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ANTONYMY IN SPACE AND OTHER STRICTLY ORDERED DOMAINS

ABSTRACT: Natural language references different types of entities. Some of these entities (e.g. degrees, locations, times) are strictly ordered with respect to one another; others (e.g. individuals, possible worlds) are not. The empirical goal of this paper is to show that some linguistically encoded relations across these domains (e.g. *under*, *slower than*) display a polar asymmetry, while others do not. The theoretical goal of this paper is to argue that this asymmetry – and its restriction to only certain relations – is due to intrinsic properties of strictly ordered domains, coupled with a bias in how language users perceive these domains.

1. INTRODUCTION

The goal of formal semantics is to model meaning in natural language. The logics they employ tend to map one sort of entity – individuals, either concrete or abstract – onto truth-values. In these formal systems, common nouns like *shoes* denote sets of individuals, quantifiers like *every* relate sets of individuals, and proper names like *Adam* and demonstratives like *this* directly refer to individuals.

Relatively recent innovations in semantics have involved the inclusion of other, distinct domains containing other, distinct entities: possible worlds (Hintikka 1961; Kripke 1963); events (Davidson 1969); times (Partee 1973); and degrees (Cresswell 1976). The inclusion of these domains and the entities that form them allows the extension of formal semantics to less canonical data. For instance, the comparative morpheme *more* in e.g. *Adam has more shoes than socks* has been argued to be a degree quantifier, not an individual quantifier (Heim 2000, 2006), and the demonstrative *yea* arguably refers to a degree in the sentence *John is yea tall*.

The goal of this paper is to present and explain data from English that demonstrate important parallels and one key difference in how two-place predicates in natural language relate entities across different domains. I will show that some two-place relations – like *under* and *slower than* – display what I call a 'polar asymmetry'; they are interpreted differently than their antonymic counterparts (in this case, *above* and *faster than*). I will further show that this polar asymmetry only extends to two-place predicates that relate entities in a strictly ordered domain; consequently we do not find a similar asymmetry in two-place predicates of individuals like *friend of* or *enemy of*.

The goal of this paper is to detail this polar asymmetry, and to explain it and its distribution across lexical items. The account presented here relies on the intrinsic differences between domains whose entities are strictly ordered – e.g. the domains of degree, time, and space – and those that are not (e.g. the domain of individuals), as well as language users' perception of these domains. I conclude by discussing the ramifications of the difference between strictly- and non-strictly-ordered domains for natural language semantics.

2. A PUZZLE IN DEGREE SEMANTICS

It's been observed that comparatives formed with a possibility modal and a negative-antonym (e.g. *slow*) have an additional reading relative to those with a positive-antonym (e.g. fast) (Seuren 1973; Rullmann 1995; Meier 2002; Heim 2007; Büring 2007). The examples in (1) illustrate this claim.

(1) a. Lucinda is driving faster than allowed on this highway.
b. Lucinda is driving slower than allowed on this highway.

I will discuss these examples in two distinct contexts; the first presents

a polar asymmetry between the positive-antonym comparative in (1a) and the negative-antonym comparative in (1b); the second does not.[1]

Imagine that Lucinda is driving on a US highway with a maximum speed limit of 100kph and a minimum speed limit of 65kph. (I'll call this the 'US Context'.) It is generally reported that the positive-antonym comparative in (1a) is true if and only if Lucinda is driving faster than the maximum speed, i.e. above 100kph. Effectively, this indicates that (1a) requires that Lucinda's speed be above (i.e. be higher than on the 'fast' scale) the *maximum* degree of fastness.

In contrast, it is generally reported that (1b) is true if and only if Lucinda is driving slower than the minimum speed, i.e. under 65kph. This indicates that (1b) requires that Lucinda's speed be below (i.e. higher on the 'slow' scale) the *minimum* degree of fastness.

This difference – that (1a) takes as its standard the maximum, while (1b) takes as its standard the minimum – might be unremarkable in isolation. It seems plausible that the difference is directly conditioned by the semantic difference of the antonyms: 100kph exceeds 65kph on the 'fast' scale, while 65kph exceeds 100kph on the 'tall' scale. But the difference is more puzzling in the context of other, related data.

Imagine instead that Lucinda is driving on a highway in Latvia, and that the speed laws in Latvia differ from those in the US in that there is a maximum speed on the highway (100kph) but no minimum speed. (I'll call this the 'Latvia Context'.) In this scenario, both of the comparatives in (1) use the *maximum* speed limit (100kph) as their standards: (1a) is true if and only if Lucinda is driving above 100kph, and (1b) is true if and only if Lucinda is driving under 65kph.

This results in the descriptive generalization in (2):

(2) **descriptive generalization, comparatives**
positive-antonym comparatives relate a degree to a maximum;
negative-antonym comparatives relate a degree to a minimum,
else a maximum

The interpretive variability of the negative-antonym modal comparative across contexts has been characterized in terms of ambiguity: (1b) is ambiguous, while (1a) isn't (Rullmann 1995; Büring 2007; Heim 2007). The basis of such theories is a characterization of *slow* as the morphologically complex negation of *fast* (as decomposable into,

roughly, 'not' and 'fast'). This predicts that the negative antonym, but not the positive antonym, has a scopable semantic component (i.e. the negation), which in turn predicts that the negative antonym, but not the positive antonym, can take scope with respect to other operators, like the possibility modal *allowed* in (1).[2] These accounts thus characterize the polar asymmetry demonstrated in (1) as a syntactic ambiguity on par with the observed ambiguity of sentences like *Everybody doesn't like ice cream*, in which the quantifier *everybody* can scope above or below the negation. I'll return to discuss such theories in more detail shortly.

There is an alternative perspective of the generalization in (2): perhaps the negative-antonym comparative in (1b) uses the maximum speed in the Latvia Context because there simply is no minimum available in that context. Implementing this perspective formally requires a context-sensitivity that is currently unavailable in standard theories of the comparative. And, if these degree relations are in fact context-sensitive, we'd expect the asymmetry in (2) to be more pragmatic than semantic in nature, which is to say we'd expect it to be general outside of this particular phenomenon and its particular lexical items.

In what follows, I will pursue this second explanation by demonstrating that the polar asymmetry phenomenon does in fact extend outside of comparatives, and that it does so in a principled way. In Section 4, I will argue that the polar asymmetry shown in (2) can be attributed to a combination of two factors: the strictly-ordered nature of the domains of degrees, locations, and times; and a bias in the way these relations are interpreted in out-of-the-blue contexts. My analysis will thus propose a general pragmatic constraint on the interpretation of relations in natural-language semantics; it will also present insight into similarities and differences between semantic domains and the consequent effect on semantic interpretation (cf. Schlenker 2006).

Before I demonstrate the relative generality of the polar asymmetry reported in (2), I'll briefly review an additional comparative example to demonstrate the generality of polar asymmetry within comparatives.

(3) a. The helicopter was flying higher than a plane can fly.
b. The helicopter was flying lower than a plane can fly.

The comparatives in (3) parallel those in (1) in that the standard, *than* phrase is formed with a weak possibility modal (in this case, *can*).

(3a) is formed with a positive antonym and (3b) with its negative counterpart.

Just as with (1), the sentences in (3) are reported to display a polar asymmetry. Suppose that, in the US, the highest that planes can fly is 15,000m, but they're additionally restricted by the military from flying below 100m. And suppose that, in Latvia, the highest that planes can fly is also 15,000m, but there are no restrictions on their minimum altitude. As before, the US Context involves a maximum and a minimum, while the Latvia Context involves only a maximum.

In both contexts, the positive-antonym comparative in (3a) is interpreted with respect to the *maximum*: (3a) is true in both contexts as long as the helicopter's altitude exceeds 15,000m. But, as before, the interpretation of (3b) alternates with the context of interpretation. In the US Context, (3b) is true only if the helicopter is flying lower than 100m, but in the Latvia Context, (3b) is true as long as the helicopter is flying lower than 15,000m. In other words, (3) provides additional support for the descriptive generalization in (2): a positive-antonym comparative is always interpreted with respect to a *maximum* standard, while a negative-antonym comparative is interpreted with respect to a *minimum* or *maximum* standard, depending on the context.

I'll reiterate that standard theories of this difference (e.g. Heim 2007) lexicalize it. They attribute the consistent interpretation of positive-antonym comparatives to the fact that these antonyms are relatively simple morphologically, and the variable interpretation of negative-antonym comparatives to the fact that these antonyms additionally encode a covert, scopable negation. The observed polar asymmetry is thus diagnosed as a scope ambiguity, the result of a null negation scoping in a meaningful way with respect to the possibility modal. I will instead pursue a pragmatic explanation of the polar asymmetry in (2), arguing that the phenomenon is more general and flexible than we'd expect if the difference were semantic (or lexicalized).

3. A PARALLEL PUZZLE FOR LOCATIONS AND TIMES

In this section, I'll argue that the polar asymmetry in (2) demonstrated for comparatives – which I take to relate sets of degrees (Seuren 1984) – is more general than previously assumed. In particular, I'll argue that

the same polar asymmetry exists for natural language relations between locations (i.e. with locative prepositional phrases) and between times (i.e. with temporal adverbs). Each of these types of relations, like adjectives, tend to come in antonymic pairs, e.g. *to the left of* and *to the right of* for locatives, and *before* and *after* for adverbs (see Cruse 1986, 1992 for discussion).

3.1. A polar asymmetry for locations

Spatial prepositions come in at least two varieties: locative Ps and path Ps. (Some, like *under*, can function as both.) The former describe the location of one individual relative to another individual; the latter describe the path of a moving individual relative to another individual. Some examples are in (4).

(4) a. The mirror is inside the box/under the painting. *locative*
b. The helicopter flew into the hangar/under the overpass. *path*

Research on the semantics of locative prepositions has been carried out largely in the framework of cognitive psychology or cognitive linguistics, and has focused on the effect of contextual factors like spatial attention and focus of the speakers and hearers on the truth conditions of sentences like (4) (e.g. Landau & Jackendoff 1993; Logan & Sadler 1996; O'Keefe 1996; Carlson et al. 2003). A notable exception is Zwarts' work on vector semantics (Zwarts 1995, 1997), which I will discuss further in Section 4.

Broadly speaking, locative prepositions are characterized as placing restrictions on the location of the center of mass of the located object (which I'll refer to as the A argument, e.g. the mirror in (4a)) relative to the center of mass of the reference object (the B argument; the box or paining in (4b)). So, for instance, the vertical locative *above* is true iff the center of mass of its A argument has a higher coordinate than the center of mass of its B argument, with some additional horizontal restrictions (e.g. A doesn't count as above B for most purposes if A is on the East Coast and B on the West Coast).

I will characterize the two prepositions *above* and *under* as antonymic because the following entailment relationship holds between them:[3]

(5) A is under B. $\Leftrightarrow$ B is above A.

It's possible for the sentences in (5) to be true even when the individuals A and B overlap spatially. That is, *The mirror is under the painting* can be true, depending on the level of granularity called for in the context, if the lower half of the painting and the upper half of the mirror overlap completely in vertical space. In an attempt to keep things simple in the discussion above, I will ignore such cases (and will therefore discuss only cases of non-overlap). This is not because such cases are anomalous – they aren't – but rather because the distinction I'll be focusing on is more clearly conveyed in cases of non-overlap.

In what follows, I'll show that antonymic locative prepositions, as relations between locations, demonstrate a polar asymmetry completely parallel to the one illustrated in Section 2. The relevant examples are in (6):

(6) a. The mouse is above the hut.
b. The mouse is under the hut.

As before, the polar asymmetry is evident when the sentences are interpreted in two distinct contexts. The first is depicted in Figure 1; I'll call it the 'Cold Context' because the hut, which has walls and a floor, is more characteristic of cold climates.

Figure 1. The Cold Context

In Figure 1 (the Cold Context), the positive-polarity locative in (6a) is true if the mouse is on the roof, or (less plausibly) if the mouse is anywhere above the roof. Since the roof marks the highest point of the hut, this is a reading that requires the A argument be higher than the hut's *maximum* vertical point.

In contrast, the negative-polarity locative in (6b) is true in the Cold Context if and only if the mouse is below the floor of the hut (or, underground). Since the floor is the lowest point of the hut, this is a reading that requires the A argument be lower than the hut's *minimum* vertical

point. This is just the difference we observed between the antonymous comparatives in (1) in the US Context in Section 2.

Imagine now the context depicted in Figure 2, involving a hut with no walls or floor (called the 'Warm Context'). Just as before, the locative construction in (6a) requires that the mouse be on or above the roof: a 'higher than the maximum' interpretation. But in this context, in contrast to the Cold Context, the negative-polar locative in (6b) is true just as long as the mouse is under the roof (in particular, if it is above ground). In contrast to the interpretation of (6b) in the Cold Context, (6b) in the Warm Context requires only that the A argument be lower than the highest point of the hut, or the *maximum* (i.e. the roof).

Figure 2. The Warm Context

As a result, we come to the same descriptive generalization as we did for the comparative constructions in Section 2.

(7) **descriptive generalization, locative prepositions**
positive-polar locatives relate the location of an individual to a maximum;
negative-polar locatives relate the location of an individual to a minimum, else a maximum

To drive this parallel home, we can reproduce the same intuitions for the comparative sentences in (8) as we got for the locative preposition cases in (6).

(8) a. The mouse is higher than the hut.
b. The mouse is lower than the hut.

Notice that, unlike the comparatives discussed in Section 2, the comparatives in (8) do not contain a possibility modal or any other scopable element besides the comparative morpheme (Heim 2000). Those

advocating an ambiguity treatment for the descriptive generalization in (2) cannot extend their explanation to the data in (8), because there is no additional element for the putative null negation encoded in the negative-antonym comparative *lower* to interact with scopally. A scope-based account of the polar asymmetry illustrated by the comparatives in (8), in terms of the Cold and Warm Contexts, would require the postulation of a null scoping element in the subordinate *than* clause of these comparatives in addition to the null negation encoded in the negative antonym.

Given the compelling parallel between (6) and (8) (and the correspondingly parallel descriptive generalizations in (2) and (7)), an account of the comparative data would ideally extend to the locative preposition data. But the scope ambiguity analysis advocated in e.g. Rullmann (1995) and Heim (2007) doesn't extend naturally to the locative data. Even granting that the preposition *under* is the marked antonym in the pair – and, therefore, that it lexicalizes a null negation that can scope independently of the preposition itself – we are hard-pressed to find anything in (6) or (8) for that null negation to interact with scopally.

To summarize: the polar asymmetry observed for comparatives in Section 2 has an apparent direct parallel in locative prepositions. The standard theory of the polar asymmetry for comparatives treats the negative-polar comparative as lexicalizing a null negation that can interact scopally with the possibility modal in the subordinate clause of comparatives like those in (1). This predicts an ambiguity: comparatives like (1b) have one reading in one sort of context and an intuitively distinct reading in another sort. Because positive-polar comparatives like (1a) lack this null negation, they are not ambiguous.

However, the locative data in (6) (and the seemingly similar comparative data in (8)) display this polar asymmetry despite the fact that they do not contain a possibility modal or any other scoping element. The inappropriateness of the scope ambiguity account for these data, coupled with the relative generality of the phenomenon, indicate the need for a different explanation of the polar asymmetry.

As suggested earlier, I will propose a distinct explanation for the polar asymmetry: a more pragmatic account of which bound (the maximum or the minimum) is available and most appropriate for a relation

in a given context. I'll postpone the presentation of this analysis until Section 4, but it's worthwhile noting here that the Cold and Warm Contexts can be construed as differing with respect to the availability of a minimum, broadly construed (just as the US and Latvia Contexts from Section 2): in this case, the hut's floor.

3.2. A polar asymmetry for times

In this section I'll present data that suggests the polar asymmetry introduced above can be extended to event times. This empirical claim is slightly more tentative due to the fact that the adverbs I'll use to demonstrate the asymmetry in temporal relations – *before* and *after* – are arguably more semantically complicated than they would be if they were temporal relations (Beaver & Condoravdi 2003; Condoravdi 2010; Krifka 2010). But I believe that the empirical claims presented here hold despite these complications.

To discuss these data, I'll help myself to two additional types of semantic entities: events (Davidson 1969) and times (Partee 1973). I'll assume that an event is associated with its runtime via a homomorphism (Krifka 1989).

Events are introduced by verb phrases; they can differ in their telicity (Vendler 1957). A telic verb phrase is associated with an event that has a semantically encoded endpoint; an atelic verb phrase is associated with an event with no semantically encoded endpoint. In English, the difference conditions the distribution of the prepositional phrases *in an hour* and *for an hour*, respectively, as demonstrated in (9) and (10) (Verkuyl 1972; Dowty 1979).

(9) a. John built the house in an hour/*for an hour. *telic*
b. John climbed to the top of a mountain in an hour/*for an hour. *telic*

(10) a. John spoke on the phone for an hour/*in an hour. *atelic*
b. John was single for an hour/*in an hour.[4] *atelic*

The interpretation of sentences relating the runtimes of two events seems to depend, in some cases, on the telicity of the event. In other words, *before* and *after* demonstrate a polar asymmetry across telic but not atelic events. I'll demonstrate this polar asymmetry first for two

pairs of *before* and *after* sentences (instead of a single pair evaluated in two distinct contexts). I'll then provide another example that more closely parallels the data discussed above.

The sentences in (11) both relate a telic, punctual event (Mary and John meeting) to an atelic event (a state: Mary's being single).

(11) a. Mary met John after she was single.
b. Mary met John before she was single.

Intuitively, (11a) is true as long as Mary met John after she ceased being single (i.e. after the time corresponding to the *endpoint* of the state of her being single). In contrast, (11b) is true as long as Mary met John before she began being single (i.e. before the time corresponding to the onset of her being single).

The next pair of sentences demonstrates that *before*, but not *after*, is subject to a change in interpretation that is the hallmark of the polar asymmetry exemplified for degrees and locations above. As before, the first event is punctual; in (12), the second event is an accomplishment, which is a telic event. This event is extended over time (from the beginning of the climb to its end), but has a salient, semantically encoded endpoint (the summit).

(12) a. Mary met John after he climbed to the top of the mountain.
b. Mary met John before he climbed to the top of the mountain.

As before, (12a) is true as long as Mary met John after the time corresponding to the *endpoint* of the climbing (i.e. after the summit). But, in contrast to (11b), (12b) is *also* interpreted with respect to the endpoint of the climbing. Specifically, (12b) is true even if Mary meets John on the face of the mountain, e.g. halfway up, as she is descending.

This is reminiscent of a polar asymmetry: *after* always relates one event to the maximal runtime of another event (e.g. (11a) and (12a)), while *before* relates one event to the to the minimal (11b) or maximal (12b) runtime of another event, depending. (11b) is false if Mary met John while she was single, but (12b) is true if Mary met John while he was climbing to the top of the mountain.

It is tempting to summarize these data, too, in terms of a polar asymmetry:

(13) **descriptive generalization, temporal adverbs**
positive-polar temporal adverbs relate the location of an event to a maximum;
negative-polar temporal adverbs relate the location of an event to a minimum, else a maximum

The status of an antonym as positive-polar or negative-polar typically tracks markedness (Lehrer 1985; Rett 2015). This is easier to determine in the case of comparatives than in the case of temporal adverbs. It is clear that the two antonyms behave distinctively here (and in the same way that I characterized as a polar asymmetry in Section 2). But there might additionally be reason to think, following Heim (2007), that *before* is a negated version of *after*: the former, but not the latter, licenses negative polarity items (NPIs; Anscombe 1964, example from Beaver & Condoravdi 2003).

(14) a. *Cleo leapt into action after David moved a muscle/could say a word.
b. Cleo leapt into action before David moved a muscle/could say a word.

While the polar asymmetry for degrees and locations was demonstrated using a single pair of sentences and two contexts, I demonstrated the putative polar asymmetry for times using two pairs of sentences. This is because VPs are, in general, either telic or atelic, so we cannot depend on context to condition the presence or absence of an endpoint. But I'll provide additional support for (13) using another pair of sentences, in (15).

(15) a. Mary called an ambulance after John was sick/finished the race.
b. Mary called an ambulance before John was sick/finished the race.

Each sentence in (15) can be interpreted with respect to one of two VPs: was sick (an atelic, stative VP) and *finished the race* (a telic, eventive VP). The two different VPs in (15a) do not affect the interpretation of the temporal adverb *after*: in both cases, the punctual event of Mary

calling the ambulance is related to the latest, *maximal* time corresponding to the second event. It is true iff Mary called after John ceased to be sick or after John completed the race.[5]

In contrast, the two VPs condition two distinct interpretations of the temporal relation in (15b). The atelic combination requires, implausibly, that Mary have called the ambulance before the *onset* of John's sickness. In contrast, the telic combination requires only that Mary have called the ambulance before the *endpoint* of John's running the race. This is the familiar pattern of polar asymmetry, in which one of two antonymous relations demonstrate an interpretive variability with respect to whether it relates one argument to the minimum or maximum endpoint of another.

3.3. Interim summary

I'll end this section with a general summary and some desiderata for a semantic or pragmatic analysis of these data.

For now, we can posit a domain-general generalization; I will revise this generalization in Section 4.3.

(16) **descriptive generalization, polar asymmetry**
Positive-polar relations use maxima as endpoints; negative-polar relations use minima as endpoints; else they use maxima.

We've seen evidence of a stronger generalization in (16): in particular, whether a negative-polar relation uses a maximum or minimum as an endpoint isn't random but predictable. Negative-polar relations use minima when they are available – either from context, in the degree and location cases, or semantically, in the time cases – and maxima otherwise. In addition to the generalization in (16), a theory of polar asymmetry would ideally explain the conditions under which the negative-polar relation receives each interpretation.

As discussed in Section 2, I know of only one account of polar asymmetry, and it has been proposed for only the degree data in (1) and (3). It was initially proposed in Rullmann (1995) and revised more recently in Heim (2007). In this account, negative adjectives are negated versions of their antonyms; this negation is either overt (in pairs like *palatable* and *unpalatable*) or covert (in pairs like *fast* and *slow*); in both cases, it can scope independently of the adjective. In sentences with an additional scoping element – like the possibility modals in (1) and (3) – the negative-polar comparatives are ambiguous, just as sentences with two scoping modals (e.g. *Everyone loves someone*) are.

As discussed in part in Section 3, a scope-based account of the comparative data in (1) and (3) looks less attractive in the context of the wider phenomenon of polar asymmetry. First, the interpretive variability of the negative-polar relations does not behave like an ambiguity: there is no context in which either reading is available; or, if there is, one reading asymmetrically entails the other (if A must be slower than B's minimum, it must also be slower than B's maximum).

Second, contrary to the scoping analysis, the availability of the interpretive variability associated with the negative-polar relation doesn't seem to depend on the presence of an additional scoping element (this point is also made in Beck 2012). The polar asymmetry was reproduced for locatives based on the availability of a lower bound in the context. The scope ambiguity analysis therefore fails to predict a polar asymmetry for the negative preposition *under* (and the negative adverb *before*).

A final consideration involves the extent to which polar asymmetry is general. I've given evidence here that it arises in relations of degrees, locations, and times, but natural language encodes relations between other things, in particular individuals. However these relations – to the extent to which they have antonyms – do not display polar asymmetry. Attempts to produce a polar asymmetry in individual relations are below.[6]

(17) a. John is the father of the people who are allowed to attend.
b. John is the son of the people who are allowed to attend.
c. John is not the father of the people who are allowed to attend.

(18) a. Mary met the guests who can speak Italian.
b. Mary did not meet the guests who can speak Italian.

The sentences in (17) relate John to a plurality of individuals who are allowed to attend; those in (18) relate Mary to a plurality of individuals who can speak Italian. The relation in (17) is encoded in a noun; (17b) and (17c) include two possible antonyms of the relation *be the father of*. The relation in (18) is encoded in a verb.

The embedded arguments of the relations, in each case, denote plural individuals (the people allowed to attend and the guests who can speak Italian, respectively). These pluralities can be modeled as an internally complex individual (Link 1983) or a set of individuals (Landman 1989; Schwarzschild 1996). The present empirical point could be modeled under either assumption; I'll choose the former for simplicity's sake.

The maximum element of the plurality is all of the individuals who satisfy the description; the minimum element of the plurality is one such individual (or two, depending on one's assumptions about the selection restrictions of the plural marker). If individual relations were to demonstrate polar asymmetry, we'd expect e.g. (17a) to be interpreted differently from (17b) or (17c) with respect to this plural individual. In particular, (17a) would be interpreted with respect to the maximal individual – all of the people allowed to attend (Jacobson 1995) – and the antonymic relations could in principle be interpreted with respect to the minimal individual. This is not, however, what we see; both (17b) and (17c) relate John to the maximal individual. (18a) and (18b) are also alike in this respect.

These data pose an even greater challenge to an explanation of polar asymmetry: a theory must explain why the phenomenon is not specific to relations between sets of degrees, as previously assumed, but also why it doesn't extend to individual relations. Further questions, assuming we must abandon the scope ambiguity approach, include the following: How do individual relations differ from degrees, locations, and times? What's the relationship between the possibility modals in the standard comparative clauses in e.g. (1) and e.g. the cold and warm contexts in (6)? And what is it about negative relations that causes this meaning flexibility: semantic complexity, markedness, or something else? My goal in the following section is to present such an explanation.

4. ECONOMY OF BOUNDS

In this section, I'll argue that the polar asymmetry catalogued here is the result of two things: the strict ordering of degrees, locations, and times (and their corresponding monotonicity); and the way we most naturally perceive space, time, etc. The latter accounts for the observed difference between positive- and negative-polar relations; since it is a non-linguistic or at least pragmatic explanation, it carries with it the prediction that the observed polar asymmetry isn't relegated to negative-polar relations in every context. In Section 4.3, I'll provide evidence (based on the work in Beck 2012) that this prediction in fact holds.

4.1. Some foundational assumptions

In this section, I'll briefly review some fundamental assumptions invoked in many standard degree semantic, vector semantic, and temporal semantic theories to model the meaning of natural-language relations between these entities and other, related phenomena. We'll see a great deal of similarity in these assumptions; this will form the basis for the unified proposal presented in Section 4.2.

As mentioned earlier, antonymic relations are duals; they participate in mutually entailing ($\Leftrightarrow$) sentences, as illustrated in (19).

(19) a. A is faster than B. $\Leftrightarrow$ B is slower than A. *degree relations*
b. A is above B. $\Leftrightarrow$ B is under A. *location relations*
c. A is after B. $\Leftrightarrow$ B is before A. *temporal relations*

This duality is modeled in the ordering lexicalized by these adjectives; a positive-polar relation like *faster* associates speeds with a natural-number-increasing strict order, $>_+$, while its negative-polar counterpart associates speeds with a natural-number-decreasing strict order, $>_-$. This models the intuition that 60kph is higher than 40kph on the 'fast' scale, while 40kph is higher than 60kph on the 'slow' scale. This intuition is confirmed by the sentences in (20).

(20) a. 60kph is faster than 40kph.
b. 40kph is slower than 60kph.

There are semantic operators in natural language that are sensitive to this difference in ordering; intensifiers like *very* situate a degree value high on the adjective's intrinsic scale, instead of some fixed scale. (21a) is true if John's speed is extremely high on the 'fast' scale, and (21b) if it is extremely high on the 'slow' scale. If *very* were instead insensitive to

lexicalized scale order, we would expect e.g. (21b) to mean "somewhat slow", i.e. a slow speed that is relatively high on the 'fast' scale.

(21) a. John is very fast.
b. John is very slow.

It's therefore plausible that any notion of maximality employed by natural language is also sensitive to intrinsic scale ordering. An order-sensitive maximality operator is defined in (22) for a scale ordering o (based on Rullmann 1995; Heim 2000). "$\iota x \phi x$" should be read as "the unique x such that ϕx".

(22) Let X be a non-empty set of entities ordered by the relation $>_o$. Then $\textsc{Max}(X) = \iota x[x \in X \wedge \forall x' \in X[x' \neq x \rightarrow x >_o x']]$

While the domains of degrees, locations, and times are not necessarily strictly ordered, the degrees, locations, and times relevant to any one sentence are. That is to say, the degrees corresponding to 60kph on the 'fast' scale and 6ft on the 'tall' scale are not strictly ordered with respect to one another, but these degrees cannot be directly related in natural language (Kennedy 1999: 36).[7]

As a result, these domains are strictly ordered for our purposes. Strict orderings satisfy the properties listed in (23), for entities a and b invoked in a natural-language relation:

(23) A domain D is strictly ordered iff:
a. D is irreflexive (i.e. for all a, it's not the case that $a > a$)
b. D is asymmetric (i.e. for all a and $b \neq a$, if $a < b$ then it's not the case that $b < a$
c. D is transitive (i.e. for all $a, b \neq a$ and $c \neq b \neq a$, $a < b$ and $b < c$ entails $a < c$
d. D is total (i.e. for all a and $b \neq a$, $a < b$ or $b < a$)

Similarly, natural language predicates can encode monotonic properties. Effectively, a property P is downward-monotonic if whenever n is in the extension of P, *n–1* is necessarily in the extension of P. The definition in (24) (from Heim 2000) is defined in a typed degree semantics; it assumes that gradable adjectives like *fast* denote relations between individuals (type e) and degrees (type d).

(24) A function f of type $\langle e, \langle d, t \rangle \rangle$ is **downward-monotonic** iff $\forall x, d, d'[f(x)(d) \wedge d' < d \rightarrow f(x)(d')]$

(24) appropriately characterizes degree properties like *fast*; in a context in which 60kph counts as fast, 70kph (higher than 60kph on the 'fast' scale) necessarily also counts as fast. Natural language also includes upward-monotonic degree properties, although these properties tend to be encoded in modal VPs. *Be enough for* is upward-monotonic because we can reliably infer from the proposition that $100,000 is enough for a graduate student to live on to the proposition that $200,000 is enough for a graduate student to live on.[8]

With these two assumptions – that properties encoded in natural language are monotonic, and that contextually relevant entities in some domains are strictly ordered with respect to each other – we can characterize the denotations of plurals in some domains (in a particular context) as intervals. The relevant notation is introduced in (25).

(25) a. **open**: $(a, b) = \{x : a > x > b\}$
b. **upper closed**: $(a, b] = \{x : a > x \geq b\}$
c. **lower closed**: $[a, b) = \{x : a \geq x > b\}$
d. **closed**: $[a, b] = \{x : a \geq x \geq b\}$

In particular, in a context in which John is driving at 60kph – taking liberties with the complex issues of granularity and precision – the degrees to which John drives fast can be represented as the interval (0,60kph]: an interval whose lower bound is zero (but does not include zero) and whose upper bound is 60kph. Correspondingly, the degrees to which John drives slow has the reverse ordering: [60kph, 0).

These characterizations extend straightforwardly to times (modulo modal statements about the future, Prior 1967), but it also extends to locations. That natural language encodes monotonic locative properties is made especially clear in vector-semantic approaches (Zwarts 1995, 1997). Essentially, the top of a table in Riga may not be intrinsically linearly ordered with respect to the back of a chair in Los Angeles, but any locative property relating the two (e.g. *east of*, *below*) compares them along a single, linear vector.

But these characterizations about monotonicity in natural language

crucially do not extend to individuals like John and Mary, at least in the context of individual relations. While it's easy to imagine a context in which John and Mary are strictly ordered with respect to one another along some parameter – who I'd rather grab a beer with, for instance – this ordering isn't invoked by individual relations. If John and Mary are in the denotation of the plural definition *people who I'd like to have a beer with*, they are not linearly ordered with respect to one another.[9] This is consistent with the modeling of plural individuals in terms of sets (Schwarzschild 1996) or join semi-lattices (Link 1983), neither of which linearly orders its members or atoms with respect to each other.

In sum: I've borrowed heavily from the degree-semantic literature to model plural degrees, locations, and times as strictly ordered intervals of entities in those domains. Implicit in this treatment is the assumption that relations of degree, locations, and times encoded in natural language are monotonic and thereby relate these intervals. For example, we can model the semantics of the comparative in terms of a relation between interval maxima (Seuren 1984, among others):

(26) John drives faster than Bill.

a. MAX(John's degrees of fastness) > MAX(Bill's degrees of fastness)

b. MAX(0,80kph] > MAX(0,70kph]

In a context in which John drives 80kph on average but Bill drives only 70kph on average, the value of the comparative is as in (26b), and the comparative is intuitively true. The equivalent sentence *Bill drives slower than John* can be formalized in an equivalent way (with degrees of slowness rather than fastness). The proposal below will mimic the successes of this treatment, but in a more semantically flexible way that can accommodate polar asymmetry.

In contrast, plural individuals cannot be modeled as intervals in particular contexts for the purpose of evaluating individual relations, because individual relations aren't scalar or monotonic in this sense. They seem generally defined to relate maximal plurals, a fact often captured in a 'homogeneity presupposition' (von Fintel 1997, although there are, infamously, non-maximal interpretations of plurals in some contexts). The data in (17) and (18) support this conclusion.

In the next section, I'll present an account of polar asymmetry that takes advantage of this difference to predict both the asymmetry itself and its apparent absence from individual relations in natural language.

4.2. The proposal

With these assumptions and the notational conventions in (25) in hand, we can recharacterize polar asymmetry in a domain-general way. My claim, informally, is that our interpretation of monotonic predicates whose arguments are intervals (i.e., plurals of strictly ordered entities) is modulated by a general principle of interpretive economy: the property is interpreted with respect to the most informative value or bound of the interval available. The generality of this interpretive principle – which I call 'Economy of Bounds' – means that it can be quite naturally cast as a pragmatic or cognitive principle, rather than one stipulated in the lexical or compositional semantics of natural language.[10] As I'll discuss in Section 4.3, this makes certain predictions about the universality and context-sensitivity of the Economy of Bounds principle.

Before presenting a semantic implementation of the Economy of Bounds principle, I'll address the relationship between maximal informativity and maximality. Imagine that a sentence like *A is under B* is in fact ambiguous in a given context: it can relate A's location to B's top (its minimum on the 'under' scale) or to B's bottom (its maximum on the 'under' scale). The readings are in an asymmetrical entailment relationship: if A is under B's bottom, it's necessarily under B's top, but not vice-versa. This means that the maximum reading entails the minimum reading. In a possible worlds semantics, the maximum interpretation is true in a strict subset of worlds in which the minimum interpretation is true. An exhortation to maximize informativity is therefore, in the context of monotonic properties, consistent with using a maximum rather than minimum bound. The maximum places the strictest requirements on the truth conditions of a relation, and is typically the one invoked in relations like the comparative.[11]

The Economy of Bounds principle draws on the fact that, given the scale-sensitive definition of maximality in (22), a maximum degree of fastness in a given context corresponds to a minimum degree of slowness, and vice-versa. In the two versions of the principle below, *A* and *B* range over intervals (plurals whose entities are strictly ordered with re-

spect to each other). In (28), x ranges over atomic individuals; for our purposes, members of a plurality X. As before, the subscript o ranges over scalar orderings: either + or –.

(27) **Economy of Bounds (*informal version*)**
For some relation R and intervals A and B, '*ARB*' is true iff some member of A exceeds (on the relevant scale) the greatest closed bound of B.

(28) **Economy of Bounds (*formal version*)**
$[[R]](B_o)(A_o) \Leftrightarrow \exists x \in A\,[x >_o \textsc{Max}(\textsc{Bound}(\mathrm{x}', B_o) \wedge x' \in B)]$[12]

(28) defines a relation R between its internal interval B and its external interval A. I assume that the relation is defined only if A and B both have the same ordering (a corollary of Kennedy's (2001) Cross-Polar Anomaly restriction). And it is true iff some member of A exceeds the maximal closed bound of B: the highest member of the interval on that scale.

In what follows, I'll illustrate how the Economy of Bounds principle predicts the polar asymmetry data. The explanation relies crucially on the observation that the contexts presented above had in common the availability of a positive-scale maximum and a negative-scale minimum, but they differed in whether they had a negative-scale maximum.

(29) reproduces the positive-polar comparative from (1a) as well as the two contexts of evaluation, now in the more perspicuous interval notation. In the US context, (29) requires that Lucinda's speed exceed (on the positive, 'fast' scale) an interval with a closed lower bound of 65kph and a closed upper bound of 100kph. In the Latvia context, (29) requires that her speed exceed (on the same scale) an interval with a closed upper bound of 100kph and an open lower bound of zero. This context-dependence is arguably introduced by the modal allowed, which we interpret according to US or Latvian laws, depending.

(29) Lucinda is driving faster than is allowed on this highway.
a. *US context*: lucinda $>_+$ [65kph, <u>100kph</u>]
b. *Latvia context*: lucinda $>_+$ (0, <u>100kph</u>]

I have underlined the highest closed bounds on the relevant scale in each context. The Economy of Bounds principle correctly predicts that

Lucinda's speed will be interpreted relative to 100kph in both contexts.

The negative-polar comparative from (1b) is similarly modeled in (30). In both contexts, (30) requires that Lucinda's speed exceed the relevant interval on the negative, 'slow' scale. As before, each context is modeled in terms of the interval of comparison, and as before, the lower bounds are the left value of the interval. Now, because the relation is negative-polar, the lower bounds are higher on the scale of natural numbers than the upper bounds (recall (20)).

(30) Lucinda is driving slower than is allowed on this highway.
a. *US context*: lucinda $>_-$ [100kph, <u>65kph</u>]
b. *Latvia context*: lucinda $>_-$ [<u>100kph,</u> 0)

The Economy of Bounds principle correctly predicts that Lucinda's speed will be interpreted relative to 65kph in the US context, because this is the highest closed bound of the internal-argument interval in that context. (This was characterized in Section 2 as a relation to a minimum.) But the principle also correctly predicts that Lucinda's speed will be interpreted relative to 100kph in the Latvia context. This is because there is no speed that is too slow for Lucinda, a restriction that's been modeled here as an open lower bound of zero. In the Latvia context, then, the interval or set of degrees corresponding to the speeds Lucinda is allowed to drive has only one closed bound, its minimum (on the 'slow' scale). In the absence of a maximum closed bound, the Economy of Bounds principle dictates that it is this bound to which Lucinda's speed is related in the comparative.

This is the source of the apparent polar asymmetry: in both contexts, the positive-polar relation was provided with a closed maximum, which is the most informative way to satisfy Economy of Bounds. But the contexts differed in whether or not the negative-polar relation was provided with a closed maximum. When it wasn't, the sentences were interpreted with respect to the other closed bound (the minimum). This accounts for the interpretive variability in a way that is completely independent of the semantic details of the sentence itself: whether the embedded clause contains a possibility modal, whether the relation involves degrees or some other strictly-ordered plural entity.

The explanation for polar asymmetry in the cases of locations and times proceeds in an identical fashion, with the locus of context-

sensitivity being the denotation of *the hut*, which varies across contexts. Those contexts differed in whether the internal argument (here, the hut) imposed a closed or open locative bound: in the Cold Context, the hut had a floor, which imposed a closed (i.e., included as part of the hut) bound on the hut's location (and which I've arbitrarily given as 1cm). In the Warm Context, the hut did not have a floor; instead the ground imposed an open (i.e., not included as part of the hut) bound on the hut's location.[13] I assume that the huts in both contexts are exactly 5m tall (i.e. 5m at their highest point).

(31) represents the positive-polar locative relation in the Cold and Warm Contexts above. In it, the mouse's location is related in each context on the positive, 'above' scale to an interval of locations (or a vector) representing the hut's spatial extension. Each of these contexts provides a closed maximum on this scale: 5m. As a result, the Economy of Bounds principle correctly predicts that the positive-polar locative preposition will be evaluated with respect to the highest point of the hut (informally, the roof).

(31) The mouse is above the hut.
   a. Cold Context: mouse $>_+$ [1cm, <u>5m</u>]
   b. Warm Context: mouse $>_+$ (0, <u>5m</u>]

(32) models the negative-polar locative relation, and we have a corresponding reversal in the direction of the scale and the interval arguments. The two contexts now differ in whether they provide a closed or open maximum (on the 'under' scale) for the relation. Economy of Bounds correspondingly predicts that the locative relation will be evaluated with respect to the hut's floor (the vector's closed bound of 1cm) in the Cold Context and with respect to the hut's roof in the Warm Context (the vector's closed bound of 5m). This was the polar asymmetry reported in Section 3.

(32) The mouse is under the hut.
   a. Cold Context: mouse $>_-$ [5m, <u>1cm</u>]
   b. Warm Context: mouse $>_-$ [<u>5m</u>, 0)

The predictions are also parallel in the time cases. Recall that the illustration of polar asymmetry in these cases involved switching VPs in the internal arguments (rather than switching contexts). Assume that Mary was single from January 2003 to December 2010, and that John began climbing the mountain at 4pm and summited it at 5pm precisely.

(33) models the truth conditions of the positive-polar temporal relation: in both sentences, Mary's meeting John is related on the positive, 'after' scale to an interval representing the runtime of the internal event argument. In the positive-polar cases, each context provides a closed maximum (on the 'after' scale); since this is the most informative bound, both sentences are interpreted with respect to this bound, the intuitive maximum.

(33) Mary met John after...
   a. ...she was single (*atelic context*): meeting $>_+$ [2003, <u>2010</u>]
   b. ...he climbed to the top (*telic context*):
      meeting $>_+$ (4pm, <u>5pm</u>]

(34) models the truth conditions of the negative-polar temporal relation; in both sentences, the meeting is related on the negative, 'before' scale to the internal-argument interval. Importantly, while 4pm demarcates the beginning of John's ascent up the mountain, it is not included in the runtime of the telic event, because it is not part of the event of John *summiting* the mountain. I've modeled this difference in terms of an open bound in (33) and (34); it formalizes the claims in Krifka (1989) that telic and atelic events differ in their cumulativity of reference.[14]

(34) Mary met John before...
   a. ...she was single (*atelic context*): meeting $>_-$ [2010, <u>2003</u>]
   b. ...he climbed to the top (*telic context*):
      meeting $>_-$ [<u>5pm,</u> 4pm)

Thus these sentences are interpreted with respect to intervals whose structures differ in a crucial way for the Economy of Bounds principle: while the sentence with the atelic internal event argument provides a closed maximum, the telic sentence provides only a closed minimum. This accounts for the interpretive variability in negative-polar temporal relations reported in Section 3.

To sum up: I've argued here that an account of polar asymme-

try across domains is readily available with the right formal model of antonymic relations and plural individuals in strictly ordered domains, coupled with a relatively intuitive principle exhorting natural language users to effectively maximize informativity when they interpret relations. Informally, when evaluating whether A exceeds an element B that spans the scale, we treat the highest bound included in B as a proxy for B. In contexts in which B's highest bound is not part of B – i.e., when B's maximum is determined by something independent of B – we relate A to B's closed minimum.

The following subsection concludes the analysis by addressing novel predictions of this pragmatic approach to polar asymmetry.

4.3. A new prediction

The scope ambiguity account of the Lucinda comparatives in (1) characterized polar asymmetry as the result of a combination of semantically marked relations (i.e. negative polarity as morphologically complex) and a scope intervener (e.g. a possibility modal). This account doesn't rely on either, allowing for the correct prediction that polar asymmetry can occur across domains and in the absence of a scope intervener (as it did in the location and time cases).

This raises the question of what, in the Economy of Bounds account, privileges negative relations. In other words, according to the above account, what is it about negative relations that results in interpretive variability? The answer is nothing, or at least nothing intrinsic. The contexts used to illustrate polar asymmetry above just happened to vary only in whether or not they imposed artificial minima, not whether or not they imposed artificial maxima. And this is a likely result of the fact that downward-monotonic properties are linguistically more common.

This makes for a weak account, relative to the scope ambiguity account: it predicts that positive relations, too, can in principle display interpretive variability in the right contexts (in particular, in contexts or sentences involving upward-monotonic relations). This result has been explicitly defended in recent work; Beck (2012) claims that the polar asymmetry observed in the Lucinda comparatives and other degree relations isn't intrinsic to negative comparatives, but negative comparatives involving downward-monotonic properties. Beck argues that a more accurate characterization of what I've been referring to as 'polar asymmetry,' at least as it pertains to comparatives, is in (35) (she uses the term 'ambiguity' to refer to what I've been calling, more theory-neutrally, 'interpretational variability').

(35) a. Positive-polar comparatives are unambiguous with downward-monotonic *B* arguments and ambiguous with upward-monotonic *B* arguments.
b. Negative-polar comparatives are ambiguous with downward-monotonic *B* arguments and unambiguous with upward-monotonic *B* arguments.

According to Beck, in certain contexts, it's the positive-polar comparative that exhibits interpretational variability. Instead of the US or Latvia Contexts, then, imagine the Germany Context, where the highway in question is an autobahn: the minimum speed on the highway is 65kph, but there is no maximum. (This is an upward-monotonic *B* argument: we can reliably infer from *n* being a permitted speed to *n+1* being a permitted speed, but not vice-versa.) The Lucinda sentences in (1) are reproduced in (36).

(36) a. Lucinda is driving faster than allowed on this highway.
b. Lucinda is driving slower than allowed on this highway.

The reported intuitions in the Germany Context are as follows: while (36a) relates Lucinda's speed to the maximum 100kph in the US context, it relates Lucinda's speed to the minimum 65kph in the Germany Context.[15] But between these two contexts the interpretation of the negative-polar (36b) remains the same: it relates Lucinda's speed to the minimum 65kph in the US Context as well as in the Germany Context.

This variability – that polar asymmetry is contextually rather than semantically conditioned – is directly predicted by the Economy of Bounds account above, which locates what I've been calling 'polar asymmetry' in a context-sensitive interpretive principle. The above account additionally predicts that the variability extends outside of comparative constructions.

While it's metaphysically challenging to produce a temporal context in which the B argument is upward-monotonic, it is relatively easy to show that Beck's observation extends to locative relations.

Imagine that a small tree is growing from the ceiling of a cave. In this context, (37a) is intuitively true as long as the snake is higher than the tree's canopy; it is consistent with the snake being on the tree's trunk or on the cave's ceiling above the tree's canopy. But in this context, the tree's canopy represents what I characterized as a *minimum* in Section 3: it is the lowest point on the tree relative to the 'above' scale. This reading of a positive-antonym *above* sentence differs from the 'above the maximum' interpretations available to the *above* sentences in the Cold and Warm Contexts. And it is predicted by the Economy of Bounds principle, given the assumption that the tree's canopy imposes a closed bound while the cave's ceiling imposes an open bound.

(37) a. The snake is above the tree.
b. The snake is under the tree.

In contrast, the negative-polar relation in (37b) receives the same interpretation as it did in the Cold Context in Section 3: intuitively, (37b) is true as long as the snake is beneath the canopy of the tree (i.e. on the ground or possibly on the wall of the cave beneath the tree's canopy). This is the objective minimum in this context – the lowest point on the tree from our perspective – but it is the highest point on the 'under' scale. In this case, the negative-antonym preposition relates the snake's location to the *maximum* bound on the tree.

To sum up this subsection: the Economy of Bounds account of polar asymmetry characterizes it as a pragmatic – rather than semantic – phenomenon. A consequence is that the interpretational variability witnessed for negative-polar relations between degrees, locations, and times (presented in Sections 2 and 3) is not predicted to be an intrinsic property of negative-polar relations, but instead to be a byproduct of how antonymic relations interact with downward- and upward-monotonic interval arguments (which can be constrained semantically or pragmatically). This prediction has already been verified by Beck (2012) in the case of comparative constructions. The case in (37) suggests that locative relations demonstrate the same flexibility, another prediction of the Economy of Bounds approach.

5. SUMMARY AND CONCLUSIONS

The Economy of Bounds approach proposed above is centered around the claim that, in strictly ordered domains, relations maximize informativity by relating to the highest endpoint on the relevant ordering (i.e. the highest closed bound of the interval on that scale). This principle explains the prima facie ambiguity of negative-polar relations in the degree, location, and temporal domains (as well as the contexts that condition it). It also explains the observations, originating in Beck (2012), that the relevant interpretational variability isn't restricted to negative-polar relations, but is instead conditioned by a variety of semantic and contextual factors.

This approach, especially in contrast to the preceding scope ambiguity account, represents the usefulness of cross-domain comparison in linguistic research: assimilating the locative relation data to the comparative data suggests that it was a mistake to condition polar asymmetry on the presence or absence of a scope intervener. It also appears to be one phenomenon that is better suited to a pragmatic or context-driven explanation rather than a semantic, scope-based one.

The current approach as it stands does however have some shortcomings. In particular, it seems relatively poorly equipped for dealing with any observed cross-linguistic or lexical differences. I have not examined the cross-linguistic universality of the empirical claims made here, but we don't need to look outside of English to find at least one lexical departure from the claims here: the negative-polar locative preposition *below* seems to significantly differ from *under* in its interpretational variability.

(38) a. The mouse is under the hut.
b. The mouse is below the hut.

While the *under* sentence in (38a) invokes different bounds in the cold and warm contexts, as detailed in Section 3, the *below* sentence in (38b) does not seem to exhibit any interpretational variability. Specifically, (38b) seems to require that the mouse have burrowed underground in both the cold and warm contexts.

If this is in fact the dominant intuition for the sentence in (38b), we have found a scalar relation that seems to be impervious to Economy

of Bound considerations: it utilizes the same bound for comparison regardless of the context (or regardless of whether that bound is open or closed). The account provided here does not in its current form predict the existence of such relations, and it's unclear how to alter the Economy of Bounds principle to allow for them naturally. To do so, more would need to be known about the prevalence and nature of these context-independent relations.

I have additionally glossed over complications involving the extension of the account to temporal relations, which are arguably distinct from degree and locative relations in their modality. It's also not clear how well the account presented here conforms to existing characterizations of the telic/atelic distinction (see endnote 10), given that an event's telos has traditionally been characterized as an open bound (Bach 1986; Krifka 1989).

Finally: I've argued here, based on the data in (17) and (18), that polar asymmetry is confined to relations between plural arguments whose atoms or members can be modeled as intervals (i.e. are strictly ordered with respect to each other in a given context). This certainly seems to hold for the relations in (17) and (18), but plural individuals have been traditionally associated with a maximal/non-maximal interpretational variability in other semantic configurations that seems temptingly similar to the phenomena addressed here: notably exhaustivity or maximality variations in free relatives (Caponigro 2004) and bare plurals or plural definites (see Malamud (2012) for a recent overview). Depending on how we model plural individuals, it might be tempting to adopt something like the Economy of Bounds principle to account for these data. This would almost certainly require a restructuring of the account here.

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Notes

[1]Negative antonyms are marked relative to their positive counterparts; this markedness is sometimes morphologically transparent (e.g. *possible* vs. *impossible*) but is also evidenced in the relative distribution of the antonyms (e.g. nominalization, *length* vs.**shorth*; Cruse 1976). For more discussion of what constitutes a positive antonym and a negative antonym, see Rett (2015).

[2]The sentence *Lucinda is driving less fast than is allowed* receives the same interpretations as (1b) leading Rullmann, Heim and Büring to assume that *less* is the negated version of *more*.

[3]Some have reported to me the intuition that *below* is a more natural antonym of *above*, and *over* a more natural antonym of *under*. I address this possibility in Section 5.

[4]Because *be single* is a state, there is a possible reading of the sentence *John was single in an hour* in which it is coerced into a telic event. This coerced, telic reading of (10b) can be paraphrased as "It took an hour for John to become single," a reading distinct from the intended, incoherent non-coerced reading, "It took an hour for John to be single."

[5]As before, the judgment for (15a) with the atelic VP (*after John was sick*) is different if the VP is coerced into a telic interpretation; in this case, the coerced interpretation functions as a euphemism for *John vomited*, which (as predicted) patterns instead with the telic VP *finished the race*.

[6]Notice that the embedded phrases in these sentences all contain weak modals, in case this is a precursor for the availability of the negative-polar interpretive variability.

[7]In indirect comparatives or comparatives of deviation (e.g. *The dinner was more expensive than it was tasty*), the degrees are not compared directly but instead compared on a third, isomorphic scale; for instance, the extent to which a value deviates from the relevant contextual standard (Bale 2008).

[8]Beck & Rullmann (1999) provide examples of putative non-monotonic degree properties, but they are all examples formed with downward-monotonic degree properties whose values have been partly prohibited by context. It seems as though non-monotonic properties cannot be encoded lexically or phrasally in natural language.

[9]In previous work (Rett 2011), I've relied on this distinction to explain the difference between acceptable exclamatives like *How fast John drives!* (an exclamation about degrees) and unacceptable exclamatives like **Who John met at the party!* (an exclamation about individuals).

[10]This principle is reminiscent of the 'Interpretive Economy Principle' proposed in Kennedy (2007) (see also Potts 2008): both rely on some intuitive notion of economy to restrict the interpretation of scalar predicates. I welcome any parallels, but there are at the very least superficial differences. Kennedy's principle addresses the difference between relative and absolute adjectives and governs the use of lexically encoded standards of comparison rather than those provided by context.

[11]This is also illustrated in the semantic treatment of the comparative in (26). In a context in which John has 3 kids and Bill has 5 kids, this treatment correctly predicts that the comparative *John has more kids than Bill* is false, because it translates the comparative

with respect to the maximum number of kids Bill has (not merely some number of kids Bill has).

[12]Where $\textsc{Bound}(\text{x}, X_o) = \iota x \in X_o[\forall x'[X_o(x') \rightarrow x >_o x']] \vee \iota x \in X_o[\forall x'[X_o(x') \rightarrow x <_o x']]$

[13]It's an open question why the bottoms of the hut's beams in the Warm Context do not count as imposing a closed lower bound like the floor in the Cold Context does. It's possible that the beams are not sufficient to create a contextually salient vector in this context for the purpose of the locative relation. Whatever the reason, the intuition seems stable across similar situations, e.g. *under the block/box* vs. *under the table/chair*.

[14]Specifically, an atelic event demonstrates cumulativity of reference because each sub--event also satisfies the event predicate (i.e. any subevent in the interval of Mary being single is an event of Mary being single). But a telic event does not: it's not the case that any subevent in the interval of John climbing to the top of the mountain is an event of John climbing to the top of the mountain (e.g. the subevent of John beginning to climb the mountain). This distinction has also proved useful in the treatment of the count/mass distinction (Bach 1986) and, correspondingly, in the semantics of quantity adjectives like *many* and *much* (Rett 2014).

[15]Beck (2012) presents detailed experimental evidence for this empirical claim broadly construed. English speakers seem to differ in whether they prefer the modal *allowed* or *can* in sentences like (36a) with upward-monotonic arguments; I have no explanation for this potential difference.

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