Second Draft

Interval Semantics for Scalar Predication*

Roger Schwarzschild and Karina Wilkinson

Rutgers University

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0. Introduction.

Scalar predicates are used to order individuals in their domain. To say that Fido is more noisy than Fida is to order him above her with respect to noisiness. *tall* presupposes a height ordering, *cold* a temperature ordering and so on. Generalizing on this ordering of individuals we arrive at the notion of a scale with a set of points representing the possible positions in the ordering that an individual might occupy. In many cases we invent names for these points: decibels, inches, degrees Centigrade, dollar amounts and so on. These points are the basis for comparison according to degree analyses of the comparative (Cresswell 1976, Hellan 1981, von Stechow 1984, Rullmann 1995). A simple version of this view says that if the dress is more expensive than the shirt, then there is point on the expense scale, corresponding to the dress, and it is above the point corresponding to the shirt. Similarly, if the point on the height scale corresponding to Frank is above the one for Meryl, then Frank is taller than Meryl. While this seems to be an intuitively satisfying story, the central claim of this paper is that:

(1) scalar predicates have a semantics based on intervals, not points.

The chief evidence for the claim in (1) will come from comparatives that contain quantifiers. The challenge these constructions present for degree analyses is easy to see. It may very well be that Frank is taller than everyone else is without there being a point on the scale corresponding to everyone else. Similarly, if the shirts range in price from $20 to $100 and the dress is $150 then the dress is more expensive than the shirts are, yet there is no point that corresponds to the shirts. Clearly, in these cases there is an interval of the height scale corresponding to everyone but Frank and which lies below Frank's height and there is an interval of the price scale corresponding to the shirts which lies below the price of the dress.

A shift similar to the one proposed here for the semantics of scalar predicates occurred in our understanding of temporal expressions. Expressions like *before* and *after* as well as the tenses are used to order events. Generalizing on the ordering, we arrive at a time line with points on it and we have invented names for these points as well. Initially, tense logics were based on these points, called moments of time. It was later discovered that intervals of time and not moments would have to serve as the basis for a tense semantics for natural language (Bennett 1977, Bennett and Partee 1972, see also Cresswell 1985 for extensive discussion). The necessary shift in perspective from points to intervals ultimately must stem from the same source in the two cases.

Comparison with temporal interval semantics will crop up at various points in our discussion. One parallel will be of particular importance. In executing a moment based tense logic it is usually assumed that specific events are related to unique moments of time. When one moves to an interval semantics, uniqueness does not come automatically. If an event occurred during an interval it occurred during all superintervals. We will discover that the same applies in the move from points to intervals in the scalar domain. The idea that individuals are related to multiple nested intervals of the scale might at first require some rethinking. But as we will see, more standard views of the mapping to scales are just an artifact of the ways we name scalar intervals as opposed to the way we name temporal intervals.

Sections 1-3 below expose the inadequacies of degree based analyses of the comparative. While negative polarity items are a side issue here, they help to sharpen the parameters of the debate and so in section 1 we use their presence in comparatives as a starting point. Section 2 shows that the problem lies with the degrees and not with how the degree analyses are executed. Since the difficulties appear to arise only when quantifiers are present, section 3 dispenses with the possibility of solving these problems using existing mechanisms for shuttling quantifiers around. In sections 4-6 an interval semantics for the comparative is developed. Section 4 shows why we can't simply replace "degree" with "interval" in existing frameworks. Section 5 establishes some general properties of scalar predicates as relations between individuals and intervals. Finally, the analysis of comparatives is worked out in detail in section 6. In section 7, there are brief discussions of a number of issues that have been discussed in connection with the comparative negative polarity items in comparatives, of vagueness, the effect of having modal in a comparative *than* clause, and an analysis of the equative which makes it look more like numerals than like the comparative. The paper concludes with some discussion of future exploration of scalar interval semantics as well as some more parallels in the domain of tense.

1. What we can learn from negative polarity items

Perhaps the most influential degree based analysis of the comparative is that of von Stechow (1984). One of the selling points for this analysis is its explanation of the occurrence of negative polarity items in *than* clauses like those in (2) below:

(2) a. This text is more difficult than <u>any</u> of the others were.
b. It is hotter in New Brunswick today than it <u>ever</u> was in LA.
c. We ate more today than we've eaten <u>in weeks</u>.

According to von Stechow's analysis the comparative is **downward entailing** with respect to the clausal argument of *than* (see also Rullmann 1995*)*. Following Ladusaw (1979), he claims this explains the fact that negative polarity items are licensed under comparative *than.* Von Stechow uses the data in (3)-(4) to demonstrate the downward entailing character of the comparative:

(3) a. Otto is fat.
b. Otto or Max is fat.

(4) a. Ede is fatter than Otto is.
b. Ede is fatter than Otto or Max is.

Whereas (3)a entails (3)b, when they are embedded under the comparative, the entailment is 'reversed'. There is a reading of (4)b on which it entails (4)a. This entailment pattern must be related to the general phenomena observed with *or* whereby in various contexts *or* appears to have the meaning of *and*. Given that this phenomenon occurs outside comparative *than* clauses (Ehrenkranz 1973) one might suspect that the *or* in (3) is not truth conditionally equivalent to the one in (4).[1] Since von Stechow's analysis makes a claim about the semantics of the comparative in general, and not about *or* in particular, we can simply leave this issue aside and verify the claims using other expressions. For example, if von Stechow's analysis were correct and the comparative was in fact downward entailing then given the entailment patterns in (5), we would expect the entailments in (6) to go through:

(5) a. Exactly 7 of my relatives are rich ➔ At least 4 of my relatives are rich.
b. Given that there are elephants in this room: Almost every elephant in this room is heavy ➔ Some elephant in this room is heavy.
c. Most of the high tech stocks were overvalued ➔ At least 2% of the high tech stocks were overvalued.

(6) a. #John is richer than at least 4 of my relatives were.
➔ John is richer than exactly 7 of my relatives were.
b. # My car is heavier than some elephant in this room is.
➔ My car is heavier than almost every elephant in this room is.
c. # Nissan is currently more overvalued than at least 2% of the high tech stocks were.
➔ Nissan is currently more overvalued than most of the high tech stocks were.

Since the entailments in (6) do not go through we are entitled to conclude that von Stechow's analysis is wrong.

This conclusion, it should be noted, does not depend at all on adopting Ladusaw (1979)'s theory of negative polarity for explaining the data in (2). It merely uses the fact that von Stechow's analysis predicts that comparative *than* clauses are in downward-entailing contexts. It should also be noted that the argument was presented in a form that was simplified relative to von Stechow's discussion. The entailment relation in (5) relates propositional type expressions. This doesn't accurately reflect the state of affairs in von Stechow's paper. For him, clauses under *than* contribute sets of degrees to the meaning of the comparative. For example, the embedded clauses of (6)a contribute the sets in (7):

(7) a. {d: at least 4 of my relatives are d-rich}
b. {d: exactly 7 of my relatives are d-rich}

But this doesn't really change things. For any degree d, if exactly 7 of my relatives are d-rich, then at least 4 of my relatives are d-rich. (7)b is therefore a subset of (7)a and so the clause under *than* in *John is richer than exactly 7 of my relatives were* entails, in a

[1] Larson (1988) specifically suggests this is a negative polarity *or* which has a conjunctive interpretation.

generalized sense, the clause under *than* in *John is richer than at least 4 of my relatives were.* Reading the arrow in (5) in this generalized sense, the argument we've made here still goes through.

Examples like those in (6) allow us to make an even stronger point. Reversing the direction of the arrows in (6) leads to entailments that are intuitively correct. This means that the clause embedded under comparative *than* is in fact in an upward entailing context! Any analysis of *more* comparatives should explain this fact and no degree analysis that we know of does.

A possible way to avoid this conclusion and to save existing analyses of the comparative is to suppose that the quantifier phrases embedded under *than* are not actually interpreted in the scope of the comparative. This would mean that the argument in (5)-(6) does not go through because the quantified clauses in (5) are not the true arguments of the comparative in (6). In the literature there are at least two proposals for how this might happen. Von Stechow himself suggested that quantifiers could be scoped outside by the usual mechanisms of quantifying in. Below we examine and reject this possibility[2]. Larson (1988), attempting to solve a similar problem facing a different theory of comparatives (Klein 1980), proposed a compositional semantics whereby the clause under *than* actually lies outside the semantic scope of the comparative. Here again, the facts in (2) are relevant. As Ladusaw (1979) showed, negative polarity items must lie in the semantic scope of their licensers; it is not enough for them to be c-commanded by a licenser at some level. If clauses under *than* did not in fact lie in the semantic scope of the comparative, they could not contain polarity items licensed by the comparative, regardless of what theory of licenserhood one adopts.

Assuming then that quantifiers in the syntactic scope of the comparative are also in its semantic scope, we are back to our original conclusion. Von Stechow's theory along with many others cannot be maintained. At this point, we need to turn to the details of these theories to see what goes wrong when quantifiers are involved.

2. Quantifiers In The Scope Of Clausal Comparatives On A Degree Analysis

Among analyses of the comparative, there are those that make reference to degrees in the object language and those that eschew degree reference (see Klein 1991 for this and other issues relating to the use of degrees). The bulk of the discussion will focus on degree analyses. As noted above, Larson(1988) has already shown that avoiding degree reference does not grant immunity from the kinds of problems we will be interested in here.

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[2] Chris Kennedy suggested to us that the analysis of Lerner and Pinkal (1992) may constitute a third option. They proposed a rule of "Nested Quantification" whereby the relevant quantifiers take scope over the degree quantifier, but crucially not higher than *than*. This protects them from some but not all of the arguments adduced below.

A typical degree analysis begins by taking the clause under *than* to denote a set of degrees, as in (8) below. The material inside the parenthesis in (8)a undergoes elision. The trace is a variable over degrees, which is bound by a lambda operator. The embedded clause denotes the set of degrees in (8)c.

(8) a. John is taller than [$_{CP}$Mary is (t tall)].
b. [$_{CP}$ *Mary is* (*t tall*)] → λd[Mary is d-tall]
c. {d: d is Mary's height} = {d_M}

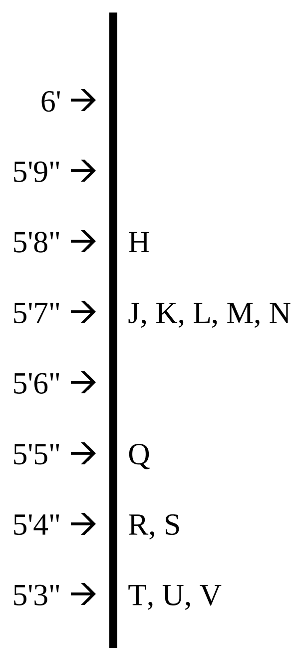
For now we are assuming that if *d* in *Mary is d tall* is assigned height h, the result is true just in case Mary is exactly h tall. This means that the set in (8)c is a singleton. The next step is to say how this set is related to John's height. Theories differ here and in (9) the options are listed:

(9) [John is taller than CP] iff: John's height is greater than:

a. some height in CP (Hellan 1981)
b. the height in CP (Russell)
c. the maximal height in CP (von Stechow 1984)
d. every height in CP (Cresswell 1976)

These theories collapse when applied to a case like (8) where the embedded clause denotes a singleton set. Predictions diverge when quantifiers occur in the embedded clause. In order to illustrate these predictions we will make reference to the scale in (10) below. It represents data on a number of suspects ranging in height from 5'3" (Tom, Uwe and Victor) up to Hubert at 5'8".

(10)



The statement below, made in reference to (10), is intuitively false:

(11) Q. is taller than everybody else is (t tall). (false of (10))

What do our theories say? To answer this question we calculate the meanings contributed by the clauses under *than*:

(12) a. λd[everyone else is d-tall]
b. {d: everyone but Q is d-tall}
c. ∅

Since the suspects are not all of the same height, this set is empty. According to the definite analyses in (9)b,c, we should find (11) uninterpretable due to presupposition failure. According the universal theory, (9)d, (11) should be true, vacuously. The existential analysis in (9)a. correctly predicts the sentence false but for the wrong reason. It would predict any sentence of the form X *is taller than everyone else* false, including the true sentence *H. is taller than everyone else is.*

As noted above, we are taking "is d-tall" to mean "is exactly d-tall". If instead we take it to mean "is at least d-tall" we get the following meaning for the clause under *than*:

(13) a. λd[everyone else is d-tall]
b. {d: H, J, K, L, M, N,R, S,T,U and V are all at least d-tall}
c. {d: d ≤ 5'3"}

Since Q's height is greater than 5'3", all the theories in (9) predict this sentence should be true or truthvalueless.

In deciding whether Q is taller than everybody else is, we don't look for a point corresponding to everyone else, but rather we scan the scale to check everyone's height. This simple observation is missed by degree analyses. Points on the scale corresponding to individuals are 'too small' to handle information about sets of individuals. This leaves us with two options. We either retain the degree analysis appealing to some mechanism for removing the offending quantifiers or we revise the analysis of comparatives so that degrees do not play a central role. We will take up these two options in turn.

Difficulties inherent in the degree analyses were illustrated using an example with a universal quantifier. However, this is by no means necessary. According to all of the analyses above the sentences below are both true:

(14) H. is taller than exactly 5 of the others are.
(15) H. is taller than only one of the others is.

And for each of the theories there are further mistaken predictions generated by considering quantifiers of various types.

3. Quantifier Removal (QR)

Crucial to the argument in the previous section was the assumption that quantifiers occurring inside a *than* clause have in-situ scope. There are some very good reasons for making this assumption. As observed in section 1, we must assume that quantifiers are at least generated in the scope of the comparative. This leaves the possibility that quantifiers are moved or 'scoped' away from this position. As Larson(1988) observed, an argument against such a move stems from the well-known parallels between constraints on quantifying-in and those imposed on Wh-movement. Wh-words may not be moved from inside a clause under *than* either overtly as in (16)a or covertly as in (16)b:

(16) a. *[Which bird]$_i$ are you taller than t_i was?
b. *She asked who was richer than who else was.

If quantifier scope opportunities are constrained in roughly the same way that Wh-movement is, then it should be impossible to grant the quantifiers in question scope outside a *than*. A related argument which doesn't presuppose the Wh-/QR connection, has to do with scope out of conjunctions. On its more plausible reading, the scope of the universal in (17) extends over the indefinite.

(17) A fly was buzzing over every drink.

If the universal occurs inside a conjunction the scope may not extend over the indefinite and we get only the implausible reading.

(18) A fly was buzzing over every drink and annoying one of the tourists.

Now consider the following example with a quantifier inside a comparative:

(19) Alice is richer than George was and than most of his children will ever be.

In order to save the degree analysis here the quantifier *most of his children* would have to scope outside of the conjunction.

Furthermore, in the normal case when quantifiers can have scopes outside their surface structure position, the wide-scope reading is in addition to the narrow-scope surface reading. But, again as Larson(1988) observed, existing analyses of comparatives would have to assume an obligatory rule of QR. This point has been obscured in the past because researchers have tended to look at examples with simple universal or existential quantifiers. In these cases the potential ambiguity would arguably be hard to detect because the two readings are often related by entailment. Furthermore in theories where definiteness plays a role, presupposition failure has been used to explain away the lack of ambiguity (Rullmann 1995). Wilkinson (1998) showed, however, that if non-monotonic quantifiers are used the two readings are logically independent and both can arise in the same context. If von Stechow's theory in (9)c were correct, for example, and if a rule of QR could scope quantifiers outside the comparative, the sentence in (20)a would be ambiguous between the paraphrases in (20)b and (20)c:

(20) a. Hubert is taller than exactly 5 of the others are
b. Find the largest height h, where exactly 5 individuals other than Hubert are h tall. Hubert is taller than that. (narrow scope)
c. There are exactly 5 individuals that are shorter than Hubert. (wide scope)

Neither reading is ruled out by presupposition when uttered with respect to (10) since there is indeed a unique height, 5'7", that exactly 5 individuals have. (20)b is clearly true and (20)c is clearly false. Yet (20)a is intuitively univocal and false. In other words, only the wide-scope reading is available showing that if QR accounts for the wide-scope it must be an obligatory rule in this case.

Another property of QR is that it is prohibited from applying to quantifiers like those in (21) below. To save degree analyses, however, this prohibition would have to be relaxed.

(21) a. Lucy paid more for her suit then they <u>both</u> paid in taxes last year.
b. It is colder in Stony Brook today than it <u>usually</u> is in New Brunswick.

Paralleling the discussion in the previous section, we observe that (21)a could be true even if there is no single amount that they both paid. Similarly, (21)b could be true even in the likely case that there is no single temperature (degree of coldness) that characterizes New Brunswick most of the time.

Finally, even if a QR solution could be maintained, it makes the wrong predictions in some cases where another scope taking element lies between the quantifier and the comparative over which it will take scope. Imagine John predicts that most of his students will get between 80 and 90 on the national exam. When the exam is over, Bill receives a score of 96 and Alex receives a score of 70. In that case, it would be fair to say that:

(22) Bill did better than John predicted most of his students would do.

But it would not be true to say that:

(23) Alex did better than John predicted most of his students would do.

After QR applies to the embedded quantifier in (22) we arrive at the paraphrase below:

(24) Most of John's students are x such that: Bill did better than John predicted x would do.

This has the welcome result that the clause under *than* can safely pick out degrees associated with individual students. The problem is that it doesn't accurately capture the meaning of (22). Since John did not make any prediction about a particular student, for any value of x, the set denoted by:

(25) λd[John predicted x would do d-well]

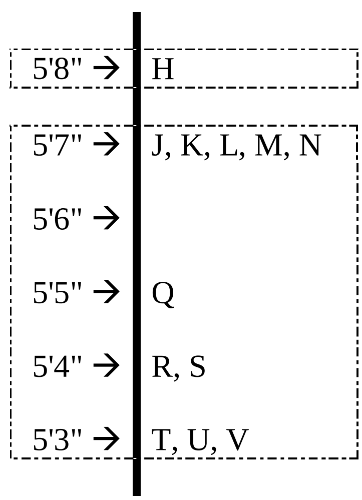
is empty. (22) is therefore incorrectly predicted to be false according to existential theory (9)a and truthvalueless according to the definite theories (9)b,c. (22) comes out true on the universal theory (9)d, but then (23) would come out true for the same reasons.

Hopefully the evidence amassed in this section will deter anyone from supposing that quantifiers under *than* are routinely scoped outside the comparative. This spells doom for the degree based analyses of section 2. Salvation will come in the following sections as our horizons broaden to encompass larger expanses of the scales on which degrees are marked.

4. Towards a Solution: Intervals in the Semantics of Comparatives.

An analysis of comparatives using intervals might begin with the following observation.[3] *Hubert is taller than everyone else is* would be true if there was an interval of a tallness scale containing the heights of everyone but Hubert and above that there was an interval containing Hubert's height, something like in the figure below:

(26)



We intend to preserve this view of the comparative as a relation between intervals of the scale, however the exact nature of the relationship will need sharpening. The examples below give an indication of what will be needed:

[3] The idea to use intervals as the basis for a semantics of comparatives is not novel. One finds this for example in Seuren (1984), Bierwisch (1987) and more recently in Kennedy (1998). Kennedy's proposal will briefly be discussed in section 7.1. Our point of departure is different from in those approaches. They are in a certain sense extensions of degree approaches and are similarly challenged by quantifiers under *than*, as Bierwisch himself noted.

(27) H. is taller than exactly 5 of the others were.
(28) H. is 1 in. taller than everyone else is.

(27) is intuitively false according to the information in (26). However, there is an interval which contains the heights of exactly 5 of the others, namely those of J, K, L, M and N, and which lies below an interval covering H's height. (28) is likewise intuitively false according to the scale in (26). But the upper interval depicted in (26) is in fact 1 in. above the lower one, the one that covers everyone but H's height. If this view is to work, we need somehow to restrict the choice of intervals that participate in the comparative relation.

In order to address this issue, we should say a bit more about relations between individuals and intervals of the scale and between one interval and another.

5. Intervals and Differentials.

The underlined phrases in the examples below are what von Stechow (1984) calls differentials:

(29) John is <u>1 in</u>. taller than Mary was.
(30) Felix is <u>a fair amount</u> richer now than he was last year.
(31) Harry is <u>a lot</u> more fascinating than his father was.
(32) It’s <u>a little bit</u> more tasty than it was when we first made it.
(33) She’s <u>no</u> slower than she usually is.
(34) Bill Clinton wasn't <u>any</u> happier than Bill Gates was.
(35) Maxine wasn’t <u>that much</u> faster than I thought she would be.

Differentials measure parts of the scale. According to (29), there has to be a 1-inch portion that lies between John and Mary. According to (31), there has to be a large portion on the fascination scale between Harry and his father. Given that these differentials are predicates applying to parts of the scale, it is interesting to notice that they are all symmetric quantifiers that apply in the mass domain. Their standard uses are illustrated below:

(36) He has <u>1 in</u> of rope in his pocket.
(37) Felix put <u>a fair amount</u> of gasoline in the tank.
(38) Harry drank <u>a lot</u> of milk
(39) There was <u>a little bit</u> of evidence to support her alibi.
(40) She has <u>no</u> interest in your proposal.
(41) I don’t have <u>any</u> rice.
(42) He didn’t drink <u>that much</u> wine.

In general, count quantifiers don't perform well as differentials[4]. **John is every/many taller than his mother was* is ill-formed. And while the negative polarity *any* is potentially a symmetric mass quantifier (41) and therefore can be used as a differential (34), free choice *any* is not a mass quantifier:

(43) #Choose any rice. (≠ choose any amount of rice)

Free choice *any* is also not symmetric and it cannot be used as a differential:[5]

(44) *With enough alcohol, you can feel any richer than Bill Gates feels.

Expressions such as *inches* and *degrees* are classifiers, which combine with count quantifiers to form mass quantifiers. They therefore enable the use of count quantifiers in differentials:

(45) He bought several *(inches) of rope.
(46) He is several *(inches) taller than he used to be.
(47) It is a few *(degrees) colder now than it was an hour ago.

The key property of the mass domain is its non-atomicity. If something is rope, than any subpart is rope, or at least that is how the language treats it. The scale is similarly a masslike object in the sense that for any way of partitioning it, say into feet, there is always a finer way to partition it, say into inches. There is then a non-atomic part-of relation (part-of: $\sqsubseteq$, proper part-of: $\sqsubset$) defined on intervals of the scale. This is in addition to the ordering relation (less-than: $\prec$, less-than or equal to: $\preceq$) necessary for scalehood. (Assume an ordering of points on the scale from bottom to top consisting of a dense, connected, irreflexive, asymmetric, transitive, total relation. Think of intervals as sets of points. For intervals I,J: $I \prec J$ iff every point in I is below every point in J.)

The massiness of the scale is reflected in a general kind of context dependence inherent in all measure expressions. *John is 6ft tall* may be true in one context, but in a more fine-grained context, it may not be. *Alice is as rich as her mother was* will count as true if wealth is measured in dollars but once we start counting pennies, that sentence may count as false. *This jar is colder than the refrigerator is* might count as false for the purposes of cooking but not for the purposes of a controlled biology experiment. One way to capture this type of context dependence is to associate each scalar expression, such as *cold*, with a relation between individuals and parts of the relevant scale. Since there is no particular interval that is associated once and for all with each individual, the extension of a scalar predicate should associate an individual with multiple intervals (eg. penny sized ones and dollar sized ones) and for certain purposes the context will decide which of them is

[4] Steve Berman pointed out the following counterexample: in *many more books*, *many* is not a mass-quantifier, but it is a differential.

[5] To the extent that one can say *with enough alcohol, you can feel richer than Bill Gates by any amount* it seems that either free choice *any* is not a true universal or that non-symmetric quantifiers are allowed as differentials.

relevant. In the future, if predicate P associates individual x with a scalar interval K, we will say that K **covers** x.

Since differentials will measure gaps between intervals we will define a ‘subtraction’ operation as well. Assuming I is above K, we want [I-K] to pick out that part of the scale that is below I and above K:

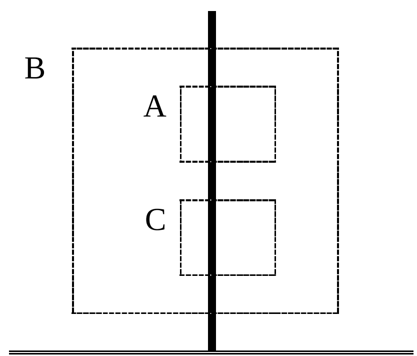
(48) For intervals I, K: If $K \prec I$, then: $\forall J: (J \prec I \ \& \ K \prec J) \leftrightarrow J \sqsubseteq [I\text{-}K]$

otherwise: $[I\text{-}K]=0$

Intuitively, I-K names the interval that “in between I and K”. The statements below illustrate some of the notions introduced so far. SOME and NO represent the meanings of the corresponding mass quantifiers. All the statements concern (49) and all are true:

SOME([A-C])	NO([A-B])	NO([B-A])	$C \prec A$	$C \sqsubset B$
NO([C-A])	NO([B-C])	NO([C-B])	$C \preceq C$	$A \sqsubset B$

(49)



We refer to the result of subtracting A from B as the “empty interval”. This interval is used in defining subtraction and in statements involving quantifiers. However, unless otherwise noted, interval variables such I,J,K should be taken to range over non-empty intervals.

In this scheme, scalar predicates denote relations between individuals and parts of the scale, or intervals. The following axioms govern these relations:

(50) For any scalar predicate extension P, individual x and portions of the relevant scale I,K:

a. $[P(x,I) \rightarrow \exists I'[I' \sqsubset I \ \& \ P(x,I')]$

b. $[P(x,I) \rightarrow \forall I'[I \sqsubset I' \rightarrow P(x,I')]$ (Persistence)
c. $P(x,I) \& P(x,K) \rightarrow \exists J[J \sqsubseteq K \& J \sqsubseteq I]$ (Overlap)

The intuition behind (50)a is that an individual, say this book over here, might be considered as large as another individual, say the book Meryl is holding. Unless the books are absolutely identical, there will be another context in which one book counts as larger than the other. In the first context, at the relevant level of detail, the smallest interval associated with the two books will be roughly the same. This smallest interval contains distinct subintervals each covering a different book and these subintervals become relevant in the more discriminating context. (50)b stems from the opposite intuition according to which if A is larger than B in one context, there will be another less discriminating context where they will count as equally large. Taking for granted that for any two intervals there is an interval that includes both of them ($\forall I,J\ \exists K[I \sqsubseteq K \& J \sqsubseteq K]$), it follows from (50)b, that if a number of individuals are related by some scalar predicate P to various intervals on a scale, then there will be some interval that covers all of them:

(51) Let S be a set of individuals:
$(\forall x[x \in S \rightarrow \exists I\ P(x,I)]) \rightarrow \exists K \forall x[x \in S \rightarrow P(x,K)]$

To find a context in which A and B count as equally large is to find a context in which the smallest interval they share is at or below the relevant level of detail for that context. (51) will be important below. It guarantees that if everyone in the domain of discourse is in the sortal domain of a predicate like "tall", there will be an interval that verifies quantificational statements such as "everyone is I-tall".

The idea that various intervals of a scale may cover the same individual is familiar from the temporal domain. The adverbials below associate the event of Frank's birth with successively smaller intervals of time:

(52) Frank was born in 1999, on June 6^{th}, at 9:00 AM.

A similar situation obtains in the locative domain. Nevertheless it might at first seem unusual to extend this idea to the scalar domain. Afterall, we could not say that this bar is 8.5ft long and then continue that it is 8ft long nor would it be informative to say that Bill Gates is a billionaire and then continue that he is a millionaire. While true, these facts turns out not to be relevant to the question of multiple interval assignment. Assume we are measuring our bar with a ruler that has marks at every half-foot. The measurement intervals are a set of ordered **non-overlapping** intervals corresponding to the marks on the ruler. One of them is labeled 8ft and the next higher one is labeled 8.5 ft. The labels indicate their distance from the bottom of the scale. The overlap principle (50)c captures the fact that an object could not be covered by two of these intervals, hence a bar could not be 8.5ft long and 8ft long, with respect to the same ruler. A nearly comparable situation arises in the temporal domain with expressions that measure extents such as *in 2 hours*. We cannot informatively say that the birth lasted 3 1/2 hours and continue that it also lasted 3 hours. Preadjectival measure phrases like duration adverbials denote non-overlapping parts of the scale. The frame adverbials used in (52), on the other hand, will turn out to be more comparable to the comparative constructions that modify scalar expressions. The somewhat stilted examples below help to make the point:

(53) The boy is sick, much more than his father is.
(54) The boy is sick, somewhat more than his sister is.
(55) The boy is sick, (but) little more than his friend is.

It will develop in the next section that the expressions following the adjective *sick* denote different possibly overlapping intervals on the illness scale. Crucially, all these examples could be simultaneously true, in which case the boy would be covered by multiple intervals.

Finally, (50)c guarantees that one individual will not be assigned two intervals that are ordered by $\prec$ with respect to each other. The following is a corollary:

(56) For any individuals x,y, scalar predicate P and intervals I,J:

$$[P(x,I) \,\&\, P(y,J) \,\&\, I \prec J] \rightarrow {\sim}\exists I'\exists J'[P(x,I') \,\&\, P(y,J') \,\&\, J' \prec I']$$

According to (56), if there is an interval covering Mary on the height scale that is above one covering John, than there is no interval covering John that is above one covering Mary.

6. Interval Semantics for Comparatives

There is an extensive literature on the syntax of comparatives which carefully considers distributional facts about the comparative with an emphasis on the question of interpreting the missing parts of the *than* clause. Once the theory here is developed we will briefly comment on the parameters it sets for the syntax. For now, it is simplest to begin with an intuitive idea of what constitutes a comparative.

The sentence in (57):

(57) New Brunswick is [2 degrees] hott**er** today **than** L.A. was last week.

compares the temperature that it is in New Brunswick today to the temperature that it was in LA last week. So, in addition to the bracketed phrase and the comparative morphology, there are two temperature predicates. We can think of these as open sentences, sentences with variable denoting expressions in them:

(58) New Brunswick is t hot today.
(59) LA was t hot last week.

We will call the clause embedded under *than,* in this case, *LA was t hot last week,* the **subordinate clause**. The clause in which the comparative occurs, (58), will be called the **main clause**. Both of these function as predicates of intervals whose arguments are given by the traces. We will use the symbols **Mn** and **Sub** to stand for these predicates. We use the symbol **Diff** to stand for the contribution to the meaning made by the differential *2 degrees*. Comparatives with no overt differential will be taken to include an implicit existential to be written as SOME. [6]

Since it is likely that phrasal and clausal comparatives differ with respect to the issues addressed here, we have been and will continue to limit discussion to clausal comparatives (annoying as that might be in some cases).

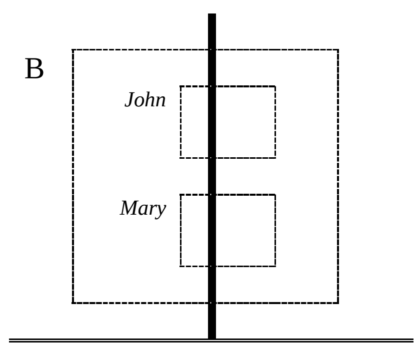
At this point, we are prepared to state a necessary condition on the truth of the comparative:

(60) $\exists$I $\exists$K [Mn(I) & Sub(K) & Diff([I-K])].

For the example in (57), this would mean that there is an interval on the temperature scale I such that New Brunswick is I-hot today, there is another interval K, such that LA was K-hot last week and I differs from K by 2 degrees.

Moving to a somewhat simpler case, according to (60), if *John is taller than Mary is* is true, there must be an interval of the height scale covering John that is some amount higher than one covering Mary. Below we have indicated three intervals of the height scale: one just covering John, one just covering Mary and the interval labeled B covering both of them.

(61)



According to (61), (60) is true because the John interval is a possible value for I and the Mary interval is possible value for K. To be sure, there are more intervals that could be pictured here covering John, Mary or both. But if John is indeed taller than Mary, there are no Mary intervals that lie above John intervals (see (56) above).

---

[6] This is reminiscent of the implicit existential in the agent argument of a passive. Like the passive agent argument, the differential can also appear finally in a *by* phrase:

(1) McConnell-Ginet made this observation earlier than I did **by** at least 25 years.

(60) is necessary, but not sufficient. Imagine a group of individuals of varying heights with John being the tallest. John is 6' tall, the next person is 5'8" and the remainder descend in height from there. In that case, (62) is true, but (63) isn't. (63) entails that everyone but John has the same height:

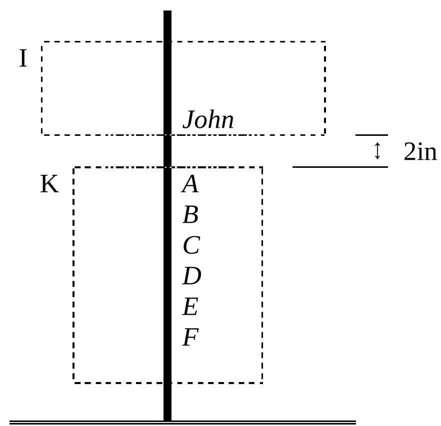
(62) John is taller than everyone else is.
(63) John is 2 in taller than everyone else is.

The condition in (60) is spelled out for (63) in (64):

(64) ∃I John is I-tall & ∃K everyone else is K-tall & 2-IN([I-K]).

As the figure in (65) below shows, the condition in (64) is met despite that fact that (63) is not true. In this and subsequent figures italicized names indicate the position of small intervals covering the named individual:

(65)



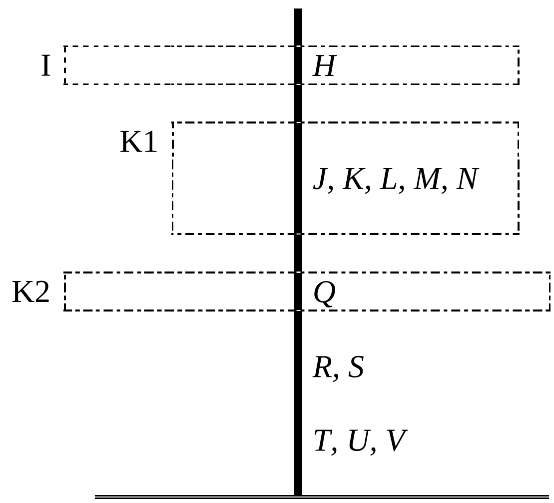
Intuitively, the differential *two inches* needs to measure not only the distance between I and K but also the distances between I and intervals throughout K. Since in (65), K has subintervals that are more than two inches from I, (63) is false. The condition in (60) can therefore be strengthened requiring K to include **only** subintervals that are separated from I by the amount given by the differential:

(66) $\exists I\ \exists K\ [Mn(I)\ \&\ Sub(K)\ \&\ \forall K'[\ K' \sqsubseteq K\ \rightarrow Diff(I\text{-}K')]]$

This condition can be strengthened even further. Recall the example in (67), which was false on the ordering depicted in (68) below.

(67) H. is taller than exactly 5 of the others were.

(68)



Notice that the interval labeled I satisfies the main clause, H. is I-tall, and the interval K1 satisfies the subordinate clause since exactly 5 others are K1 tall. Furthermore, every part of K1 is some distance away from I:

$$\forall K' [(K' \sqsubseteq K1) \rightarrow \text{SOME}([I\text{-}K'])).$$

The condition in (66) holds despite the fact that (67) is false. What intuitively makes (67) false is that there are other intervals, K2 for example, all of whose parts are also some distance away from I, but K2 does not satisfy the subordinate clause. This observation leads to the following strengthened condition:

(69) $\exists I\ \exists K\ [\text{Mn}(I)$
$\&\ \text{Sub}(K)$
$\&\ \forall K'[\ K' \sqsubseteq K\ \rightarrow \text{Diff}(I\text{-}K')]$
$\&\ \forall K''[\ K \sqsubset K'' \rightarrow (\exists K'\ [K' \sqsubset K''\ \&\ \sim \text{Diff}([I\ \text{-}K'])])]$

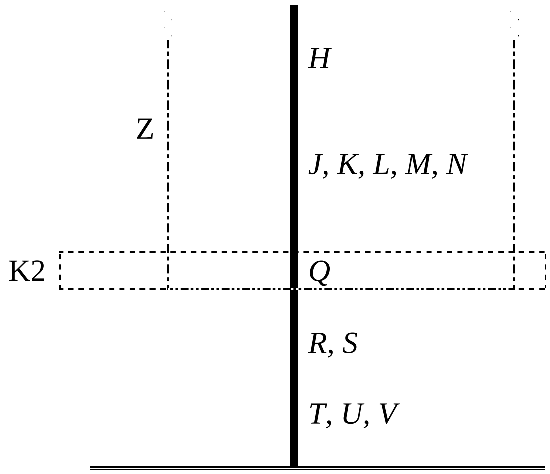
The last conjunct requires that K be the largest interval that satisfies the second to last conjunct. In the case of (67)/(68) above, the largest interval every part of which is some distance from I begins just below I and continues down to the bottom of the scale. That interval does not satisfy the subordinate clause and so (67) is false.

Now consider the interval K2 again. Suspect Q is K2 tall. Next, imagine finding all the intervals that lie some distance below K2. Put them together into an interval we call J. J begins just below K2 and extends to the bottom of the scale. Exactly 5 individuals are J-tall. The condition in (69) is therefore correctly met for the true sentence *Q is taller than exactly 5 of the others are*. Keeping with the interval K2, consider the interval given by [K2-I], that part of the scale which is below K2 and above I. There is in fact no part of the scale that fits this description hence we get the empty interval. The same would hold if we replaced I with any interval above K2 or if we had K2 itself. Putting all these intervals K2 and above together we get an interval, call it Z. Z begins with K2 and extends upwards to the top of the scale (if there is one). The following statement is true:

(70) $\forall K'[K' \sqsubseteq Z \rightarrow NO([K2\text{-}K'])]]$
$\& \ \forall K''[Z \sqsubset K'' \rightarrow (\exists K' [K' \sqsubset K'' \ \& \sim[NO(I\text{-}K')])]$

The situation is roughly as depicted below:

(71)



Since Q is K2-tall and H is Z-tall, the condition in (69) is met for the true sentence *Q is no taller than H is.*

At this point existential quantification over K in (69) is misleading since the requirements imposed on K are satisfied by only one interval.[7] To make this more apparent, we define a maximality operator as follows:

(72) $\mu K'[\phi] = K$ iff: $\forall K'[K' \sqsubseteq K \rightarrow \phi(K')]]$
$\& \ \forall K''[K \sqsubset K'' \rightarrow (\exists K' [K' \sqsubset K'' \ \& \sim \phi(K')])]$

The condition in (69) can now be rewritten as:

(73) $\exists I \, [Mn(I) \ \& \ Sub(\mu K'[DIFF(I\text{-}K')])$

According to (73), to show that a comparative statement is true we show some interval I that satisfies the main clause. Then we find the largest interval all of whose parts are

[7] Suppose you had two distinct intervals, K1, K2 such that both were candidates for $\mu K'[\phi]$ (both consisted of only ϕ parts and both had no superinterval consisting of only ϕ parts). Consider M which has K1 as part and K2 as part and no part which is not also a part of K1 and K2 (M need not be convex, ie there could be 'gaps' in it). Neither K1 nor K2 could satisfy the second conjunct of (72) because of M ($K1 \sqsubset M \ \& \sim\exists K' [K' \sqsubset M \ \& \sim \phi(K')]$).

below I by the amount given by the differential. We then show that that maximal interval satisfies the subordinate clause.

It is probably wise at this point to pause to consider what's behind (72), appealing again to intuitions about temporal scales. We've used the term "maximality" and we've pointed out that the μ operator picks out a unique interval (see footnote 7). Both of these properties have at times been attributed to the definite article, suggesting that one place where we might find a similar effect is with definite descriptions of time intervals. Consider the use of the definite article in the following sentence:

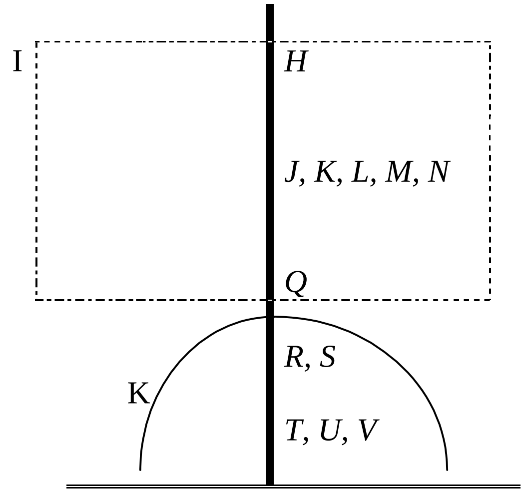
(74) A mysterious balloon floated on a wave around the time Calypso had that nasty cough.

The noun phrase beginning with *the time…* appears to denote a unique time interval, the one that coincided with Calypso's cough. What is that interval? Since the embedded clause is stative, there is no minimal time interval of Calypso having the cough, hence minimality (by itself) couldn't give us uniqueness. On the other hand, any time interval containing the coughing is an interval when Calypso had the cough, so there is no maximal interval either. Instead, we choose a time interval K satisfying the following two requirements: all parts of K are times of Calypso having that cough and any K", a proper superinterval of K, contains times where Calypso doesn't have the cough. This is just μ operating in the temporal domain.[8]

In strengthening the condition in (60) we looked inside the 'subordinate' interval K, the same should be done for the main clause interval. To see that, note that our earlier explanation for why (67) (*H. is taller than exactly 5 of the others are*) is false in (68) would not have gone through if we had begun with a larger interval I, as in the figure below:

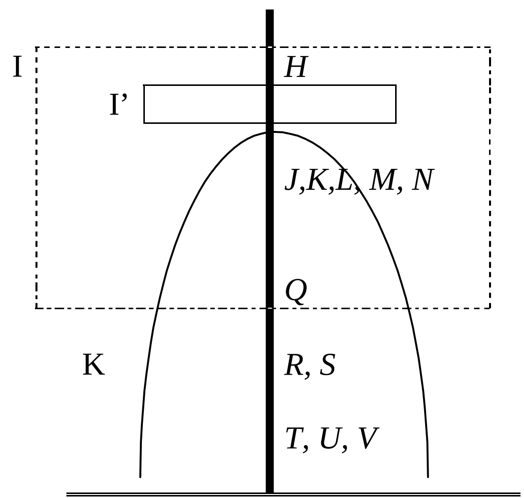
[8] Why can't we simplify μ so that μK'[ϕ] includes every K' that satisfies ϕ? Here's one reason. Reexamine the diagram in (71). The interval that includes the entire scale pictured there is an interval K' such that NO(K2-K'). On the proposed simplification, μK'[ϕ] would include that interval. Since that interval covers any individual depicted, it would follow that Q is no taller than R is and Q is no taller than T is and so on. Note, the proposed simplification is simply a sum operator of the kind proposed as the interpretation for the definite article in the mass and plural domain (Link 1983 or Sharvy 1980). But this is NOT what we want here.

(75)



K pictured here satisfies the subordinate clause and it is the largest interval consisting just of intervals that are some distance below I. Again the problem arises because while I picks out the interval K which meets the relevant requirements, I contains subintervals, such as I' in the figure below which does not meet the requirements:

(76)



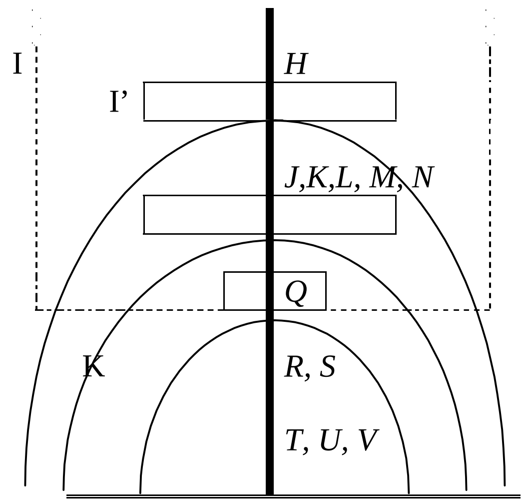
In this figure, K is the largest interval composed entirely of intervals some distance below I'. But K does not satisfy the subordinate clause (*exactly 5 others are K-tall* is false).[9] So the reference to the upper interval I will also be required to be the largest interval consisting entirely of I' which satisfy the requirements imposed by the subordinate clause and the differential:

[9] As an exercise the reader can also verify that although *H is no taller than Q is* is false for (71), it would satisfy the condition in (73). [Hint: let Z be the main-clause interval]

(77) $Mn(\mu I'[Sub(\mu K'[DIFF(I'-K')])$

(77) requires that the main clause of the comparative be satisfied by the largest interval each part of which has the following property: the maximal interval consisting of just intervals separated from it by the differential verifies the subordinate clause. The following figure captures a moment in the verification of the sentence *H is taller than at least five of the others were*:

(78)



Three subintervals of I have been checked. In each case, the interval below it (indicated with a parabola) covers at least 5 individuals other than H. Since I covers H., the sentence is true. The process will continue covering the entire span from above R. and S. to the top of the scale, if there is one. From the formula in (77) and the figure in (78), it develops that an expression of the form "differential *more than* S" defines an interval. In (78), the interval I is the denotation of "some+er+than+at least 5 of the others were t tall". This was the basis for our announcement in the previous section that the expressions following the adjective *sick* below denote intervals:

(53) The boy is sick, much more than his father is.
(54) The boy is sick, somewhat more than his sister is.
(55) The boy is sick, (but) little more than his friend is.

(53), for example, asserts that the boy is I-sick, where I is the interval given by the comparative *much more than his father is (sick)*.

This brings us to the question of how the semantics we have proposed constrains syntactic analyses of the comparative. The answer is that it will depend very much on assumptions about how meanings are computed. We should therefore just say what the system needs to achieve. For (53), it seems reasonable to think of *more* as denoting a function which takes two arguments. One argument is provided by the *than* clause and it corresponds to Sub in (77). The second argument is provided by the differential. The function applies to these arguments to give an interval. That is the interval described in (77) as μI'[Sub(μK'[DIFF(I'-K')]. That interval serves as an argument for the function denoted by *sick* resulting in a one-place predicate over individuals, which applies to the boy. Unlike in (53)-(55), in run of the mill comparatives of the form *John is much taller than George is* the interval denoting expression appears to be wrapped around the scalar predicate. In order to 'set things right' we have the usual choices. Either the syntax-semantics map involves more than just sisterhood interpreted as function argument application or the meanings of the parts involve more than the functions and arguments just described or most likely a combination of these last possibilities. Furthermore, although the semantic proposal made here was developed on the assumption that the subordinate clause contains an interval-type trace, this is not necessary. In particular, we are not committed to an ellipsis analysis of the missing material in the *than* clause as opposed to an analysis in which the missing material is the type of a one-place predicate (see Kennedy 1999, Klein 1980).

In the previous section it was claimed that comparatives are scalar counterparts of temporal frame adverbials. In both cases, these expressions can be used to name multiple intervals covering the same individual. In order to demonstrate this for the comparative, we compute a collection of comparatives in the figure below (assume in each case that the letters correspond to the relevant boys):

(79)

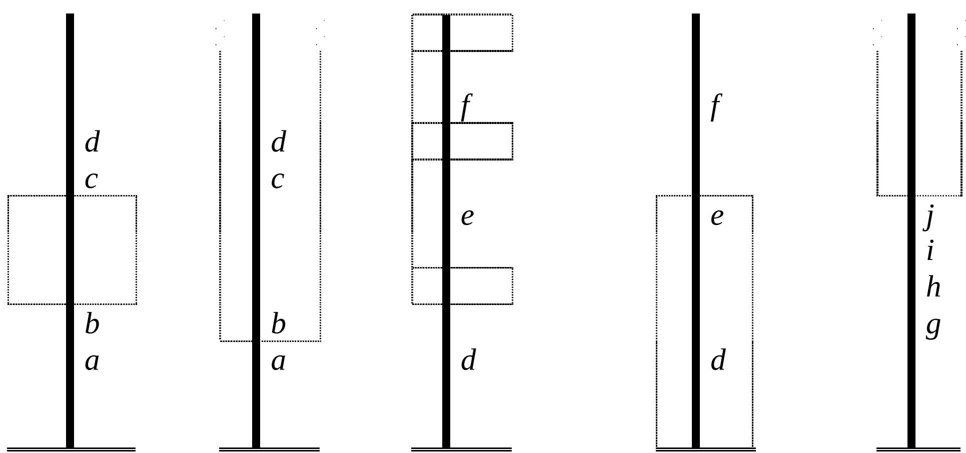


Fig. 1 | Fig 2 | Fig 3 | Fig 4 | Fig 5

Fig. 1	Fig 2	Fig 3	Fig 4	Fig 5
(tall)er than exactly 2 of the boys are	*(tall)er than one of the boys is*	*2 in (tall)er than one of the boys is*	*no (tall)er than e is*	*(tall)er than all of the boys are*

Given that the interval in Figure 1 is a subinterval of the one in Figure 2, if the interval in Figure1 covers Maxine, the one in Figure 2 will as well. This corresponds to the intuition that if Maxine is taller than exactly 2 of the boys then she is taller than one of the boys, an example of the upward entailing character of the comparative noted in section 1. The interval in Figure 3 is discontinuous. The principles for assigning intervals to individuals actually predict that scalar predicates will relate individuals to discontinuous intervals and Maxine is related to such an interval if she is 2 in taller than one of the boys.[10] The interval in Figure 3 is not a subinterval of the one in Figure 4 but they do overlap. This means that if Maxine is 2 in taller than one of the boys is and e is one of the boys, it is possible but not necessary that Maxine is no taller than e is.

This concludes the development of an interval-based semantics for comparatives. The proposed theory avoids the problems associated with point-based degree approaches by allowing for quantifiers under *than* to be interpreted in-situ in comparatives. While points on a scale may do the job where comparison between individuals is concerned (and one should in principle prove that the present account reduces to a point account in such cases), a study of the full range of cases shows that they are not at the heart of scalar predication.

7. Tangents

7.1. More On Negative Polarity Items.

It was pointed out in section 1 that degree analyses are executed in a manner that incorrectly gives them a downward entailing quality. Comparatives are in fact upward entailing and we should now show why this is so.

It is the upward entailing nature of the comparative that allows one to conclude from the fact that (80) entails (81)

(80) Exactly 7 of my relatives are rich.
(81) At least 4 of my relatives are rich.

that (82) entails (83):

(82) John is much richer than exactly 7 of my relatives were.
(83) John is much richer than at least 4 of my relatives were.

The relevant fact here is that any interval that satisfies (84) satisfies (85) as well:

(84) Sub1(K) $\hookrightarrow$ "Exactly 7 of my relatives are K-rich."
(85) Sub2(K) $\hookrightarrow$ "At least 4 of my relatives are K-rich."
(86) $\forall$K[Sub1(K) $\rightarrow$ Sub2(K)]

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[10] The limits of figure drawing are stretched in this example. The thickness of the three boxes should be small, representing insignificant widths relative to 2 inches (but see section 7.3, on vagueness). Another expression that would denote a discontinuous interval is *exactly 2 degrees or exactly 8 degrees* (hott)*er than the white flask was.* And if the copier runs at 3 speeds, then the comparative in *the collator runs at* ***2 pages*** *fast**er*** ***than the copier runs*** would denote a discontinuous interval.

This fact just follows from the meaning of the quantifiers *exactly 7* and *at least 4*. No assumptions about how intervals work are at issue.

As we will show below, from (86) it follows that the interval denoted by the comparative marker in (82) is a subpart of the interval denoted by the one in (83):

(87) J1 = ⟦ *much -er than exactly 7 of my relatives were t rich* ⟧
(88) J2 = ⟦ *much -er than at least 4 of my relatives were t rich* ⟧
(89) J1 $\sqsubseteq$ J2

Since J1 is a subpart of J2, by persistence (50)b (page 14), if John is J1-rich, then he is J2-rich. In other words, (82) entails (83). The inference does not depend on any particular fact about the example except the one in (86) and the meaning of the comparative. It follows therefore that the comparative must be upward entailing. What is left now is to derive the claim in (89) revealing the source of the upward entailingness.

Given the condition on the truth of a comparative in (77) (page 22), (89) translates into:

(90) (μI'[Sub1(μK'[MUCH(I'-K')]) $\sqsubseteq$ (μI'[Sub2(μK'[MUCH(I'-K')])

Suppose (90) did not hold. In that case, there would be an interval, δ, that was part of J1 but not part of J2:

(91) δ $\sqsubseteq$ (μI'[Sub1(μK'[MUCH(I'-K')])

(92) ~[δ $\sqsubseteq$ (μI'[Sub2(μK'[MUCH(I'-K')])]

From (91) and the definition of μ (page 19) it follows that:

(93) Sub1(μK'[MUCH(δ-K')])

From (93) and (86) we have that:

(94) Sub2(μK'[MUCH(δ-K')])

and from (94) and the definition of μ (page 19) we have that:

δ $\sqsubseteq$ (μI'[Sub2(μK'[MUCH(I'-K')])

which contradicts (92) hence we must retract out initial assumption. (90) is in fact true. The upward entailing property of the comparative follows from its semantics and in particular, the way that the μ operator works.

At this point we have gained an explanation for why the comparative is upward entailing but we are left wondering why negative polarity items licensed in the comparative? Assuming negative polarity items require implication-reversing contexts (Fauconnier 1975, Ladusaw 1979), how are we to explain their presence in comparatives?

Implication reversal presupposes the selection of an ordering of the relevant meanings. What we have shown is that the comparative is not downward entailing, if the ordering is based on logical entailment. So one possibility is that the comparative is implication reversing but relative to a different ordering. There are at least two other orderings available. One is the ordering relation necessary for scalehood, the one we signify with '$\prec$'. The other is the part-of relation ($\sqsubseteq$) that holds between intervals on the scale. What one might show is that relative to one of these orderings the comparative is implication reversing. Since in the theory we have proposed the comparative amounts to a function from a set of intervals to an interval, ideally one would show how these orderings generalize to sets of intervals and then show that the comparative-function is implication reversing.

This probably cannot be done in as straightforward a manner as just described, though there is a basic intuition about the comparative that can be of some inspiration here. Assume Goliath is bigger than David is. It follows that if Og is bigger than Goliath than Og is bigger than David is. This entailment stems from persistence (50)b (page 14), and the fact that the interval denoted by "more than Goliath is t big" is a **subpart** of the interval denoted by "more than David is t big" (compare figures 2 and 5 on page 23). So if Og is covered by the former, he must be covered by the latter. This is specific example of a general fact according to which as you move upward, relative to $\prec$, say from David to Goliath, the result of applying the comparative function moves you downward relative to the part-of relation on intervals.

In order to capitalize on this we need to generalize the $\prec$-ordering to sets of intervals. One possible way to do this is to use the join operator:

(95) $\sqcap$S denotes the largest interval which is part of every interval in S.

This operator is not defined for every set of intervals. It will be defined in the case where we have a set of intervals covering a single individual such as Goliath. Our generalization of $\prec$ will now be cast as:

(96) $S1 > S2$ iff $\sqcap S1 \succ \sqcap S2$

Letting $\mathbb{C}_{some}$ be the meaning of the comparative with *some* as the differential, we now have:

(97) $S1 > S2 \quad \rightarrow \quad \mathbb{C}_{some}(S1) \sqsubseteq \mathbb{C}_{some}(S2)$

(97) looks as though it says that $\mathbb{C}_{some}$ is implication reversing. But this doesn't follow automatically as it does when only one ordering is used. With two orderings one has the added burden of deciding in some absolute sense what counts as upward for each of the

orderings. Only then could we read (97) as saying that as the *than* clause arguments go upward, the intervals denoted by the corresponding comparatives go downward.

Kennedy (1998) appeals to exactly this kind of extended view of implication reversal in his treatment of adjectives like *difficult* and *dangerous* which create monotone decreasing contexts and which have polar opposites (*easy, safe*) with do not. Following are two of his examples showing the monotonicity properties of the polar opposites *safe* and *dangerous*:

(98) It's dangerous to drive in Rome ➔ It's dangerous to drive fast in Rome.
(99) It's safe to drive fast in Des Moines ➔ It's safe to drive in Des Moines.

Kennedy also treats scalar adjectives as relations between individuals and an interval on the scale[11]. He then goes on to show that given certain independently justified assumptions about these relations, *safe* is upward entailing and *dangerous* is downward entailing. His demonstration relies on using the same two relations we have used and he also assumes that if I is part of J, then I is 'lower' on the part-of scale. Kennedy's work is important here because we are concerned with problems involved with using two scales. In Kennedy's case, it is precisely because there are two scales that related adjectives can come in downward and upward monotonic polar pairs. *safe* and *dangerous* are tied up with the very same $\prec$ relation. This is used to explain why if A is more dangerous than B, then B must be more safe than A. But crucially the higher you are on **that** scale, the **larger** ($\sqsubseteq$) your degree of safety and the **smaller** ($\sqsubseteq$) your degree of danger. So while multirelational implication reversal has added complications it is flexible in a way that may be necessary to capture linguistic generalizations.

Be that as it may, it is interesting to note that the claim in (97) doesn't extend to comparatives whose differential is *no* or *exactly 4*. Comparatives with *exactly 4* as a differential do indeed reject negative polarity items in their scope (Rullmann 1995:104-107) but *no* comparatives allow them.[12]

One final remark concerns the semantics of the negative polarity items themselves. As with the entailingness properties, the results in our account conflict with standard practice but seem to accord with intuition. Ladusaw(1979:Ch.IV, §2) argued that polarity *any* is to be understood as an existential narrowly scoped relative to the licenser and not as a universal widely scoped relative to the licenser, as in other work.

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[11] Kennedy follows degree approaches in relating each individual to a unique interval, so for differently 'sized' people there is no interval that they all share. Another difference with the analysis proposed here is that for Kennedy the intervals always include either the bottom of the scale (for positive adjectives like *safe*) or the top part of a scale (for negative adjectives like *dangerous*).

[12] There are comparative particular polarity items which don't sound good with *no*: *It was* (#*no*) *hotter than hell*, *He was* (#*no*) *happier than a pig in shit.* Possibly *no* licenses NPIs in a different way.

Accepting Ladusaw's argument, we incorrectly predict that *John is closer to me than he is to anyone else* would be true if, for example, John was closer to me than he was to just one other person (the picture would look like figure 2, in (79) page 23). Similarly, if negative polarity *ever* is existential, *Paris is colder today than it ever was before* would be true if Paris was colder than it was on just one day in the past. These incorrect predictions should not trigger a revision of our analysis of the comparative. What we seem to have here are universal readings for these polarity items.[13] Unlike in other contexts where polarity items are licensed, in the comparative they paraphrase as universals, not as existentials. The paraphrases in (100) work, while the one in (101) doesn't.

(100) a. If you've ever taken a driver's exam, you know what it's like.
If you've taken a drivers exam at least once, you know what it's like.

b. No child ever took a driver's exam
No child took a driver's exam (at least) once.

c. Any child who has ever seen a horror movie has trouble sleeping.
Any child who has once seen a horror movie has trouble sleeping

(101) Paris is colder today than it ever was before.
≠Paris is colder today than it was at least once before.

As is well known, universals scoped widely relative to negation are equivalent to existentials scoped narrowly relative to negation. Similar facts hold for the other licensers above. It is also a fact that universals scoped widely relative to the comparative are equivalent to universals scoped narrowly relative to the comparative. These facts are illustrated below:

(102) John is not married to a boxer.
Every boxer is such that: John is not married to him.

(103) That picture was more shocking to me than it was to every man in Sally's tour.
Every man in Sally's tour was such that: That picture was more shocking to me than it was to him.

If polarity items were in fact wide-scope universals, they would be equivalent to narrow scope existentials in the examples in (100) and to narrow scope universals in (101). This would explain the paraphrases in those examples. How this is accomplished and how to answer Ladusaw's objections is left for future research.[14]

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[13] This would explain Larson(1988)'s observation that they can be modified by *almost*.
[14] One possibility sort-of along the lines of Kadmon and Landman(1993) is to retain the idea that the negative polarity items in question are existential but to allow that the domains of these quantifiers are universally quantified from the outside. This would seem to be more in keeping with the arguments in section 3 and would do a better job with licensers like *few* and *rarely*.

7.2. Modals in comparative *than* clauses.

An interesting and puzzling aspect of this story is the use of modals. As von Stechow (1984) observed, when *can* appears in a *than* clause it triggers a kind of maximal reading. *Jack ran faster than Jill can run* requires Jack's speed to have exceeded the **highest** speed attainable by Jill. One finds the reverse phenomenon with necessity modals. *Jack ran faster than he had to, to catch the rabbit* only requires Jack's speed to have exceeded the **minimal** rabbit catching speed. Compare these intuitions to what one gets when one attempts a possible worlds paraphrase of these modals:

(104) *can* paraphrased
Jack ran faster than Jill ran in some possible world compatible with her abilities.

(105) *had to* paraphrased
Jack ran faster than he did in every possible world where he caught the rabbit.

Contrary to the paraphrases in (104) and (105), the intuition is that *can* under comparative *than* acts like a universal over worlds while *had to* acts like an existential. A reason to think this might have something to do with negative polarity is that *can* and *have to* are among the modals that when juxtaposed to a negation take (semantic) scope under it. If we look at modals that display the opposite behavior the intuitions switch. Compare the following sentences and their possible worlds paraphrases, which now seem to work:

(106) a. Jack ran faster than Jill might have.
b. Jack ran faster than Jill did in **some** possible world compatible with what I know.

(107) a. Jack ran faster than he should have.
b. Jack ran faster in the actual world than he did in every world in which he did what the law requires.

7.3. Vagueness

The presence of vagueness crops immediately with the necessary condition on comparatives (60) introduced at the beginning of section 6 (page 16). The effects are probably there for all choices of differential, but it will suffice to illustrate them for the case of SOME. (60) instantiated with SOME gives us:

(108) $\exists I\ \exists K$ [Mn(I) & Sub(K) & SOME(I-K)]

As noted earlier differentials are mass quantifiers and it is no surprise therefore that they bring with them the context dependence and vagueness of these quantifiers. The context dependence of *some* can be seen in the following examples:

(109) There is some wood in your eye.
(110) There is some wood in your truck.

What counts as 'some' in a context in which (109) is uttered would be far less than the amount that would count as 'some' in context like (110). The vagueness of these quantifiers can be seen by staying within one context, say the one in (110). There are clearly small amounts of wood that would not make (110) true, there are large amounts that would make it true and there are still other amounts that one may not be able to decide about. The same goes for the other differentials and for other scalar predicates.

According to (108) these properties should project to the comparative. And indeed, given two pieces of rope for instance, we may very well judge:

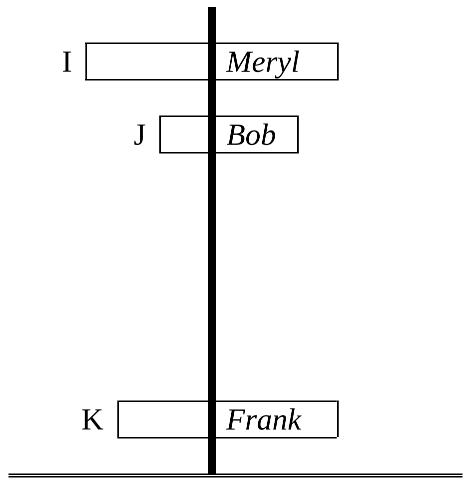
(111) This rope is longer than that one is.

as true in a physics experiment but false in a hardware store. Moreover, within the hardware store there may be pairs of ropes for which we cannot decide once and for all that (111) is true or false.[15]

Now suppose that Meryl is without a doubt richer than Frank is. According to (108) that would mean there is an interval covering Meryl on the wealth scale that is separated from an interval covering Frank by an amount that clearly counts as 'some':

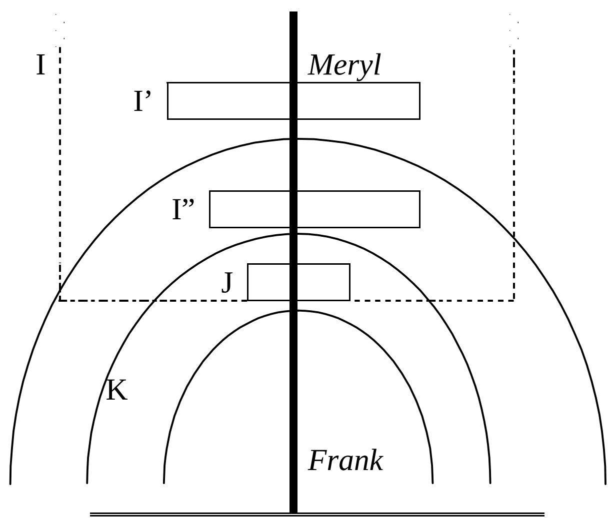
[15] One might argue that there is a qualitative difference between the vagueness and context dependence seen here in (109)-(111) and the type exhibited by simple adjectives like *long*. When we announce that this rope is not longer than that rope, we might be aware that if were to get out our microscopes our decision would change. After so doing, we would say, in fact it actually is longer, that is, if we didn't mind being laughed out of the hardware store. On the other hand, if we say that that rope is not long, we don't have the feeling that it actually might turn out to be long if really checked carefully. Perhaps this is the basis for the view that the comparative is a vagueness eradicator, at least as far as unidimensional adjectives are concerned (McConnell-Ginet1973, Kamp 1975, Klein 1980). In light of the discussion of (109)-(111), eradication seems like overkill.

(112)



Let us also suppose that it would be hard to judge whether Meryl is richer than Bob. In (112) then [I-K] is a clear case of 'some' but [I-J] is not. But now we return to the full-blown analysis of the comparative argued for above. In (113) below we are in the midst of showing that *Meryl is richer than Frank is* is clearly true.

(113)



For each of the little subintervals of I, we've checked the maximal subintervals below them (indicated with a parabola) to verify that it covers Frank. Eventually we will include all of I up to the top of the scale (if there is one) and we will cover Meryl. But wait a minute. Focus on any of the subintervals, say I". To include that in I we need to build up K. In doing that we added up **every** interval that was some distance below I". What about J does that get included in K or not? Suppose its distance from I" is the same as [I-J] in figure (112). That distance was neither truly "some" nor truly not "some" and this indeterminacy, we claimed, projected to the comparative accounting for our indecision regarding *Meryl is richer than Bob is*. If we did the same here we would predict that *Meryl is richer than Frank is* is also indeterminate and in fact all comparatives should lack truth-values!

This problem seems amenable to a supervaluation approach[16]. We should judge the comparative true, if it is true with respect to any sharpening of the vagueness, false if false with respect to all sharpenings and otherwise indeterminate. Given the starting point for the discussion of Meryl, Bob and Frank, no matter what we decide about [I"-J], *Meryl is richer than Frank is* will come out true. On the other hand, different sharpenings of SOME will matter in the case of *Meryl is richer than Bob is* so that is indeterminate. It remains to be seen whether supervaluation gives the right results in all cases, especially where the differential includes a hedge (e.g. *nearly 1 in taller, roughly 1 mph faster*).

7.4. Equatives and Numerals

It is commonplace to treat equatives alongside comparatives. The purpose of this section is to sketch an analysis of the equative and of numerals that does justice to similarities as well as differences with the comparative.

The semantics of comparatives proposed here relies crucially on the meaning of the particular differential that has been chosen. Equatives, though syntactically similar to comparatives in English, do not allow for differentials.

(114) #He is 2 in. as short as his brother was.
(115) #He isn't that much as short as his brother was.

Moreover, as Klein(1991:676-677) points out, cross-linguistically these two constructions are fairly sharply distinguished. Besides syntactic distinctions in various languages, Klein, citing Ultan(1972), notes that comparative and superlative markers are similar to each other and generally dissimilar to equative markers. Suppletive paradigms join comparatives with superlatives distinguishing both from the equative and the positive: *better ~ best* versus *good ~ as good*. It is plausible then that the correct analysis of equatives would not parallel that of the comparative too closely.

Equatives came up in our initial discussion of intervals in an informal way. It was pointed out that

(116) *Alice is as rich as her mother was.*

will count as true if wealth is measured in dollars but once we start counting pennies, that sentence may count as false. In effect then, we are equating an interval that marks Alice's

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[16] The classic supervaluationist account of vagueness is Fine(1975). See Keefe and Smith (1997) for discussion of the history of this idea (p.25-26) and for other approaches to vagueness. One alternative, the epistemic view, seems particularly relevant to the issues addressed in footnote 15.

wealth with one marking her mother's wealth, taking into consideration the level of detail in the conversation. Using the concept of a ruler as our guide, we associate with a context a partition of the scale into equal sized, contiguous intervals. We will call these intervals "unit degrees". Alice is as rich as her mother is if her unit-degree of richness is equivalent to her mother's. Moving from a fine grained context to a rougher grained one increases the size of the unit-degree intervals and the truth of an equative is preserved[17]. Moving in the opposite direction, however, may lead to reversal of the truth of an equative as we saw with Alice when we started counting pennies. The general idea is that:

(117) for any given context, the equative is true if the unit-degree satisfying the subordinate clause also satisfies the main clause where the context determines what counts as a unit-degree.

According to (117), if an equative is true, there must be a contextually specified unit-degree[18] which satisfies the subordinate clause. Our experience with degree analyses of comparatives tells us we had better check what happens when quantifiers are involved, as in the following examples:

(118) Alice is as rich as everybody else is.
(119) The subject shouted "bird" as quickly as he shouted only one other word.
(120) Seymour was as smart as one of the girls was.

The analysis we have given so far predicts that (118) is true just in case we are in a context where everybody has the same unit-degree of wealth, otherwise no unit-degree will satisfy the embedded clause. This prediction is correct on the "exactly" reading, but not on the "at least" reading (Seuren 1984, Rullmann 1995). This difference is spelled out as:

(121) Alice is exactly as rich as everybody else is.
(122) Alice is at least as rich as everybody else is.

Only (121) intuitively entails that for all intents and purposes, everybody has the same unit-degree of wealth. (122) does not carry this entailment. It could be true in a context where wealth is measured in the number of watermelons a person has and where no two people have the same number of watermelons. It is sufficient that Alice has more than any of the others. One might try to argue that (121) is, in fact, the only reading we get for (118). But even in that case, we still need an analysis of (122) that doesn't commit us to a unique unit-degree that everybody shares. Another problem with our initial proposal in (117) is that it makes reference to **the** unit-degree satisfying the subordinate clause. But (119) could be true even if there are many speeds, s, such that the subject shouted only one word at speed s. And (120) could be true even if there is many IQ's, such that one of the girls is that smart. Clearly, the unit-degree idea might be on the right track, but the implementation in (117) needs immediate revision.

[17] This assumes that new boundaries are not drawn in the process. The picture is one of moving from a ruler where centimeters are indicated to one where meters are the smallest unit indicated.
[18] Here and throughout this section "contextually specified degree" means an interval that counts as a degree in the context. It doesn't mean a degree that is specified to satisfy the relevant requirement being discussed, ie in this case that it satisfies the equative clause.

The use of the modifiers “exactly” and “at least” is reminiscent of discussion of numeral modifiers. There too we find that <u>bare</u> numerals can have readings spelled out with these modifiers. The chart below shows various contexts where these different readings arise both for numerals and for equatives:

Modifier	Numeral	Equative
exactly	(How many children does John have?) He has three children.	(How tall is Bill?) He is as tall as Peter.
at least	You must have 4 dollars to enter.	You must be as strong as Bill to be accepted.
	He ate four cookies, if not more.	He went as far as Billy went, if not further.
at most	You can eat four cookies. (but no more)	You can go as far as Billy went (but not further)

The parallel with numerals suggests a line of analysis that follows the treatment of numerals in Kadmon(1987). Like Kadmon, we want a semantics for the simple equative that can be modified by “exactly” or “at least” and we ultimately need a pragmatic account of how the meanings of these modifiers show up in the bare case. To pursue this line, we should first get straight what the readings are for the modified cases and then go about deciding whether we can successfully extract the modifiers to get a reasonable story for the bare case. Keeping in mind the trouble we had above by assuming uniqueness, we start with the following basic intuition, ignoring “at most” for the moment:

(123)

Alice is exactly as rich as Bill is. IS TRUE IF there is some wealth interval that covers Bill that also covers Alice and that interval is a contextually specified unit-degree.

Alice is at least as rich as Bill is. IS TRUE IF there is some wealth interval I_{Bill} that covers Bill and there is some wealth interval I_{Alice} that covers Alice, and $\forall K[K \sqsubseteq I_{Bill} \rightarrow K - I_{Alice} = 0]$.
and the intersection of I_{Bill} and I_{Alice} is a contextually specified unit-degree.

(it follows that “exactly” entails “at-least” but not vice-versa)

The truth conditions for the equative that are reflected in the intuitions on the right in (123), now make correct predictions for the cases considered. (121) but not (122) requires a unit-degree that covers everybody, meaning that in the relevant context, everybody has the same unit-degree of wealth. And since we have existential truth conditions, (119) and (120) no longer breakdown for lack of uniqueness. On the “exactly” reading of (119) for example, we require some unit-degree of speed with which the subject shouted “bird” and with which he shouted one other word. This allows that he shouted many words, with different unit-degrees of alacrity.

Next, we attempt to extract the modifiers from the equatives. In the following sketch we make similar assumptions (or non-assumptions) about the syntax-semantics of equatives that we made with comparatives (eg. “subordinate clause” means the clause under *as* and the equative is interpreted without the higher adjective- though see the brief remarks at the end of section **6**.). The interpretation of the bare equative is as follows:

(124) *as-as-S* denotes the following set of intervals
{I: ∃J, J satisfies S, the intersection of J and I is a contextually specified unit-degree and it includes a bound for I.}

Now we outline the action of the relevant modifiers when they apply to an expression denoting a set of intervals like the one defined in (124):

(125) *exactly*: limits the set to contextually specified unit-degrees.
(126) *at-least*: limits the set to intervals with no upper bound.
(127) *at most*: limits the set to intervals which contain the zero point of the scale.

The rule for *at least* assumes scales that are not upwardly bounded. If the scale is in fact finite, then we need to say:

(128) *at-least*: limits the set to intervals which contain the top most point.

The figures in (129)below illustrate how things are meant to work:

(129)

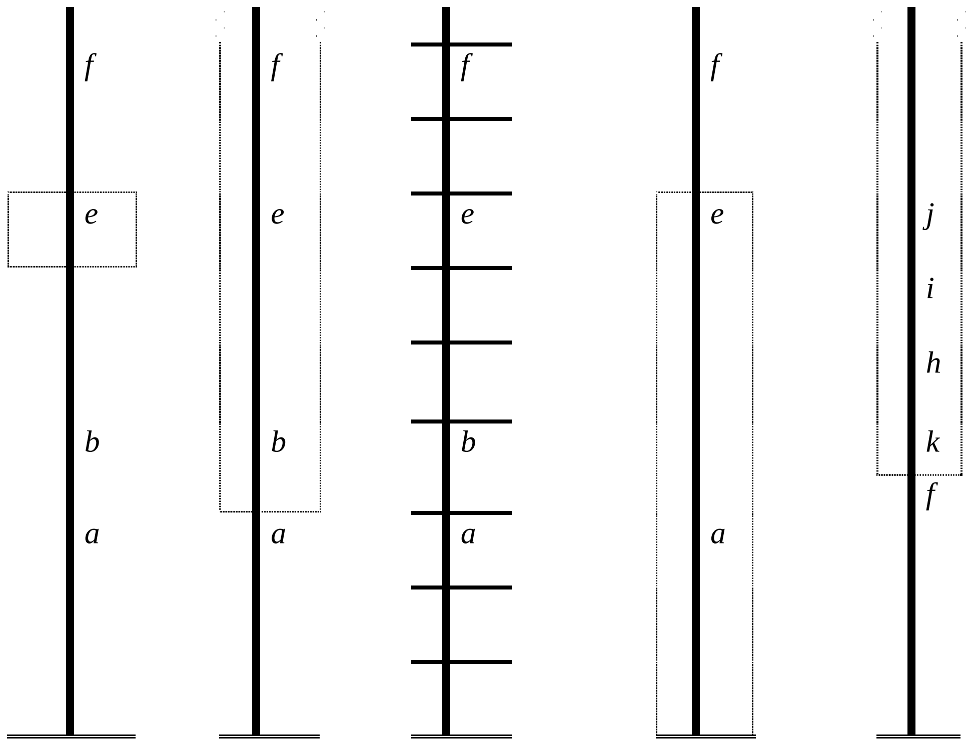

Fig. 6 | Fig 7 | Fig 8 | Fig 9 | Fig10

exactly as tall as e is

at least as tall as b is

CONTEXTUALLY SPECIFIED UNIT DEGREES

at most as tall as is

#at least as tall as k is.

The unit degrees are indicated in the middle in Fig 8. In figures 6,7 and 9, we have indicated an interval in the set denoted by the expressions in italics below. Note that since the subordinate clause contains no quantifiers, there is just one such interval in each case. Finally, the interval in figure 10 does not fit the specifications. Call the interval depicted in figure 10, I. There is no interval J such that I ∩ J is a contextually specified degree AND I ∩ J contains a bound for I. To make things right, the interval must extend down to include *f*. This corresponds to the fact that in this context, anyone who is at least as tall as k is at least as tall as f and vice-versa.

We now assume that the grammar conspires to make it true that x is Ω-tall, where Ω denotes a set intervals, just in case **there is an I** in Ω and x is I-tall. In other words, we need to assume that somehow an existential comes in from the outside, applying to all equatives after modification. Kadmon faced a similar challenge in her account of the numerals, but in her case she needed no explanation because she worked in a DRT framework where the idea of external existential quantification is central.

It should be noted that the bare equative is analyzed here in such a way that it says next to nothing. To be as tall as Jane, for example, is just to be covered by some interval on the height scale that has a unit-degree-overlap with an interval covering Jane. This would be true for any heighted person. This is pretty much the right outcome, if we truly believe that the bare equative is somehow vague or ambiguous between an at-least, an exactly and an at-most reading. As on Kadmon's account, we should like eventually to have a pragmatic story explaining how we routinely rescue this gross violation of the Maxim of Quantity.

While paralleling an account of numerals, the story told here is about scalar intervals. As such it still looks quite different from accounts of numerals, unless we adopt a view like that of Nerbonne (1995) where numerals are understood as relating to points on a scale. The intuition very roughly would be that a predicate like 4-boys would be true of x if x is an object that is at the "4-portion" of the boy scale. We might modify things in such a way that 4 denotes a set of intervals around a certain point with the modifiers working roughly as defined in (125)-(127).

Hopefully, this sketch makes plain how equatives are like comparatives and how they differ. The differences can be appreciated by considering the two sentences below which are truth conditionally equivalent, however, if we are right, the procedure for arriving at those truth conditions is very different:

(130) Quentin is no taller than Hank is.
(131) Hank is at least as tall as Quentin is.

7.5. A Positive Note

Degree analyses of the comparative standardly interpret the positive in terms of the comparative. *John is cold* is true, on that view, if John's temperature is at or above a contextually specified point on the thermometer. This presumes an implausible degree of precision in ordinary conversations. The move to interval semantics allows us to suppose that the context specifies an interval on the thermometer, and conversations could easily differ on the size of such intervals. Degree approaches can't get around this by supposing that what counts as a 'point' is itself context dependent (somewhat along the lines of the contextually specified unit-degrees discussed in section 7.4). For I may say to you that (a) Bill is cold and you might then reply that since (b) Carey is 2 degrees colder than Bill is, it follows that Carey is cold. On a degree analysis, the relevant points have to be standard degrees on a thermometer in order to interpret the comparative in (b). At the same time, neither of us presupposes a thermometric point that is fixed for coldness and which Bill's temperature is taken to exceed. Note further, that within an interval approach, the semantics of the positive need make no reference to the comparative relation, it only needs to require that the contextually specified intervals be topless (or contain the top point). This accords with Klein and McConnel-Ginet's idea that the positive is morphologically simpler in every case than the comparative and so it should not be derived from it.

8. The Interval Perspective

The main thrust of this paper has been that scalar predication requires an interval semantics rather than a semantics based on points. This entails a rethinking of the semantics of scales, so much influenced by the point talk connected with devices of measurement. The main argument has been based on the comparative construction especially where quantifiers are concerned.

The hope is that this change in perspective will lead to better understanding of other related phenomena, as was the case with the shift from moments to intervals in tense semantics. Examples that might yield to an interval analysis include expressions such as *the 20-40 range*, *the upper part of the 30th percentile* and *Bill's approximate height*. Another promising candidate is **interval definites,** examples of which appear below:

(132) The distance between the computer and most of the heaters is less than 2 feet.
(133) The distance between the clock and either of the sockets is more than 40 ft.
(134) He can write a paper in the time it takes to go from Pittsburgh to any city in Europe.

The definite descriptions in these cases do not refer to specific distances or times in the traditional sense. Interval definites share properties with the comparatives studied here. First of all, they give the appearance of having readings in which quantifiers are assigned abnormally wide scope[19]. Compare (132) to the example below where intervals are not involved:

(135) The chair between the computer and most of the heaters is made of wood.

most of the heaters cannot take scope outside the definite in (135) the way it seems to in (132). And like comparatives, interval definites allow negative polarity items like *either* and *any*.[20, 21]

The analogy with tense suggests a number of questions. We briefly consider two of them. First, are there temporal constructions that 'scan' parts of the time line like the comparative? A probable candidate for such a parallel would be the semantics of *before*, which again show many of the characteristics of the comparative *than* clauses including quantifier scope interactions (e.g. *before exactly 4 soldiers died*) and negative polarity licensing (recently discussed in Landman 1991:140-145, Ogihara 1995). The use of differentials is particularly telling. If one says that Jack wrote the book before he committed the murder, we understand the book writing event to precede the murder. However, if one says that he wrote the book 10 minutes before he committed the murder,

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[19] It may be the case that to get this reading you need to stress the quantifiers (*most, either, any*).

[20] Interval definites might be a subspecies of amount relatives (Carlson 1977). Amount relatives include cases like *the chairs that there were in the house* where the head noun *chair* does not come from the realm of measurement.

[21] Interval relatives seem to resist negative quantifiers and 'negative' verbs:

(1) #The distance between the clock and none of the sockets is more than 40 ft.
(2) We can eat lunch in the time Bill said/*denied it takes to reconnect the mainframe.

as do comparative *than* clauses (Lees1961).

we don't simply understand the writing event to precede the murder by 10 minutes. We understand that every part of the writing preceded the murder by 10 minutes, roughly speaking, making for a very short book! As with the comparative, the differential *10 minutes* measures distances between all relevant subintervals.

Going the other way, a question that arises from the parallel with tense is whether there are individuals that are unrelated to any points. In the case of tense, one of the early arguments for interval semantics (Bennett 1977, Bennett & Partee 1972) was the use of accomplishment predicates such as *build a house*. Events of house building normally take place over extended intervals. There usually just is no moment of time that can be called the time of the building. What would be a comparable situation on a scale, say of height? If an individual x is p-tall, where p is a point, then the following holds within the domain of heighted objects:

(136) ∀y[y is taller than x or y is as tall as x or x is taller than y]

This is parallel to an event taking place at a moment: any other event is either before, after or cotemporal with it. This is exactly what is not the case with your average house building. So we are looking for some individual and scalar predicate P where the following holds:

(137) ~∀y[y is more P than x or y is as P as x or x is more P than y]

or equivalently:

(138) ∃y[y is not more P than x and y is not as P as x and x is not more P than y]

Consider a room whose temperature ranges from 68° to 75° depending where you stand. This cup of hot tea is hotter than the room and the room is hotter than the cool glass of water sitting beside the tea. But what do we say about the cookie whose temperature is 70°? It is neither as hot, nor hotter than nor less hot than the room. The room is covered solely by irreducible intervals on the temperature scale and the cookie 'lies in the middle of it'. Of course there are recognizable parts of the room that do correspond to points on the scale, but that is not different from the house building which likely has recognizable moment sized subevents. Here's another example from a different realm. Jill likes to swim and wants to live near the ocean. She thought of living in the lighthouse, which sits right above the beach, but that was taken. She considered living with Bill's mother, but that is very far from the coast. So she needs to decide between two counties, Monmouth and Ocean, both of which are near the coastline. She asks Jack whether Monmouth and Ocean are equally close to the shore. He answers that it depends where, parts of Monmouth are pretty close to the shore and parts are far from it and likewise for Ocean County. Well, which one is closer, Jill persists? Neither, he replies, it depends where in Monmouth and where in Ocean. If Jill were to ask how close Ocean County is from the shore, her question could not be answered with a point or near-point denoting expression such as *5 miles*. One could however make use of an interval denoting expression: it is clos*er* to the shore *than where Bill's mother lives*.

Putting these last observations together with our earlier results, a picture emerges in which intervals play a robust role in our understanding of scalar predication. We have individuals that are minimally covered by chunk sized intervals of the scale, expressions that denote intervals of the scale and we have seen some use of quantification over intervals.

Bennett and Partee (1972) point to another property of intervals relevant to tense semantics and that is their part-whole structure. The verbs *begin* and *finish* serve to locate an event e in terms of a temporal relation e bears to a larger (potential) event E. In the case of *begin,* e occurs in the initial part of the interval in which E occurs. In the case of *finish*, e occurs in the final part of the interval in which E occurs. A parallel diagnosis seems plausible for the superlative. Suppose I is the smallest interval on the fluffiness scale that covers the ducks. Then the fluffiest duck is covered by a final subinterval of I and the least fluffy duck is covered by an initial subinterval of I.

Finally, in (79), at the end of section 6, we made use of discontinuous (ie non-convex) intervals. One might suppose that in tense semantics we only encounter convex intervals, so that this would be where tense and scalar semantics part ways. This suspicion is dispelled by a Bennett and Partee's (1972) discussion of the semantics of *resume*. *John resumes building a house* is true at I_1 just in case *John build a house* is true ($I_0 \cup I_1$) where I_0 is strictly before I_1. This allows a significant gap between I_0 and I_1. A relevant intuition is that the same house has to be under construction at I_0 as at I_1, hence the need to refer to a non-convex interval.

9. Conclusion

Scalar predicates relate individuals to parts of a scale. The discovery that it is intervals which form the basis for this relation paves the way for understanding this as a relation that is monotonic with respect to the part-of ordering. Monotonicity is key in the analysis of expressions in which individual quantifiers and scalar predicates are mixed. Once this much is in place, we gain a new perspective on other aspects of scalar predication and a bridge is thrown up between the semantics of tense and the semantics of scalar predicates.

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