# Introducing propositional discourse referents[1]

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**Abstract.** This paper addresses the question of which structures make propositions available for anaphoric reference, i.e., which structures introduce propositional discourse referents. I describe two current approaches to this question—one syntactic and one discursive—and then identify data which pose challenges to each approach. As an alternative, I offer a novel proposal: proposition-embedding operators introduce discourse referents for their propositional arguments. I show one way to formally model this generalization, using Update with Modal Centering (Bittner, 2011).

**Keywords:** propositional anaphora, discourse referent, small clause, adverb, raising, control.

## 1. Introduction

Karttunen (1969) is a systematic examination of which constructions license anaphoric reference to an individual, that is to say, in Karttunen's terms, which constructions introduce a *discourse referent* (dref). As Karttunen (1969) showed, not all indefinite noun phrases make an individual available for anaphoric reference, as exemplified by (1).[2]

(1)     # Lucy doesn't have <u>a car</u>. *It* is blue.                    (cf. Karttunen, 1969: (4))

Karttunen (1969) concluded that NPs introduce drefs in sentences whose propositional content is "asserted, implied or presupposed by the speaker to be true" (p13). But as Krifka (2013) has shown, the same generalization does not hold for the introduction of propositional discourse referents (pdrefs), as demonstrated by (2).

(2)     Lucy doesn't <u>have a car</u>. She tells people *that*, though.        (cf. Krifka, 2013: (24))

The indefinite NP under the scope of sentential negation in (1) does not introduce a dref,[3] where the clause [Lucy has a car] under the scope of sentential negation in (2) *does* introduce a pdref which is available for reference by the anaphor *that* in the following sentence.

Given this discrepancy, a question arises as to the correct generalization for the introduction of pdrefs: which constructions license anaphoric reference to a proposition? This is the question which I will address in this paper.

There are two types of approaches to answering this question which are represented in the literature. For the remainder of this section, I will briefly introduce each approach, before challenging them both in the following sections.

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[2]For purposes of illustration, sentences throughout will have (relevant) anaphors italicized and their (intended) antecedents underlined.

[3]Or its dref is otherwise inaccessible to the anaphor in the following sentence.

## 1.1. A syntactic approach

One response to the question of pdref introduction is to look to syntax. Krifka (2013) identifies the introduction of discourse referents with specific syntactic projections. In particular, TP and higher projections (like NegP for sentential negation) introduce propositional discourse referents, while $\nu$P introduces event discourse referents and ActP introduces speech act discourse referents. For example, Krifka (2013) provides the analysis in (3b) for the sentence in (3a).

(3)    a.    Ede didn't steal the cookie.            (Krifka, 2013: (24))

      b.    [$_{\text{ActP}}$ ASSERT [$_{\text{NegP}}$ *Ede did-n't* [$_{\text{TP}}$ $t_{\text{Ede}}$ $t_{\text{did}}$ [$_{\nu\text{P}}$ $t_{\text{Ede}}$ $t_{\text{steal}}$ *steal the cookie*]]

           $\hookrightarrow$d$_{\text{speech act}}$       $\hookrightarrow$d$'_{\text{prop}}$       $\hookrightarrow$d$''_{\text{prop}}$   $\hookrightarrow$d$'''_{\text{event}}$

                                                (Krifka, 2013: (22))

On this analysis, the TP introduces a pdref ($d''$) for its content—the proposition 'Ede stole the cookie'—, and NegP introduces a pdref ($d'$) for its content—the proposition 'Ede didn't steal the cookie'. This is a necessary condition: whenever you have a certain structure, you have the associated discourse referent.

This analysis makes clear predictions about which constructions should license anaphoric reference to a proposition: constructions involving TP or higher projections should have pdrefs introduced for (and by) each of those structures. These predictions are easily tested, as we will see in Sections 2 & 3.

## 1.2. A discursive approach

Another approach to the question of pdref introduction looks not to syntax but to discourse structure. Theories of discourse which make use of Discourse Representation Structures (DRSs) or elementary discourse units (EDUs) to model things like discourse relations (e.g., Asher, 1993; Carlson and Marcu, 2001; Asher et al., 2012; Hunter and Asher, 2016; Asher et al., 2017) can identify these structures with the introduction of pdrefs. For example, some implementations of Discourse Representation Theory (DRT) explicitly assign discourse referents for (sub)DRSs, as in $p_1$ in (4a), and Segmented DRT assigns a label to every (sub)SDRS, as in the 𝕜s in (4b).

(4)    a.                                               b.
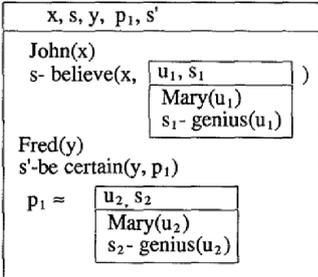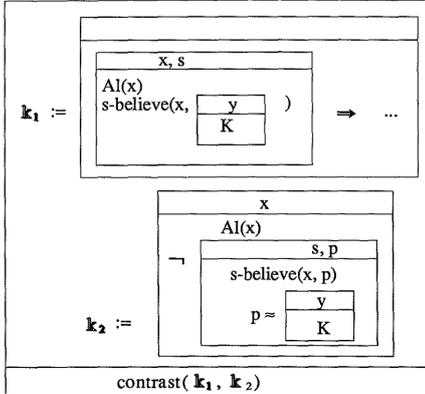


(Asher, 1993: 242)                                        (Asher, 1993: 324)

It would be very natural to extend this pattern to all such discourse structures, and to associate a pdref with every (sub)DRS or EDU.

The predictions made by this type of approach for specific constructions are a bit harder to pin down than the syntactic approach, as it is not always clear what the appropriate representation for any given construction is, i.e., how many (sub)DRSs or EDUs make up a particular construction. That said, discourse annotation manuals like Carlson and Marcu (2001) & Asher et al. (2012) provide guidelines for the identification of EDUs, and sufficiently so that we can test the predictions of this discursive approach.

1.3. A brief note on methodology

To test the predictions made by each of these approaches, what we need is a method for evaluating the availability of a proposition (plausibly) introduced by some non-matrix material. In other words, we will have a structure like (5), and we are looking to see whether the proposition associated with some embedded content ($q$) is available for anaphoric reference. However, because the proposition denoted by the matrix clause ($p$) is an available antecedent, we need some way to rule that out as a competitor.

(5)  $[_p \ldots [_{q?} \ldots ]\,]$

In order to ensure that we are testing for $q$ and not $p$, I will be using what I call a *Moore's frame*, inspired by Moore's paradox (Moore, 1993), the observation that sentences like (6) can never be uttered felicitously.

(6)   It's raining but I don't believe it's raining.

I will use this type of frame so as to make a matrix-level interpretation—where the propositional anaphor is interpreted as referring to the matrix clause proposition—an unsuitable infelicitous interpretation. If the target sentence still has a felicitous interpretation, despite being in a Moore's frame, then I take that to be strong evidence that some non-matrix proposition has an associated pdref which is available for anaphoric reference. On the other hand, if the target sentence fails to have a felicitous interpretation, then I take that as evidence that there is no alternative non-matrix pdref available.

Throughout, I will use the propositional anaphor *that*, as it has the widest distribution (i.e., has the fewest selection restrictions) of the overt propositional anaphors (Snider, 2017a). I will rely on predicates which take propositional arguments—like *true*, *believe*, and *tell*—in order to diagnose the felicity of such propositional anaphors and as such, the presence of propositional discourse referents. Finally, sentences marked here as infelicitous may have felicitous variants which do involve anaphora, so long as that anaphora is to events or individuals as opposed to propositions; but considering that the felicity of other types of anaphora has no a priori bearing on the availability of propositional anaphora, and as such does not constitute counterevidence to any claims advanced here, I put such examples aside for present purposes.

## 2. Subclausal data

### 2.1. Small clause constructions

Small clause (SC) constructions involve a noun and a predicate, which together compose the small clause, following a verb. SC constructions have a number of different functions: they can introduce a predication, cause, result, or epistemic state, among other things (Wilder, 1991).

The syntactic approach makes a clear prediction here. Small clauses have been described in the literature as VPs or alternatively as special Predication Phrases (PrP; Bowers, 1993; Balazs, 2012). Both of these phrase types are structurally lower than TP, so we needn't decide between these two types of accounts, as both are equivalent for present purposes. On either of these analyses of small clauses, the syntactic approach predicts SCs not to introduce pdrefs. The discursive approach is less clear on this case, as small clauses aren't mentioned in Asher (1993) or Asher et al. (2012). Carlson and Marcu (2001) can be said to cover SCs only if SCs count as "clausal complements"; if they are not, then SCs should not constitute EDUs.

The prediction of the syntactic approach, at least, is borne out by most kinds of SC constructions:

(7)    # Lucy wanted <u>her steak rare</u>, but *that*'s not true. (It's medium.)        SEC. PRED.

(8)    # Lucy made <u>Charlie angry</u>, but *that*'s not true. (He's happy.)        CAUSATIVE

(9)    # The rabbi pronounced <u>them married</u>, but *that*'s not true. (They're single.)   RESULT

Even though (8) conveys the proposition 'Charlie was angry', that proposition does not have an associated pdref which is available for reference by the anaphor *that*.

But not all SC constructions behave the same way; the epistemic SC in (10) does seem to have an associated pdref, as the proposition it conveys is felicitously referred to by the anaphor.

(10)     The rabbi considered <u>them married</u>, but *that*'s not true. (They're single.)  EPISTEMIC

The small clause *them married* introduces a pdref in (10), even though no pdef is introduced for *them married* in (9). For either of the existing approaches to account for these data, the occurrences of *them married* must be represented differently in (9) & (10). For the discursive approach, *them married* must constitute an EDU in (10) but not in (9). For the syntactic approach, *them married* must be located within TP in (10) but not in (9). This is not *a priori* impossible, if (only) the former is a covert infinitive, for instance, but this would at least necessitate a reanalysis of our current understanding of the syntax of SC constructions. However, this reanalysis appears at best ad hoc, and at worst dangerously cyclical: if we don't have an independent reason to distinguish the structures of (9) & (10), then we end up defining a structure as a TP only when it licenses anaphora.

### 2.2. NP adverbial constructions

Constructions where an adverb acts as a modifier in the nominal domain also serve as an interesting testing ground for these approaches. The syntactic approach predicts that no modifier

in the nominal domain should introduce a pdref, as this domain is below TP. The discursive approach stipulates that adverbial-modified clauses only constitute EDUs if those adverbs are temporal (Carlson and Marcu, 2001) or the clauses are elliptical (Asher et al., 2012), and so predicts that none of the following examples should introduce non-matrix pdrefs.

Most NP adverbials are well behaved in this regard, and don't introduce pdrefs:

(11)    # Lucy lifted a fairly <u>heavy box</u>, but I don't believe *that*.                DEGREE

(12)    # Lucy lifted a surprisingly <u>heavy box</u>, but I don't believe *that*.          EVALUATIVE

The proposition 'The box was heavy' isn't an available antecedent in either (11) or (12), even though both sentences entail that proposition; in both examples, the Moore's frame renders the utterance infelicitous, suggesting that no non-matrix proposition has an associated pdref. This is the case regardless of whether the agent-anchored adverb *surprisingly* in (12) is anchored to the speaker or to the subject (Lucy). In other words, no matter who was surprised by the heaviness of the box, that proposition isn't available for anaphoric reference.[4]

Epistemic adverbs, however, do allow for anaphoric reference to a non-matrix proposition:

(13)    Lucy lifted a supposedly <u>heavy box</u>, but I don't believe *that*.            EPISTEMIC

The felicity of (13) despite the Moore's frame indicates that there is a non-matrix proposition which is available for anaphoric reference. And the most natural reading of (13) is that the speaker believes that Lucy lifted a box which was supposedly heavy, but they don't believe the box was in fact heavy. In other words, the proposition 'the box was heavy' seems to be what was supposed and what is disbelieved.

Taken at face value, it would seem that the phrase *heavy box* would have to constitute a TP in (13)—but not in (11) or (12)—in order for the syntactic approach to account for these data.

One potential analysis that a defender of the syntactic approach might suggest is that in fact the sentence in (13) has a structure as in (14), making it equivalent to (15).

(14)    $[$ supposedly $[_{TP}$ Lucy lifted a $t$ heavy box $]\,]$, but I don't believe that.

(15)    Supposedly, Lucy lifted a heavy box, but I don't believe that.

This movement of *supposedly* to a position structurally higher than TP would mean that it could introduce a pdref (in just the same way that NegP introduces a pdref in (3)), thus leaving a non-matrix proposition to deny. And in fact this analysis is very much in line with Cinque (1999), which locates epistemic adverbs higher than TP. If this analysis is correct, however, then (13) and (15) should be identical in meaning, where they seem not to be. To illustrate this difference in meaning, consider a context in which Lucy is known to be the strongest person alive, participating in some competition which involves box lifting. In such a competition, one might expect Lucy to be able to lift any box, but still disagree about the heaviness of any particular box. In such a context, in reporting on an event in which the participants lifted a

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[4]The subject-anchored reading is perhaps the most plausible: 'Lucy lifted a heavy box, but I don't believe that she was surprised it was heavy'. Even this reading is unavailable, however.

small canvas box, a spectator might felicitously say (13), while an utterance of (15) would be strange.

This analysis also requires that any other inferences that one might understand from (13)—that the speaker believes 'some box exists', that the speaker believes 'Lucy lifted that box', that the speaker doesn't believe 'the box is heavy'—must all be implications, as the only asserted content is of the form *Supposedly p but I don't believe p*.

The discursive approach, meanwhile, cannot account for (13), as it is neither temporal nor elliptical. Taken together, then, we have reason to believe that at least some material which on current analyses is below TP, or does not constitute an EDU, nevertheless introduces pdrefs.

## 3. Multiclausal data

In this section, we turn to raising and control constructions. Much ink has been spilled in the syntactic literature over the status of the complements of raising/control/ECM verbs, specifically over whether they are TPs or CPs. Fortunately for our purposes, these are equivalent under the syntactic approach as far as the introduction of pdrefs is concerned. Whether one of these clausal complements is a TP or a CP, it should in either case introduce a pdref (and thus be available for anaphoric reference). As a result, the syntactic approach predicts all of the examples in this section to allow for felicitous anaphoric reference to a proposition denoted by the embedded clause.

On the discursive approach, clausal complements are only considered to be EDUs if they are non-infinitival complements of cognitive or attribution verbs (Carlson and Marcu, 2001) or are infinitival purpose clauses (Asher et al., 2012). None of the following examples fit these criteria, so the discursive approach predicts none of the examples in this section to involve the introduction of a pdref for non-matrix content. As a result, all of the following examples are predicted to be infelicitous.

Both approaches predict uniformity across the class of raising and control constructions, and they predict exactly opposite behavior. Any data is guaranteed to contradict at least one of the approaches. As we will see, however, neither approach predicts the behavior observed here.

All subject raising constructions introduce pdrefs for their clausal complements, as in (16).

(16)    <u>Lucy</u> seemed/appeared <u>to be at the party</u>, but *that* wasn't true. (She was at home.)
                                                                      SUBJECT RAISING

(16) is felicitous and the proposition 'Lucy was at the party' is the natural antecedent to the anaphor *that*, so the complement clause does have an associated pdref. This is in line with the predictions of the syntactic approach, but contrary to those of the discursive approach.

No object control constructions, however, introduce pdrefs for their complements, as in (17).

(17)    # Patty asked/begged <u>Lucy to be at the party</u>, but Linus didn't believe *that*. (He thought
          she would stay home.)                                        OBJECT CONTROL

(17) is infelicitous even with a follow-up attempting to coerce the intended interpretation, where the proposition associated with the complement clause is the antecedent of the anaphor *that*. This infelicity indicates that there is no available pdref for the complement clause. This behavior accords with the predictions of the discursive approach, but runs counter to those of the syntactic approach.

We already have in these two classes of constructions enough reason to doubt both the syntactic and discursive accounts, but examining the full paradigm gives us a clearer picture of when pdrefs are introduced. Having seen the behavior of subject raising and object control constructions, one might expect the introduction of pdrefs to fall along raising & control lines (where only the former introduce pdrefs), or similarly, along subject & object lines. As it turns out, however, neither class of constructions behaves uniformly. Both object raising & subject control constructions *sometimes* introduce pdrefs for their infinitive complements:

(18)    Patty expected <u>Lucy to be at the party</u>, but Linus didn't believe *that*. (He thought she would stay home.)                                                                         OBJECT RAISING

(19)    # Patty wanted <u>Lucy to be at the party</u>, but Linus didn't believe *that*. (He thought she would stay home.)                                                                         OBJECT RAISING

(20)    <u>Lucy</u> claimed <u>to be at the party</u>, but *that* wasn't true. (She was home.)
                                                                                                                  SUBJECT CONTROL

(21)    # <u>Lucy</u> tried <u>to be at the party</u>, but *that* wasn't true. (She was home.)
                                                                                                                  SUBJECT CONTROL

The object raising constructions in (18) & (19) constitute a minimal pair, the only difference being the choice of verb, *expect* vs. *want*. Only the former is felicitous, suggesting that only in (18) is a pdref introduced for the complement clause. Similarly, the subject control constructions in (20) & (21) constitute a minimal pair, differing only in their verbs, and only the former is felicitous. The complement of *claim* has an associated pdref, but the complement of *try* does not. The non-uniform behavior of these classes is a challenge for both the syntactic and discursive approaches, which predicted uniform behavior across all types of raising and control constructions.

These minimal pairs suggest that there is something about the embedding verbs themselves which is relevant for predicting the introduction of pdrefs, not just the structures they embed.

## 4. Generalization & Discussion

### 4.1. A new generalization

The data presented in the previous two sections challenge both the syntactic and discursive approaches to the introduction of propositional discourse referents. Both approaches focus on the structures themselves—be they syntactic or discourse structures—where the data presented above suggest that it is not a specific structure that is responsible for the introduction of pdrefs, nor is the discourse status of the respective propositions (Snider, 2017b). Instead, these data— in particular, the minimal pairs of the small clause-embedding verbs *consider* vs. *pronounce*,

the raising verbs *expect* vs. *want*, and the control verbs *claim* vs. *try*—suggest that it is the embedders of those structures which is important in determining whether a pdref is introduced.

In particular, I argue that paying attention to the semantic types of the arguments that these verbs take is what is crucial to identifying the appropriate generalization. Many English verbs are quite flexible about what types of arguments they can take, and English also allows for fairly flexible type-shifting; nevertheless, note that verbs like *want* and *try* are incompatible with *that*-clause complements (standardly considered propositional), unlike *expect* and *claim*.

(22)      Lucy expects that Charlie will come to the party.

(23)      Lucy claims that Charlie will come to the party.

(24)      * Lucy wants that Charlie will come to the party.

(25)      * Lucy tries that Charlie will come to the party.

Note also that the arguments of *expect* and *want* can be described as being *true* or *false*—properties of propositions—while the arguments of *want* and *try* cannot.

(26)      What Lucy expected is true/false.

(27)      What Lucy claimed is true/false.

(28)      * What Lucy wanted is true/false.

(29)      * What Lucy tried is true/false.

Verbs like *expect* and *claim* take arguments whose semantic type is that of a proposition, while verbs like *want* and *try* do not. Only by paying attention to the semantic type of the arguments that these verbs take, in particular to which ones are compatible with propositional arguments, can we make the right generalization:

(30)    Generalization: Operators which take propositional arguments introduce discourse referents for those arguments.

Thus far, we have only discussed the introduction of pdrefs for the propositions associated with embedded clauses, but as we can see in examples like (3), the matrix proposition also always has an associated pdref (even if that pdref is an infelicitous antecedent, as in a Moore's frame context). Ideally, we should want our generalization about the introduction of pdrefs to cover these cases as well, not just embedded clauses. Fortunately, we can capture the introduction of pdrefs in both matrix and embedded clauses if we consider sentential mood markers to themselves 'embed' the matrix proposition, following Bittner (2011). On this type of analysis, sentential mood markers take a (matrix) proposition as an argument and output instructions for what to do with that proposition (updating the common ground, partitioning the context set, etc.).

Having included sentential mood markers, we can expand the set of operators included within the generalization in (30). This set of operators includes, among other things, the declarative mood marker DECL, sentential negation NEG, and embedding verbs like *consider*, *seem*, *appear*, *expect*, and *claim*. For a more comprehensive survey of which operators are included (and excluded), see Snider (2017a).

4.2. Comparison with existing approaches

The new generalization proposed here makes reference to the semantic type of the arguments of various operators, and in that regard is a semantic approach to the question of pdref introduction. In that this generalization deals with combinatorics, it is also syntactic in nature; however, it also goes beyond the tools of syntax (syntactic category, movement/extraction type) and makes reference to descriptions which are semantic in nature. That said, there is nothing here which is fundamentally incompatible with either a syntactic or discursive approach, if the same behavior here could be predicted using the tools of those worlds. The challenge for those approaches would be in incorporating the insights gained here in a way that doesn't seem arbitrary or ad-hoc. Doing so might require reanalyzing theories of certain structures (e.g., small clause constructions), drawing subdivisions within existing classes of structures (e.g., subject control constructions), and/or extending theories to new paradigms (e.g., extending Cinque, 1999 on adverbs and Hacquard, 2011 on modals to all verbs).

The crucial difference between this generalization and those suggested by the existing approaches is not one of domain but rather of attention to structure versus surrounding context. Where the existing approaches pay attention to whether a given phrase is or isn't a TP/EDU, regardless of where it appears, the generalization proposed here is sensitive to the environment in which the phrase occurs, in particular the embedding operators. If one does not attribute pdref introduction to the embedding context, then one is forced to explain the non-uniform behavior of phrases like *them married* or *Lucy to be at the party*. On the current approach, two phrases which are string-identical can differ in semantic type if one is type-shifted (e.g., from an event to a proposition), and such an operation might be required for that phrase to be taken as an argument of an operator which only takes propositional arguments (e.g., the verbs *believe* and *doubt*). In contrast, a purely syntactic or discursive approach would have to explain this non-uniform behavior without making reference to this sort of motivated type-shifting.

4.3. Comparison with Karttunen (1969)

Like the generalization proposed here, that of Karttunen (1969) is sensitive to context in the way described above; that is to say, it looks beyond the structure itself. That said, the context sensitivity of the two proposals differs in two ways.

According to Karttunen (1969), what introduces (individual) discourse referents isn't just the structure NP, but rather the NP in particular contexts, namely sentences whose propositional content is "asserted, implied or presupposed by the speaker to be true". This stipulation is the first important point of departure between these two generalizations: the introduction of propositional discourse referents is crucially insensitive to truth. As we saw in (2), the prejacent of sentential negation has an associated pdref, where that prejacent proposition is not only not "asserted, implied or presupposed by the speaker to be true", but is in fact asserted by the speaker *not* to be true. The introduction of individual drefs, then, is sensitive to truth in a way that the introduction of propositional drefs is not.

The context sensitivity of these generalizations also differs in terms of locality: the general-

ization proposed here is sensitive only to the immediate context of the phrase in question—its embedder—where Karttunen's (1969) generalization is sensitive to the global context of a noun phrase—the truth status of the sentence[5]—regardless of the local context in which the noun phrase appears.

The generalizations proposed here and in Karttunen (1969) are also similar in that they both adhere to versions of what has been called in the nominal domain the *formal link* condition/constraint: the requirement that an e-type pronoun have an overt NP antecedent, and that that antecedent not be a sub-part of a word (see Postal, 1969; Evans, 1977; Kadmon, 1987; Heim, 1990; Patel-Grosz and Grosz, 2010 among others).[6] This need for a formal link has been invoked to explain contrasts like (31) and (32).

(31)  a.    One of the ten balls is missing from the bag. It's under the couch.

     b.    # Nine of the ten balls are in the bag. It's under the couch.           (Partee, 1989)

(32)  a.    Linus owns a dog and it bites him.

     b.    # Linus is a dog-owner and it bites him.                               (cf. Evans, 1977)

Even though the question of the location of the tenth ball is equally salient in both versions of (31), only when that ball itself is overtly mentioned is anaphoric reference to it felicitous. That *nine of the ten balls* entails the existence of a tenth ball is not enough for that tenth ball to be referred to anaphorically. Similarly, even though what it means to be a dog-owner is to own a dog, and even though the word *dog-owner* contains the string *dog*, nevertheless the anaphor *it* cannot refer to the dog that Linus owns in (32b). And, if one objects to (32) on the basis of uniqueness—that *dog-owner* is underspecified about the number of dogs which are owned, thus not satisfying the uniqueness requirement of *it*—the same objection probably can't be levied against (33), on the assumption that people have at most one nose.[7]

(33)  a.    Marcie had a bloody nose, and now it's sore.

     b.    # Marcie had a nosebleed, and now it's sore.

The discussion of this phenomenon in the literature has been restricted to the nominal domain, but a parallel constraint appears to be present in the propositional domain as well. While the generalization advanced here does not associate pdref introduction with any particular structure, it does require that the propositions being referred to be represented overtly—albeit in the semantic representation, not the syntactic one—in the same way that the formal link condition requires overt antecedents. This has already been illustrated here, insofar as a proposition's being entailed by a sentence is not enough for that proposition to be available for anaphoric reference, as we saw for example with the causative small clause in (8). The same is true of the existence presupposition associated with a *wh-* question, as in (34).

(34)    Who was at the party? Because Lucy told me *that*.

        # *intended*: that someone was at the party           EXISTENCE PRESUPPOSITION

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[5]That is, the truth status from the perspective of the speaker.

[6]That Karttunen (1969) identifies individual dref introduction with (a subset of) overt NPs ensures that the first clause of the formal link condition is satisfied. And if one considers the incorporation of *dog* in the word *dog-owner* (as in (32b)) to be morphological, rather than syntactic, then Karttunen's generalization satisfies the second clause as well.

[7]My thanks to Eitan Grossman for help in constructing this pair of examples.

And as perhaps the closest parallel to Partee's (31), we can also observe that only the nucleus proposition which partitions a polar question, and not its complement, has an associated propositional discourse referent, as illustrated in (35) & (36).[8]

(35)   Did Franklin go to the party? Because Lucy told me *that*, but I didn't see him there.
          ✓ *intended*: that Franklin went to the party                          NUCLEUS

(36)   Did Franklin go to the party? Because Lucy told me *that*, but I thought I saw him there.
          # *intended*: that Franklin didn't go to the party                     COMPLEMENT

This suggests that while there are differences between the introduction of individual and propositional discourse referents, they also share deep similarities.[9]

## 5. Implementation

The previous section introduced a novel generalization about the introduction of propositional discourse referents: operators which take propositional arguments introduce discourse referents for those arguments. In this section, I sketch out one way that this generalization could be modeled formally, using Update with Modal Centering ($UC_\omega$, Bittner, 2011).

Update with Modal Centering is an update semantics which tracks knowledge via a changing information state. The information state is a set of pairs of lists of discourse referents; each pair consists of a top ($\top$) list and a bottom ($\bot$) list, which respectively model the center and periphery of attention. What makes $UC_\omega$ an attractive option for modeling the generalization discussed in the previous section is that it tracks discourse referents not only for individuals (type $\delta$), but also for events ($\varepsilon$), states ($\sigma$), times ($\tau$), worlds ($\omega$), and propositions ($\omega t$).[10] As such, it already includes the formal tools we need in order to model the introduction of propositional discourse referents; what remains is to describe precisely how that is handled in this system. In order to do so, it will be instructive to look at a toy example of what $UC_\omega$ looks like.

Abstracting over tense for present purposes, a simple predication like *Marcie danced* will be given the $UC_\omega$ translation as in (37).

(37)   Marcie danced $\rightsquigarrow$ $^\top[\,x\,|\,x = \text{marcie}\,]$; $[\,w\,|\,\text{danced}_w\langle\top\delta\rangle\,]$

Each expression enclosed in square brackets represents one update, and sequential updates are delineated by a semicolon. The first update in (37) adds an individual discourse referent to the $\top$-list, identifying that discourse referent with the individual marcie (given by the model). The second update adds a world-type discourse referent to the $\bot$-list, a variable over those worlds in which it is true that the topical individual ($\top\delta$)—the individual most recently added to the $\top$-list, so here marcie—danced in those worlds.[11] In this way, $UC_\omega$ models each morpheme as

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[8]This has consequences for how we interpret the semantics of a polar question, suggesting a formal representation only of the nucleus proposition (along the lines of Bolinger, 1978), in contrast to a Hamblin semantics where both propositions are represented equivalently, though the latter may still be accurate for *wh-* questions and alternative questions (see Gawron, 2001; Rooij and Šafářová, 2003, among others).

[9]See Snider (2017a) for more on the formal link condition on propositional anaphora.

[10]I omit here the full formal definitions which underlie $UC_\omega$; see Bittner (2011).

[11]This update is the sort which can expand the number of pairs of lists in the information state. If there are multiple

contributing one or more discrete updates, where each update crucially depends on one another in order to model the desired compositional meaning: the verb *danced* introduces the worlds in which the topical individual danced, and it is only when it follows the update triggered by the name *Marcie* that that topical individual is guaranteed to be marcie.

The translation in (37) does not fully reflect the effects of an assertion of the sentence *Marcie danced*, however. We have introduced a set of worlds, but haven't done anything with those worlds, updated the common ground, learned about the actual world, etc. In order to handle that, we supplement (37) with the declarative mood marker DECL, which in English has a phonological reflex at least in terms of intonation. Building on Murray (2014), we associate DECL with four distinct updates.

(38)   DECL $\rightsquigarrow [\,p\,|\,p = \bot\omega\|\,]; [\,\bot\omega \in \top\omega\|\,]; [\,\top\omega = \bot\omega\,]; {}^{\top}[\,p\,|\,p = \top\omega\|\,]$

The first update introduces a propositional discourse referent into the $\bot$-list[12] for the bottom world column ($\bot\omega\|$), the set consisting of the collection of the most prominent worlds across all of the $\bot$-lists in the information state. (Recall that the information state is a set of pairs of lists; $\|$ operates across each pair in the set.) This set of worlds will be the set of worlds just introduced in the previous update, those worlds in which the matrix predication holds, i.e., here, the worlds in which Marcie danced. The same way that *danced* relies on the prior update to ensure that its argument introduces the topical individual, DECL relies on the fact that its argument—the matrix clause—will have introduced a set of worlds to be collected and labeled with a propositional discourse referent. It is this update which does the work we most care about here: it introduces the propositional discourse referent associated with the matrix clause.

The second, third, and fourth updates of (38) are as presented in Murray (2014). The second update represents a proposal to update the common ground, by restricting the (most prominent) $\bot$-worlds—the worlds associated with the matrix clause—to a subset thereof, down to only those which are also in the set of topical worlds ($\top\omega\|$), i.e., the context set. The third update-models the actual update of the context set by restricting the (most prominent) $\top$-worlds—the worlds in the context set—to only those worlds which match their respective (most prominent) $\bot$-world—a member of the subset of the worlds associated with the matrix clause, created by the previous update. And finally, the fourth update introduces a new propositional discourse referent into the $\top$-list for this newly-restricted context set, to act as the starting point for updates triggered by subsequent utterances.

Murray (2014) associates the second, third, and fourth updates of (38) with the declarative mood. The first update—the one we are most interested in here—is part of the presentation of

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worlds in which the condition is met—here, where the topical individual danced—then the output information state is one in which there is a pair of $\top/\bot$-lists for each such world. The $\top$-list in each pair will contain (the discourse referent associated with) marcie, and each $\bot$-list will contain (a discourse referent associated with) a different world in which Marcie danced.

[12]UC adds propositional discourse referents to the $\top$-list only to represent the context set; this is a privileged position, ensuring that sentence- and discourse-initial updates always interact with the information state in the desired way. As a result, all of the propositional discourse referents used for anaphora—those we are interested in here—will be added to the $\bot$-list. Other types of discourse referents are added to either $\top$ or $\bot$ on the basis of their center/periphery status.

an utterance's at-issue content in Murray (2014), not directly linked to any specific morpheme. Here, we associate this update with DECL, but also crucially with other proposition-taking operators. As part of DECL, $[\,p\,|\,p = \bot\omega\|\,]$ introduces a propositional discourse referent for the matrix clause, but only as a result of following the updates associated with the matrix clause. The same update can do parallel work for non-matrix content when it is associated with other operators, as the information state of the system is different. For example, if we associate this same update with sentential negation, we get a UC$_\omega$ translation as in (39).

(39)   NEG $\rightsquigarrow [\,p\,|\,p = \bot\omega\|\,]; \; [\,w\,|\,w \notin \bot\omega\|\,]$

On this analysis, the NEG operator associated with sentential negation triggers two updates. The first introduces a propositional discourse referent for the set of most prominent $\bot$-worlds across the entire information state; this will be the set of worlds associated with the prejacent of sentential negation. The second introduces into the $\bot$-list the worlds *not* currently in the set of those most prominent $\bot$-worlds, i.e., those not in $p$; these worlds collectively make up the complement set of the prejacent worlds.[13]

To see this in action, consider a sentence like *Marcie didn't dance*. This will get an analysis equivalent to DECL (NEG (*Marcie danced*)).[14] NEG introduces the pdref for the worlds in which Marcie danced (the prejacent of sentential negation), and DECL introduces a pdref for the worlds in which she didn't (the matrix clause). In both cases it is the same update— $[\,p\,|\,p = \bot\omega\|\,]$—which is responsible for pdref introduction. It is the context in which the update occurs, in particular which worlds are the current most prominent $\bot$-worlds, which determines which set of worlds get associated with a new propositional discourse referent.

This pattern extends to other proposition-taking operators: by associating them with the same UC$_\omega$ update, they too introduce discourse referents for their arguments.

(40)   say $\rightsquigarrow [\,p\,|\,p = \bot\omega\|\,]; \; [\,w\,|\,\text{say}_w\langle\top\delta, \bot p\rangle\,]$

For a proposition-embedding verb like *say*, for instance, the UC$_\omega$ translation in (40) makes use of this same update. The first update of (40) introduces a pdref for the currently most prominent $\bot$-worlds, which will be those worlds associated with *say*'s complement clause. The second update then introduces into the $\bot$-lists those worlds where the topical individual ($\top\delta$) is in a saying relation with the most prominent $\bot$ proposition, which will be the very proposition introduced by the previous update. The treatment will be parallel for other proposition-taking operators, including embedding verbs like *believe* and *expect* (but not verbs like *want* and *ask*): their UC$_\omega$ translation will include the same update as DECL and NEG, which is responsible for the introduction of pdrefs, along with the other update(s) associated with their lexical meaning.

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[13]One can also think about this second update as equivalent to $[\,w\,|\,w \notin \bot p\,]$, where rather than referring again to the same set of worlds via $\|$, the second update instead refers to the pdref introduced by the first update. Considering that propositions are sets of worlds, these are equivalent. This second formulation is reminiscent of Stone and Hardt (1999), wherein both modals and sentential negation are anaphoric on propositions, as the second update would crucially rely on the discourse referent introduced in the first.

[14]As noted above, I abstract here over tense. The actual UC$_\omega$ translation of *Marcie didn't dance* will also be more complicated than sketched here in that the morpheme associated with sentential negation, *n't*, is located between the words which comprise its prejacent. See Bittner (2011) for details on compositional rules for UC$_\omega$ in the style of Combinatory Categorial Grammar (CCG, Steedman, 2000) which allow for non-string-contiguous morphemes to compose.

## 6. Summary

While researchers have investigated under what circumstances individual discourse referents are introduced, less work has been done on addressing the same question for the propositional domain. This project attempts to close that gap. In this paper, I have reviewed two types of approaches to the question of pdref introduction which are represented in the literature: a syntactic approach which associates pdref introduction with syntactic categories such as TP, and a discursive approach which assigns pdrefs to (sub)DRSs or EDUs. I then presented data which challenge both of these approaches, including data from small clause constructions, nominal adverbial constructions, and a variety of raising and control constructions. This data led me to propose a novel generalization, one sensitive to semantic type: proposition-embedding operators—including the declarative mood, sentential negation, and a number of embedding verbs, among others—introduce discourse referents for their propositional arguments.

With this new generalization in hand, we were able to make comparisons not only to the existing approaches to propositional dref introduction mentioned above, but also to Karttunen's (1969) generalization for individual dref introduction. The two generalizations differ in their sensitivity to truth: individual drefs are only introduced in contexts where the speaker takes the sentence to be true, where even propositions asserted to be false can have associated pdrefs. On the other hand, the propositional generalization proposed here and the individual generalization from Karttunen (1969) are similar in that both adhere to their respective versions of the formal link condition.

Finally, I described one way that the proposed generalization can be modeled formally, using Update with Modal Centering. Building on insights from Bittner (2011) and Murray (2014), I identified a particular update which is responsible for introducing propositional discourse referents in simple unembedded clauses. I then showed how it can be associated not only with the declarative mood (and thus matrix clause content), but also with sentential negation and other proposition-embedding operators. The result is a system which tracks propositional discourse referents, including for sentences with multiple such pdrefs which might be suitable antecedents for subsequent anaphoric reference. This implementation is straightforward in that the same update serves the same function, being associated with different propositional operators. That said, this is just one possible implementation; the same generalization can be modeled in other systems as well.

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