property of times true of times at which the fish was still alive:

(20) a. John thought that the fish was still alive
      b. [$_{TP}$ past$_1$ [John thought that$_1$ [$_{TP}$ $\emptyset_1$ the fish was still alive]]]. (Kratzer, 1998)

Using the concept of *self-ascription* to simplify the presentation, we can understand that the attitude verb in (20a) requires that the subject self-ascribe the relevant property at the time identified by the matrix tense. This will mean that in the past, John self-ascribed the property of being at a time in which the fish was still alive (he 'self-located' as being at a time with that property). As was pointed out by von Stechow (1995), the link between the evaluation time of the embedded property and the time corresponding to the subject's *now* allows the upper limit constraint (*Abusch's constraint*) to be derived from the semantics of the embedding verb.

The analysis of sequence of tense in the complement of attitude verbs, and the explanation of the upper limit constraint presented above, appeal to a bound variable interpretation of the embedded tense. As a variable, tense in the embedded clause does not carry deictic presuppositions, and the embedded morphology simply reflects agreement with higher tenses.

In this section we have examined arguments from the sequence of tense literature that point to a difference in the interpretation of tenses embedded in relative clauses and tenses embedded in the complement of attitude verbs. In the first we observe a free interpretation, and in the latter a bound variable interpretation. The discussion of tense in the sequence of tense literature is made without major ontological commitments regarding the nature of temporal entities. In the next section we will see that with the situations interpretation of a referential theory of tense presented in Section 2, the differences we have observed between bound and free tenses permit the *de re* analysis to make correct predictions regarding the resolution of similarity in embedded counterfactuals. We will examine counterfactuals in both relative and complement clauses in the scope of quantified subjects.

4 Relating the interpretation of similarity to the interpretation of tense

As we noted in Section 2.3, the fact that the truth of a counterfactual depends on what is happening in part of the world (situation) does not in itself justify an analysis according to which some expression makes reference to that part of the world (situation) (as an analogy, the fact that a specific individual may be responsible for the truth of the sentence *A man smiled* does not justify the claim that some constituent in the sentence refers to that man). In this section we will provide support for the *de re* analysis by examining examples in which the variation in the interpretation of tense that we

observed in Section 3 correlates with variation in the evaluation of similarity. We will be interested in counterfactuals embedded in relative clauses and in the complement of attitude verbs. We will use sentences with quantified subjects as a tool to detect variation in the evaluation of similarity.

To see how the argument will proceed, consider again the denotation for the modal proposed by the *de re* analysis, and compare it with a Lewis-Stalnaker style denotation:

(21) *De re* proposal
$[\![$**if** p, **would** $q]\!] = 1$ iff
$\{s'_L : s < s'_L \wedge p(s'_L) = 1\} \subseteq \{s'_L : \exists s''_L : s'_L < s''_L \wedge q(s''_L) = 1\}$,
where p and q are propositions, s is a past situation in the actual world, and s_L is a situation that satisfies the set of laws L salient in the context.

(22) $[\![$**if** p, **would** $q]\!] = 1$ iff   (a Lewis-Stalnaker style analysis)
$\{w : S(w_0)(p)(w)\} \subseteq \{w : q(w)\}$
where p and q are propositions, w_0 is the actual world, and S is a contextually given similarity relation.

According to (21), quantification will take place over situations that are similar to the actual world with respect to s, where s is the denotation of past tense. The prediction is that variations in the interpretation of past tense could affect how we identify s, and thus affect also the evaluation of similarity. According to (22), however, similarity is calculated globally by salient a similarity relation. Crucially, this view does not tie similarity to tense.

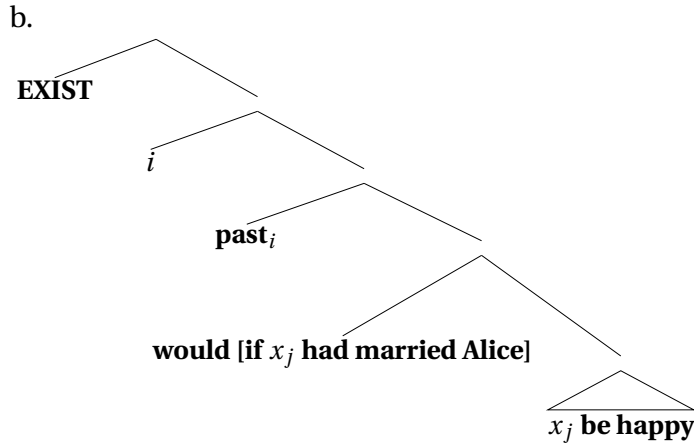## 4.1 Counterfactuals in the complement of propositional attitude verbs

Let us begin by examining the interpretation of counterfactuals in the complement of propositional attitude verbs. Consider the counterfactual in (23a), uttered in the scenario described below:

(23) *Scenario:* John and Jack both wanted to marry Alice. She was wealthy and beautiful. John believed that money would have made him happy, and Jack believed that beauty would have made him happy.
  a. Both men believed that if they had married Alice, they would have been happy.

Given the context provided in (23), it is clear that the men had, intuitively, different reasons for reaching the conclusion that marriage with Alice would have made them happy. The analysis of counterfactuals provided in (6) can be straightforwardly related to an analysis of the propositional attitude verb in a manner that predicts this result. A proposal for the denotation of the embedded clause is given in (24):

(24) a. [believed that if they had married Alice, they would have been happy]

b.

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        EXIST
              i
                  past_i
                         would [if x_j had married Alice]
                                                           x_j be happy
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The proposal in (24) includes an index binding the pronoun introduced by tense. With this analysis, tense in the complement clause is actually a bound-variable tense, and the temporal location of the embedded clause will be decided by the embedding verb (as discussed in Section 3.2). Tense morphology on the embedded verb is past in agreement with the c-commanding past tense in the matrix verb. The embedded tense does not carry deictic presuppositions.

As we noted in Section 3.2, tenses in the complement clauses of attitude verbs are bound. The index i in (24b) binds the embedded tense, resulting in a property of situations (proposition) that is true of situations that support the truth of the counterfactual. These are situations such that all the lawlike situations that include them (modally) in which the antecedent is true are also situations in which the consequent is true. This proposition itself is not a good argument for belief. Generalizing a *de se* semantics for belief, *believe* relates a proposition and an individual, resulting in truth when the individual self-ascribes the property of living in a world in which the proposition is true. The problem is that an individual can believe a counterfactual without it being the case that his/her belief worlds themselves support the truth of the counterfactual (typically, the belief worlds will be 'too big', and include features that are incompatible with the antecedent). It does not seem correct to claim that the proposition generated by abstracting over the denotation of *past* is itself true of the belief worlds of the subject. What seems correct is to say that there is some situation in the belief worlds of the subject in which (of which) such proposition is true. The role of the EXIST predicate is thus to mediate between the property of situations generated by abstracting over tense and the world-level property of situations that is suitable as an object of belief. EXIST thus maps properties of situations that may be smaller than worlds to properties of situations that are true of worlds.[2] The latter will constitute an adequate object for *believe*. Here I am proposing that mediation between the two is carried out via existential quantification:

(25)   a. $[\![\textbf{EXIST}]\!](p) = \lambda w \exists s[s < w \wedge p(s) = 1]$
       b. $\lambda w \exists s[s < w \wedge \{s'_L : s < s'_L \wedge g(j) \text{ married Alice in } s'_L\} \subseteq$

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[2] The EXIST operator is somewhat reminiscent of an aspectual operator, as characterized by Kratzer (1998), following Klein (1994). Aspectual operators map properties of events to properties of times, quantifying over event arguments. The EXIST operator maps properties of 'small' situations to properties of worlds, quantifying over the small situations. The investigation of such parallelisms remains for future research.

$$\{s'_L : \exists s''_L : s'_L < s''_L \land g(j) \text{ is happy in } s''_L\}]$$

Given the proposal in (25a), the complement of *believe* in (24a) will be the proposition in (25b). This is the proposition true in a world iff there exists a situation that supports the truth of the counterfactual. This proposition can be an adequate argument for believe: an individual can be said to believe a counterfactual if s/he self-ascribes the property of living in a world in which there exists a situation that supports the truth of the counterfactual.

The semantics in (25b) makes correct predictions for examples with quantified subjects, like (24). The sentence will be true iff it is the case that for each man x, x self-ascribes the property of living in a world in which the proposition in (25b) is true. This allows each man to believe the counterfactual for 'different reasons', since the situation that supports the truth of the counterfactual can vary from one man to the other.

A global similarity analysis is at a disadvantage with examples in which counterfactuals are embedded under quantifiers. According to the global similarity analysis, a counterfactual invokes a contextually salient measure of similarity. There is no room here for variation under a quantificational subject. To see the difficulties that can arise with a single measure of similarity, consider the example in (26):

(26) John is well informed, and believes that Verdi was Italian and Bizet was French. Jack however, believes that Verdi and Bizet were twins, and that both were French.

   a. Both men believe that if Bizet had been Italian, Verdi and Bizet would have been compatriots.

Our intuitions tell us that the counterfactual in (26a) is (or can be) true. Again, the men have arrived at their beliefs for, intuitively, different reasons. As we have seen, this can be captured with the analysis in (25), since the choice of *res* situation will be allowed to vary with the men (the situation that Verdi was Italian for John and the situation that Verdi and Bizet were twins for Jack). A single, contextually salient, measure of similarity, however, would get us into trouble. For suppose that context is such that similarity with respect to nationality is given paramount importance (S). Then, (26a) will be true iff for each man it is the case that for all of his belief-worlds, the most S-similar worlds in which Bizet was Italian are also worlds in which Verdi and Bizet were compatriots. For John this will not be problematic. Given that he believes that Verdi was Italian, and S prioritizes nationality, in the most similar worlds in which Bizet was Italian, Verdi will have been Italian too, and therefore Verdi and Bizet will be compatriots. But in the case of Jack, we will obtain wrong results. Jack believes that Verdi and Bizet were twins, and that they were both French. If Jack has come to believe that *if Bizet had been Italian, Verdi and Bizet would have been compatriots*, it can only be because similarity ignores the facts regarding Verdi's nationality (according to Jack!), and prioritizes the fact that they were twins. We will not predict that both men believe the counterfactual if similarity is resolved assigning the same weight to the facts regarding Bizet and Verdi's nationalities in both cases. But if there is a single, contextually given similarity relation, it is not clear why similarity would care about Verdi's nationality when looking for the antecedent worlds relevant for John's belief, and not care about Verdi's nationality when looking for the antecedent worlds relevant to Jack's beliefs.

The conclusion we draw from the discussion above is that a single notion of similarity will not give us correct results in examples like (26), in which the men can be

said to hold the belief for different reasons. The existential quantifier over situations in (25) makes better predictions here, supporting the *de re* proposal. Notice that it would not really help the global similarity view to change the contextually given similarity relation for an existentially quantified one, and thus allow for distribution under quantified subjects:

(27)   a. Both men believe that if Bizet had been Italian, Verdi and Bizet would have been compatriots.

   b. Where *S* is a contextually supplied similarity relation, *A* is the antecedent proposition, and *C* the consequent proposition,
       $\lambda w \exists S \{w' : S(w)(A)(w') = 1\} \subseteq \{w' : C(w') = 1\}$

With an existential quantifier over the similarity relation, the truth of a counterfactual would require that all worlds that are similar to the evaluation world in some respect in which the antecedent is true should also be worlds in which the consequent is true. This appears to be too strong, since the domain of quantification will now include many more worlds than are actually relevant. And as we will see in the next section, existential quantification over the similarity relation would also be problematic in other examples.

As a final remark in this section, I will point to a source of concern. The proposal in (25) ties the truth of the belief of a counterfactual to the existence of a situation that supports the counterfactual. This 'existential' semantics predicts that conjunctions like (28) can be true:

(28)   Sara believes that if New York were in Georgia, New York would be in the south, and that if New York were in Georgia, Georgia would be in the north.

This is because, if Sara's geographical beliefs are accurate, there will be a situation in Sara's belief worlds that supports the truth of the counterfactual that *if New York were in Georgia, New York would be in the south*. This is the situation of Georgia being in the south. There will also be a situation that supports the truth of the counterfactual that *if New York were in Georgia, Georgia would be in the north*. This is the situation that New York is in the north. Maybe we an explain the oddness of this example by claiming that if we have to resolve the reference of two tense pronouns with the same antecedent, it is just pragmatically difficult to assign them different interpretations. Typically, the utterance of (28) will be understood in a context in which one of the situations has become more important, and this will make it difficult to shift the referent of the second tense pronoun. However, this is speculative, and the topic requires further research. It is worth pointing out, however, that while the proposal in (25) predicts that (28) can be true, it does not make the same prediction for (29):

(29)   Sara believes that if New York were in Georgia, New York would be in the south and Georgia would be in the north.

Whatever may be Sara's beliefs about the location of New York and Georgia, there won't be a situation in Sara's belief worlds that supports the truth of the counterfactual that *if New York were in Georgia, New York would be in the south and Georgia would be in the north*.

4.2 Counterfactuals in relative clauses

In this section we will examine the interpretation of counterfactuals in relative clauses. As we noted in Section 3.1, tenses in relative clauses have been claimed to be free, referring to some contextually salient entity (in our situations framework, a contextually salient situation). Given the *de re* analysis, the proposal that tenses in relative clauses are free makes different predictions for the resolution of similarity in counterfactuals in relative clauses embedded under quantifiers as opposed to complement clauses embedded under quantifiers. These predictions appear to be confirmed. Consider the example in (30):

(30)   At the party, John met Jane and Jim met Joan. Jane and Joan had both been in the space program at NASA, though some years apart. They were both expelled.

    a.   #At that party, both men met a woman who would have been the first woman in space if she hadn't been expelled from NASA.

The counterfactual in (28a) is odd in the context provided above. It clearly isn't because of the fact that there were different women involved, since a sentence of the form *At the party, both men met a woman who ate a lot of cheese* would be perfectly fine if they met different women. Neither can we attribute the oddness of (30a) to the fact that there cannot be two different women of whom the counterfactual would be true. Suppose that Jane had been chosen by NASA to be the first woman in space, but something went wrong and she was expelled from the program. In such circumstances, (31) would have been true:

(31)   If Jane hadn't been expelled from NASA, she would have been the first woman in space.

Imagine now that after Jane was expelled, NASA selected Joan to be the first woman in space. But again, something went wrong and Joan was expelled. (32) would also have been true:

(32)   If Joan hadn't been expelled from NASA, she would have been the first woman in space.

The *de re* analysis of counterfactuals, together with the observation that tenses in relative clauses remain free, correctly predicts that even if (31) and (32) are true, (30a) will be odd. To see this, consider the interpretation of the generalized quantifier *a woman who would have been the first woman in space if she hadn't been expelled from NASA*:

(33) $\lambda P \exists x [x$ is a woman $\wedge$
    $\{s'_L : s < s_L \wedge x$ has not been expelled from NASA in $s'_L\} \subseteq$
    $\{s'_L : \exists s''_L : s'_L < s''_L \wedge x$ is the first woman in space in $s''_L\} \wedge P(x) = 1]$
    where $[\![\textbf{past}]\!]^{w,g}$ in the embedded counterfactual is s.

‼️   `I suspect it should be` $s < s'_L$ `instead of` $s < s_L$ `in the first set description.`

As we see in (33), *a woman* introduces existential quantification over women, but the interpretation of tense is referential (this is a relative clause with a free tense pronoun). This means that tense will refer to a salient situation. When *a woman* is interpreted in the scope of the quantifier *both men*, it will be possible to vary the women

that each men met (the existential will distribute), but it won't be possible to vary the situations referred to by tense. This means that in order for (30a) to be true, there would have to be a situation in the world that supports the truth of both counterfactuals in (31) and (32). And this cannot happen. For suppose we consider a situation that supports the truth of (31). This would be a situation in which Jane was chosen by NASA to be the first woman in space. This situation will not make the second counterfactual true: in the situations in which Joan is not expelled from NASA and Jane has been chosen to be the first woman in space, Joan will not be the first woman in space (and vice versa).

In (27) we considered and discarded the possibility of allowing the similarity relation associated with the counterfactual to be existentially quantified over. Let us note that such a view would make incorrect predictions for the case of relative clauses:

(34) $\lambda P \exists x [x$ is a woman $\wedge$
$\exists S \{w' : S(w_0)(x$ is not expelled from NASA$)(w') = 1\} \subseteq$
$\{w' : x$ is the first woman in space in $w'\} \wedge P(x) = 1]$
where w_0 in the actual world.

In (34) I have presented the denotation for the generalized quantifier *a woman who would have been the first woman in space if she had not been expelled by NASA*, allowing existential quantification over the similarity relation associated with the counterfactual. This treatment of similarity would allow the similarity relation to vary with the choice of men when the relative clause is interpreted in the scope of the quantifier *both men.* Given our judgments, this would be a mistake.

For the sake of completeness, further examples following this pattern are provided below:

(35) a. #Both women drove a car that would have won the race if it hadn't broken down.

b. #Both professors had a student who would have discovered DNA if she had persevered.

5   Conclusion

In this paper we have examined examples in which counterfactual conditionals are embedded in relative clauses and in the complement clauses of attitude verbs. We have used examples with quantified subjects to test the options available for the interpretation of similarity. We have observed that our evaluation of similarity varies depending on whether counterfactuals are found contexts in which embedded tenses are bound and the *res* situation is existentially quantified over (attitude complements), or in contexts in which embedded tenses are free (relative clauses) and the *res* situation is identified deictically. The presence of quantified subjects has allowed us to detect the variation.

The conclusion is that the interpretation of tense affects the evaluation of similarity. This is straightforwardly accounted for by an analysis of counterfactuals that links the resolution of tense to the resolution of similarity. For this reason, counterfactuals in embedded contexts provide support for the *de re* analysis of counterfactuals.

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