Percentages, relational degrees, and degree constructions[*]

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Abstract Comparatives and equatives are usually assumed to differ only in that comparatives require that one degree be greater than another, while equatives require that it be at least as great. Unexpectedly, though, the interpretation of percentage measure phrases differs fundamentally between the constructions. This curious asymmetry is, we suggest, revealing. It demonstrates that comparatives and equatives are not as similar as one might have thought. We propose an analysis of these facts in which the interpretation of percentage phrases follows straightforwardly from standard assumptions enriched with two additional ones: that percentage phrases denote 'relational degrees' (type $\langle d, d \rangle$) and that the equative morpheme is uninterpreted.

1   Introduction

It's both natural and typical to suppose that comparatives and equatives are closely related. The simplest assumption is that they differ in only one respect: the degree relation. A comparative requires that one degree be greater than another, whereas an equative requires only that one degree is at least as great as another. This predicts that they should behave similarly in a variety of contexts, as indeed they do. It predicts that, in particular, they should behave similarly in the presence of a differential measure phrase (e.g. *six inches taller*). With most measure phrases, they do. But a curious—and, we will argue, revealing—asymmetry arises when the measure phrase expresses a percentage. In comparatives, it is interpreted like a differential. In equatives, it is interpreted multiplicatively.

The explanation we will pursue involves a relatively standard analysis of comparatives, but an unusual one for equatives. We'll propose leaving the equative morpheme itself uninterpreted and taking percentage phrases to denote functions from degrees to degrees. From this alone will follow standard truth-conditions

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for the equative and the asymmetry in percentage interpretation. All the pieces fit compositionally without further assumptions—but crucially, only on the older and more popular of two competing approaches to structure of degree constructions. We take this as an argument for that approach, in which DegPs denote generalized degree quantifiers (Chomsky 1965; Bresnan 1973; Heim 2000; Bhatt & Pancheva 2004 among others). It may also have consequences for the broader and relatively ill-understood puzzle of how factor phrases (as in *three times taller*) work.

We further articulate the puzzle in section 2. In section 3 we'll take the first step toward a solution, namely, recognizing the relevance of what we'll call relational degrees. Section 4 applies the idea to comparatives, showing how the correct readings are predicted on orthodox assumptions without any further stipulations. Section 5, on equatives, is where things get more interesting. There we make the small but radical departure from standard assumptions of leaving the equative morpheme itself uninterpreted, which yields the correct readings for equatives. In section 6 we explore the percentage facts relate to the broader puzzle of how multiplicative expressions work in natural language more generally. Section 7 concludes.

2   The puzzle

A typical (though by no means universal; see, among others, Schwarzschild & Wilkinson 2002; Rett 2013 and Anderson & Morzycki 2015 for differing viewpoints) approach to the semantics of comparatives and equatives is that they're very similar, differing only in whether the degree relation is reflexive. Here's a fairly standard version, from Kennedy & McNally 2005, in which adjectives are taken (standardly) to denote relations between degrees and individuals:

(1)   a. $[\![er/more\ than\ d_C]\!] = \lambda G_{\langle d,et \rangle} \lambda x\ .\ \exists d[d > d_C \wedge G(d)(x)]$

      b. $[\![as\ as\ d_C]\!] = \lambda G_{\langle d,et \rangle} \lambda x\ .\ \exists d[d \geq d_C \wedge G(d)(x)]$

These denotations assume that complement of the degree word—the *than* phrase in comparatives and the phrase headed by the second *as* inmcc equatives—denotes a degree, d_C above.

However, an unexpected asymmetry of interpretation arises when these morphemes combine with a percentage phrase:

(2)   a. That Accord is 30% more expensive than that Civic.   *(price is 130%)*

      b. That Accord is 30% as expensive as that Civic.   *(price is 30%)*

(3)   a. Floyd is 60% taller than Clyde.   *(Floyd is 160% of Clyde's height)*

      b. Floyd is 60% as tall as Clyde.   *(Floyd is 60% of Clyde's height)*

In the comparative cases, the first compared individual is claimed to be greater in degree than the second. In the equative cases, though, it's actually claimed to be lesser. This is surprising, inasmuch as this is literally the only logical possibility ruled out by the $\geq$ relation that equatives allegedly express. The asymmetry persists even when the percentages go above 100%, as seen in (4). Even though Floyd is claimed to be taller than Clyde in the equative cases, the degree to which he's taller is still lower than in the comparative case:

(4) a. Floyd is 200% taller than Clyde.   *(Floyd is 300% of Clyde's height)*
     b. Floyd is 200% as tall as Clyde.   *(Floyd is 200% of Clyde's height)*

We will refer subsequently to this phenomenon as the INTERPRETATION ASYMMETRY.

This is not the only asymmetry to be found here. There's also a more subtle one having to do with the structure of the measure phrase itself. One way to refer to a degree on a particular scale is to supply a percentage phrase with an *of* complement.[1] Thus although *60%* refers to a percentage and not, say, a degree of height, *60% of six feet* or *60% of Clyde's height* do refer to degrees of height. And of course, expressions that refer to degrees of height can occur as measure phrases with adjectives that measure on the relevant scale. So alongside *two feet taller than Clyde*, we expect to find expressions like (5):

(5) ?Floyd is 60% of Clyde's height taller than Clyde.

The *of*-phrase would normally be absent, of course, and (5) is unwieldy. That's to be expected, perhaps, because (5) runs afoul of pragmatic and parsing considerations. It's needlessly verbose, which offends the pragmatics, and it's needlessly center-embedded, which offends the parser. But crucially, (6) is emphatically unacceptable, and the contrast between the two is clear:

(6) *Floyd is 60% of Clyde's height as tall as Clyde.

We will call this contrast the OVERT COMPLEMENT ASYMMETRY.

There's a third, more general asymmetry. Multiplicative measure phrases can combine with equatives, but differential ones—that is, ordinary, non-multiplicative ones—cannot:

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1 Using the term 'complement' presupposes a syntactic analysis, one we'll adopt primarily for terminological convenience.

(7) a. Floyd is $\left\{ \begin{array}{l} 60\% \\ \text{twice} \\ \text{three times} \end{array} \right\}$ as tall as Clyde.

   b. *Floyd is 6 feet as tall as Clyde.

In fact, even multiplicatives in a *by*-phrase cannot combine with an equative:

(8) a. *Floyd is as tall as Clyde by 60%.

   b. Floyd is taller than Clyde by 60%.

The meaning of (8a) should be precisely the same as that of (7a), but nevertheless this is crashingly bad. We'll have nothing to say about the contrast between (7a) and (8a). But at a minimum, it's clear that the equative cannot combine with any type of differential phrase. We will call this the EQUATIVE MEASURE PHRASE BAN.

   The task before us, then, is to supply an analysis that will account for these three generalizations—the Interpretation Asymmetry, the Overt Complement Asymmetry, and the Equative Measure Phrase Ban.

3 Relational degrees

So then why are multiplicative measure phrases in equatives like (7a) allowed? Clearly, they must be different in some way from differential measure phrases.

   To probe the difference, it will help to momentarily shift our attention to uses of percentage phrases outside of degree constructions. These can occur with the *of*-degree complements briefly mentioned above, as in (9):

(9) a. Floyd's height is 80% of Clyde's height.

   b. 80% of 200 is 160.

The full percentage phrases in (9)—*80% of Clyde's height* and *80% of 200*—are in the place where we would normally expect a degree-denoting expression. One indication of that is that both of the sentences in (9) identify the referent of a percentage phrase with a degree (namely, Floyd's height and 160, respectively).

   Importantly, the *of*-complements also contain expressions that denote degrees (namely, Clyde's height and 200). That suggests that a bare percentage like *80%* map degrees on a scale to other degrees on the same scale, making them of type $\langle d,d \rangle$.[2]

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2 We're restricting ourselves here to the degree use; we make no claims about other uses, such as *28% of Americans say chocolate is one of their favorite ice cream flavors*. One might suspect these of mapping individuals to individuals, which in turn may suggest the need for some type flexibility.

We're going to call this a RELATIONAL DEGREE. The term isn't ideal because, crucially, we're not proposing that bare percentages denote relations between degrees. The analytical intuition behind the term is rather that they express something like a degree, but not an ordinary one. They are, after all, ways of describing one degree in terms of another degree. Like ordinary degrees, percentages are ordered, they form a scale, they can be compared, and they support the calculation of differences. But of course, unlike ordinary degrees, they can be used to characterize other degrees on arbitrary scales. So they are degrees in a more abstract higher-order way, and the type $\langle d,d \rangle$ reflects that. It's suitably more abstract, but still makes available an ordering, a scale, comparison, and calculating differences. And of course it's the type that the syntax points to.

What all this leads to is denotations as in (10):

(10)   a. $[\![\,80\%\,]\!] = \lambda d \,.\, \mathbf{80\%} \times d$

        b. $[\![\,80\%\,]\!]\,([\![\,of\,200\,]\!]) = \mathbf{80\%} \times \mathbf{200}$

It's worth noting that, while relational degrees as we've defined them are novel, the intellectual underpinnings aren't. Sassoon (2010b), for instance, discusses factor phrases such as *twice* in terms of measurement theory in a similar spirit (albeit not with the same $\langle d,d \rangle$ denotations). She notes that when factor phrases are used, it's not that specific units are assigned, but rather that a ratio measurement between the two objects is established. Our approach makes this intuition explicit; a relational degree encodes that invariant ratio relationship. In other words, whatever degree is taken in by the relational degree will be combined with a different degree via multiplication. But crucially, the degree that the relational degree takes in doesn't matter; the output of the relational degree will always be proportional to the input, regardless of the degree used.

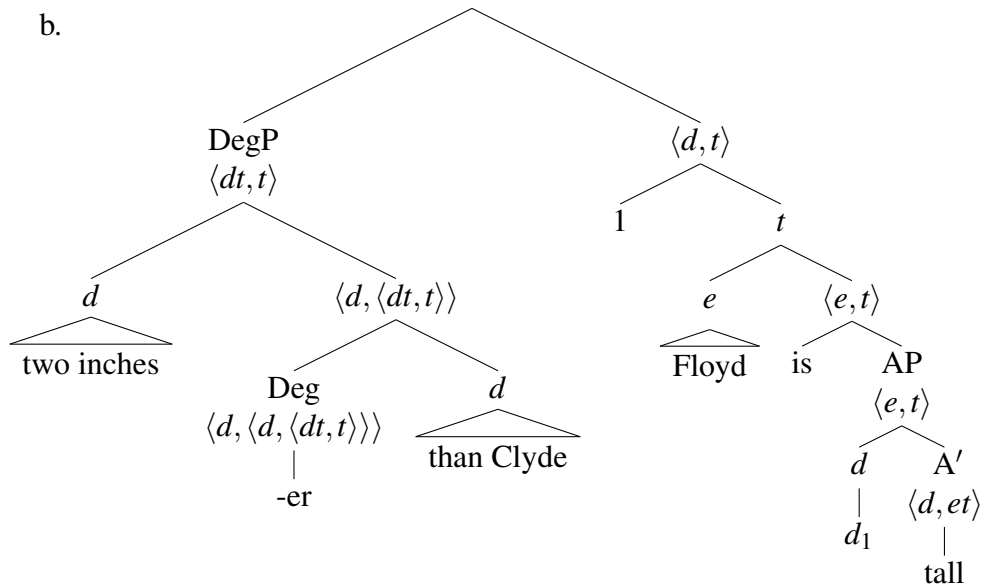## 4   Comparatives

4.1   Ordinary comparatives

With the notion of relational degrees and denotations for percentage expressions in hand, we're in a position to plug these elements into the larger picture of how degree constructions work compositionally.

First, some background assumptions about comparatives. We will adopt a 'small DegP' structure in which the specifier of AP is occupied by a DegP that excludes the adjective itself (Chomsky 1965; Bresnan 1973; Heim 2000; Bhatt & Pancheva 2004 among others) and denotes a generalized quantifier over degrees (type $\langle dt,t \rangle$). This assumption isn't innocent. Indeed, it will prove crucial.

Standardly, we will assume that a differential comparative such as (11a) involves an underlying structure in which the DegP *two inches -er than Clyde* is generated in the specifier of the AP headed by *tall*. Because it denotes a generalized quantifier over degrees, it would bring about a type clash if it were interpreted in situ, so it must QR and leave behind a degree-denoting trace (written here d_1), thereby resolving the type clash:

(11)   a. Floyd is two inches taller than Clyde.

   b.

DegP $\langle dt,t \rangle$

d — two inches

$\langle d, \langle dt,t \rangle \rangle$

Deg $\langle d, \langle d, \langle dt,t \rangle \rangle \rangle$ | -er

d — than Clyde

$\langle d,t \rangle$

1   t

e — Floyd   is

$\langle e,t \rangle$ AP $\langle e,t \rangle$

d | d_1

A$'$ $\langle d,et \rangle$ | tall

For convenience, we treat *than Clyde* as an elided form of *than Clyde is tall* (Hankamer 1973; Bresnan 1973) and take it, standardly, to denote the degree to which Clyde is tall. (Note that this is probably not actually the right analysis of phrasal comparatives, at least in many languages (Lechner 1999; Heim 1985; Merchant 2009; Xiang 2005; Bhatt & Takahashi 2007, 2011).) A further notational convenience: we will write the degree this phrase denotes as simply $d_{\mathbf{Clyde}}$.

The differential comparative morpheme *-er* collects up this degree and the degree expressed by the differential measure phrase *two inches*, sums them, and requires that the result be no smaller than the maximum degree in the set of degrees created by abstracting over the trace position, which in this case is the set of Clyde's degrees of tallness:

(12)   a. $[\![\text{-}er]\!] = \lambda d \lambda d' \lambda D \,.\, \mathbf{max}(D) \geq d + d'$

   b. $[\![\text{-}er]\!] ([\![\textit{than Clyde}]\!])([\![\textit{2in}]\!])([\![\textit{1 Floyd is } d_1 \textit{ tall}]\!])$

   $= \mathbf{max}([\![\textit{1 Floyd is } d_1 \textit{ tall}]\!]) \geq d_{\mathbf{Clyde}} + \mathbf{2in}$

   $= \mathbf{max}(\lambda d_1 \,.\, \mathbf{tall}(\mathbf{Floyd}, d_1)) \geq d_{\mathbf{Clyde}} + \mathbf{2in}$

Simple comparatives with no overt differential measure phrase won't play an important role here, but to accommodate them it suffices to assume that they they have an unpronounced measure phrase denoting some nonzero degree (Schwarzschild & Wilkinson 2002). Alternatively, one could assume a distinct non-differential comparative morpheme alongside the differential one that simply lacks the differential argument position.

4.2 Percentage Differential Comparatives

The interesting case for current purposes, though, is percentage differentials as in (13):

(13)   Floyd is 10% taller than Clyde.

The only novel element here is the percentage phrase. Following the discussion in section 3, we assume that, in general, expressions like *10%* denote relational degrees, functions from degrees to degrees:

(14) $[\![\,10\%\,]\!] = \lambda d \,.\, \mathbf{10\%} \times d$

The first argument is often provided by an overt *of* PP, as in (15a), yielding interpretations like (15b):

(15)   a. 10% of Clyde's height is 7 inches.
        b. $10\% \times d_{\mathbf{Clyde}} = \mathbf{7in}$

Of course, the *of* PP is often phonologically unexpressed and provided anaphorically. We'll represent this by striking out material, although we needn't commit ourselves to the claim that this is a syntactic ellipsis process:

(16)   The height of the top hat needs to be about 10% of Clyde's total height. 10% ~~of Clyde's height~~ is 7 inches.

Because the first argument is present, though implicit, the second occurrence of *10% ~~of Clyde's height~~* in (16) denotes an ordinary, non-relational degree.

That, we'd like to suggest, is what also happens in percentage differentials in comparatives. The differential measure phrase position in comparatives must contain a degree-denoting expression to fit in type-theoretically. A bare percentage phrase denotes (by hypothesis) a relational degree, type $\langle d, d \rangle$, so it couldn't be interpreted there. But it is necessary to assume on independent grounds, as in (16), that the argument of a bare percentage can be left unexpressed. This alone ensures that a

percentage phrase should be interpretable in that position, and that it should receive a differential interpretation. The structure, then, would look like this:

(17)   a. Floyd is 10% ~~of Clyde's height~~ taller than Clyde.
       b.
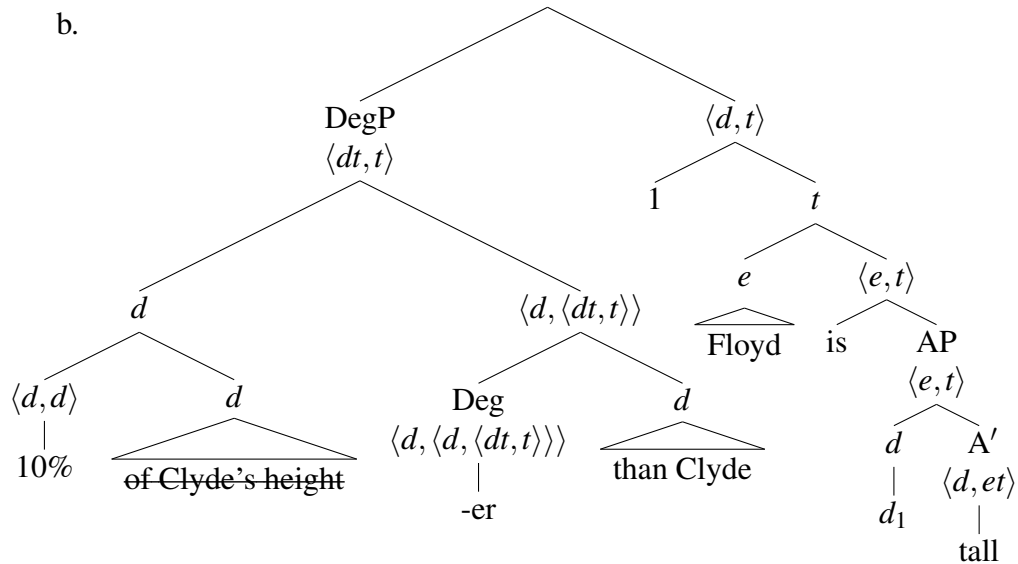
The denotation will be mostly as in the ordinary differential case:

(18)   a. $[\![\text{-}er]\!] = \lambda d \lambda d' \lambda D \, . \, \mathbf{max}(D) \geq d + d'$

   b. $[\![\textit{10\%}]\!] \, ([\![\textit{of Clyde's height}]\!]) = \mathbf{10\%} \times d_{\mathbf{Clyde}}$

   c. $[\![\text{-}er]\!] \, ([\![\textit{than Clyde}]\!]) \, ([\![\textit{10\% of Clyde's height}]\!]) \left(\left[\!\!\left[\begin{smallmatrix} \textit{1 Floyd is} \\ d_1 \textit{ tall} \end{smallmatrix} \right]\!\!\right] \right)$

   $= \mathbf{max} \, ([\![\textit{1 Floyd is } d_1 \textit{ tall}]\!]) \geq [\![\textit{than Clyde}]\!] + \mathbf{10\%} \times d_{\mathbf{Clyde}}$

   $= \mathbf{max}(\lambda d_1 \, . \, \mathbf{tall}(\mathbf{Floyd}, d_1)) \geq d_{\mathbf{Clyde}} + \mathbf{10\%} \times d_{\mathbf{Clyde}}$

Thus the height Floyd must now meet or exceed is that of Clyde plus another 10% of Clyde's height on top of that. Crucially, the result here is a differential(/additive) interpretation, not a multiplicative one—which accords with the Interpretation Asymmetry.

One might imagine similar analyses for e.g. *10% too tall*, and for any degree construction that can host a differential measure phrase. But, as we've observed, equatives are different with respect to this, in a way that merits explanation. That's the puzzle to which we will now turn.

5 Equatives

5.1 Ordinary equatives

The natural move here would be to treat equatives the same way as the comparative: to QR the degree quantifier using a denotation for the equative degree morpheme as_{Deg} that's similar to *-er*, à la (19):

(19) $[\![as_{Deg}]\!] = \lambda d \lambda D . \mathbf{max}(D) \geq d$

One of the arguments for doing this with the comparative is to address scope ambiguities, as in (20):

(20)   The paper is required to be less long than that.

This sentence has two readings. On the first, you can't go above some paper length (say, ten pages) because the requirements state that that's the maximum length. The other reading says that the minimum length is something you've exceeded, so you've met the minimum requirements. These readings can be distinguished by adding, "so you're OK/not OK":

(21)   a. The paper is required to be less long than that, so you're OK.
                           (paper doesn't need to be as long as that, but it can be)
       b. The paper is required to be less long than that, so you're not OK.
                           (paper required to be shorter)

Heim (2000) mentions that you can get a similar effect with the equative when you use *exactly*:

(22)   The paper is required to be exactly as long as that.

But we're unconvinced that (22) has two readings, at least in the way that (20) does. It's not clear what the two readings would be, and the "OK/not OK" test from (21) doesn't help, as it simply addresses whether a goal was met, independent of any scopal properties. Unfortunately, Heim doesn't provide an example of the ambiguity with an equative.

  Here we come to the other analytical innovation we'd like to propose, beyond percentages as relational degrees. In general, the same reading for equatives that (19) provides can be obtained simply by leaving as_{Deg} uninterpreted. Instead of providing the $\geq$ degree relation explicitly in the denotation of the equative degree morpheme, it can arise naturally in precisely the same way as with ordinary measure phrases such as (23a):

(23)   a. You must be $\left\{ \begin{array}{l} \text{47 inches tall} \\ \text{this tall} \end{array} \right\}$ to ride the rollercoaster.

   b. You must be as tall as this line to ride the rollercoaster.

Under normal circumstances, (23a) receives an 'at least' interpretation, and all heights from 47 inches up satisfy the requirement, even though there is no equative morpheme in sight.[3] That (23b) gets a similar reading falls out from the standard move of treating the second *as* phrase as ultimately of type *d*.

   In both cases, the denotation needn't include an explicit $\geq$ degree relation because it's built into the structure of scales. Anyone whose maximal height is greater than five feet also has a height of five feet, and this fact is sufficient to ensure that a semantics that requires Floyd to have a height of five feet will still be satisfied if his maximal height is greater.

   So if we leave as_{Deg} uninterpreted, our DegP is simply of type *d* and there's consequently no need to QR, meaning everything can be interpreted *in situ*:

(24)

$$\langle e,t \rangle$$

DegP $\langle d,et \rangle$
d

tall

Deg d
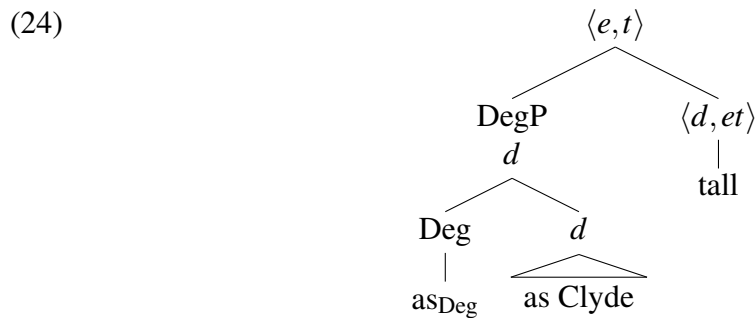
as_{Deg} as Clyde

(25)   a. $[\![as_{Deg} \; as \; Clyde]\!] = [\![as \; Clyde]\!] = d_{\mathbf{Clyde}}$

   b. $[\![tall]\!] ([\![as_{Deg} \; as \; Clyde]\!]) = \lambda x \, . \, \mathbf{tall}(x, d_{\mathbf{Clyde}})$

This is equivalent to a semantics that would deliver (26):

(26) $\lambda x \, . \, \mathbf{max}(\lambda d_1 \, . \, \mathbf{tall}(x, d_1)) \geq d_{\mathbf{Clyde}}$

The *in situ* interpretation we adopt here predicts that equatives should fail to give rise to scope ambiguities.

5.2   Percentage Equatives

All well and good, but what about percentages? Since they're relational degrees of type $\langle d,d \rangle$, they fit neatly into place:

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[3] We hope to sidestep here the vexed broader question of whether the measure phrase itself should be regarded as having an 'at least' or 'exactly' interpretation.

(27)

AP
$\langle e,t \rangle$

DegP
d

$\langle d,et \rangle$

tall

$\langle d,d \rangle$

60%

Deg′
d

Deg

d
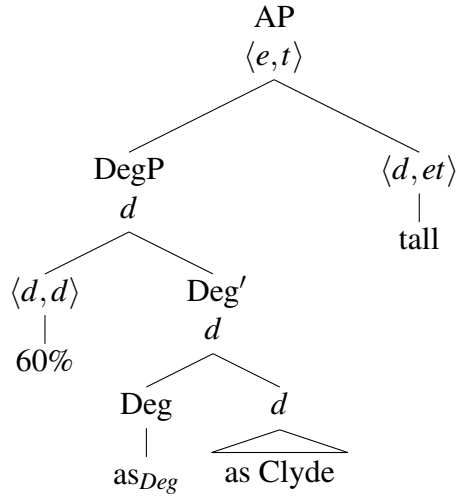
as$_{Deg}$

as Clyde

(28) a. $[\![60\%]\!]\,([\![as_{Deg}\ as\ Clyde]\!]) = \mathbf{60\%} \times d_{\mathbf{Clyde}}$

b. $[\![tall]\!]\,([\![60\%\ as_{Deg}\ as\ Clyde]\!]) = \lambda x\,.\,\mathbf{tall}(x, \mathbf{60\%} \times d_{\mathbf{Clyde}})$

Happily, (28b) works out exactly the way we expect, with x having a height equal to 60% Clyde's height.

Most importantly, this accounts for the three properties of the construction we identified at the start. The Equative Measure Phrase Ban exists because there's simply no place for another object of type d to slot in, and any attempt to do so would immediately lead to a type clash. The ill-formedness of *three feet as tall as Clyde* follows from the impossibility of combining the degree-denoting Deg′ *as_{Deg} as Clyde* with the degree-denoting measure phrase *three feet*.

Similarly, the Overt Complement Asymmetry is the result of no spot existing for our *of*-complement to fit in. So the ill-formedness of *60% of Clyde's height as tall as Clyde* follows from the impossibility of combining the degree-denoting Deg′ with the degree-denoting expression *60% of Clyde's height*.

Finally, the Interpretation Asymmetry is accounted for by having the percentage directly modify the *as* degree phrase, leading to the difference in meaning between the equative and comparative percentage phrases.
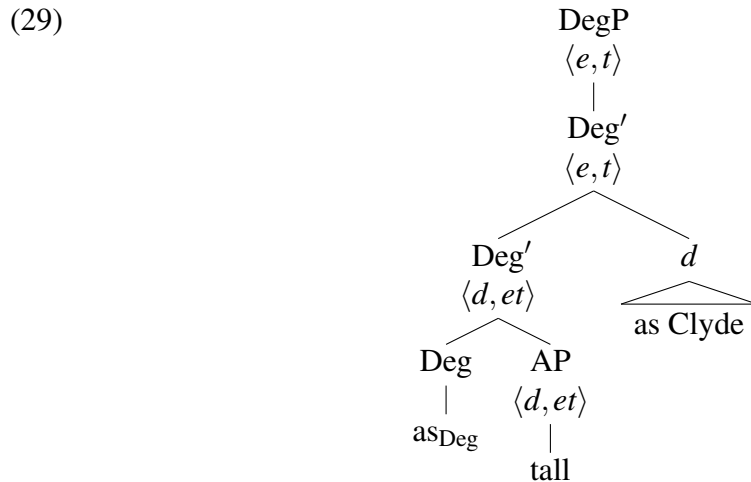
6 Consequences

6.1 The structure of DegP

There is an alternative structure for degree constructions on the market: the big-DegP view, in which DegP is a functional category on top of AP (Abney (1987); Corver (1993); Grimshaw (1991); Kennedy (1997) among others). On this view, no

movement occurs, and the degree morpheme combines with AP before the standard phrase (i.e., the *than-* or *as*-phrase).

Interestingly, the kind of analysis we pursue here can't be implemented straight-forwardly on this approach. The difficulty isn't in leaving the equative morpheme uninterpreted. That possibility plays out very similarly, and all the pieces fall into place:

(29)

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                        DegP
                        ⟨e,t⟩
                          |
                        Deg′
                        ⟨e,t⟩
                      ⎯⎯⎯⎯⎯⎯⎯⎯⎯
                  Deg′              d
                 ⟨d,et⟩         ⎯⎯⎯⎯⎯⎯
                ⎯⎯⎯⎯⎯         as Clyde
             Deg      AP
              |      ⟨d,et⟩
            as_Deg     |
                      tall
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(30) $[\![\, as_{Deg}\ tall\,]\!]\,([\![\, as\ Clyde\,]\!]) = \lambda x\,.\,\mathbf{tall}(x, d_{\mathbf{Clyde}})$

Nor is there any obstacle here to the general idea of relational degrees or to our analysis of the internal structure of percentage phrases. The difficulty comes in integrating these two components. It's not clear how to introduce a bare percentage phrase like *80%* into this tree. The normal position for measure phrases in this approach is the specifier of DegP. But that option isn't available because Deg′ denotes a property of individuals, so it can't combine with a relational degree. One might assume, tenuously, that the percentage phrase occurs somewhere other than a normal measure phrase position, perhaps lower in the tree. But that's of no help type-theoretically. The fundamental challenge is that the percentage phrase, being of type $\langle d,d \rangle$, must combine with the degree-denoting standard phrase *as Clyde*. If it could occur adjoined to it, the semantics would be as it should be—but that's not where the percentage phrase is pronounced, and we know of no syntactic argument that it occurs in that position, and no independently-motivated syntactic process by which it might move leftward over the adjective.

So for that reason, our analysis isn't compatible with the big DegP view, and to the extent that that analysis is convincing, it constitutes an argument in favor of the small DegP view. In one respect, that's a little odd. Perhaps the most important difference between the two approaches is that the small DegP view involves QR

and therefore predicts scope ambiguities and the big DegP view does not. On our proposal, equatives are interpreted without movement, as is standard for all degree constructions on the big DegP view. One might have thought that that point of agreement would point to a deeper synergy. Yet so far as we can see, that's not where the compositional chips fall.

6.2 Factor Phrases

We've demonstrated that an apparently small puzzle regarding percentages leads to some insights about the nature of comparatives and especially equatives. The next natural question is how this relates to multiplicatives in general, such as *three times*. This is a more pressing question than one might think. Some work (including Parsons 1990, Doetjes 1997, Landman 2004, and Gobeski in preparation) has been done on the event-counting version of factor phrases such as *three times*, as in (31):

(31)   Floyd walked the dog three times.

But very little has been done on the multiplicative degree version. Perhaps the most extensive work thus far was done by Bierwisch (1989), who noted that equative modification tended be multiplicative, while comparative modification was additive. Subsequent mentions of factor phrases have either been made largely in passing, as in Rett (2008) and Sassoon (2010a,b), or have focused on a particular factor phrase rather than on the broader picture (as Bochnak 2010 does with *half*, Gobeski 2011 with *twice as tall/*twice taller*, or Kayne 2015 with *twice*). This means that multiplicative factor phrases are something of a neglected area. Our work here is a step toward redressing the balance.

On the face of it, there should be little issue with treating *two times* the same way as a percentage, as (32) illustrates:

(32)   a. Floyd is two times as tall as Clyde.
        b.

733
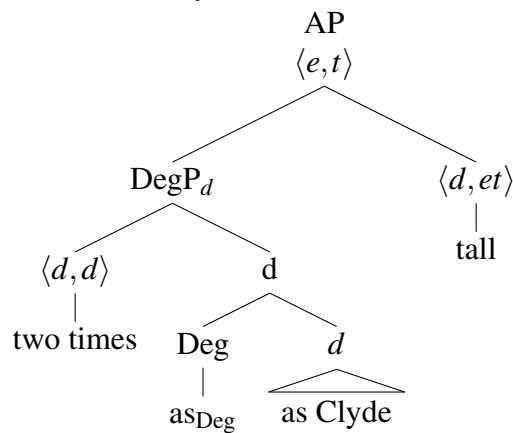
    c. $[\![\,two\ times\,]\!] = \lambda d \, . \, 2 \times d$

    d. $[\![\,two\ times\,]\!]\,([\![\,as_{Deg}\ as\ Clyde\,]\!]) = 2 \times d_{\textbf{Clyde}}$

    e. $[\![\,tall\,]\!]\,([\![\,two\ times\ as_{Deg}\ as\ Clyde\,]\!])([\![\,Floyd\,]\!]) = \textbf{tall}(\textbf{Floyd}, 2 \times d_{\textbf{Clyde}})$

This works out the way we'd expect, but the problem lies with sentences like (33):

(33)   Floyd is two times taller than Clyde.

Given what we said regarding percentage comparatives, we should expect that (33) should mean something akin to *Floyd is three times as tall as Clyde*: i.e., Floyd's height equals Clyde's height plus two times Clyde's height. But instead (33) is interpreted to have the same meaning as (32a).

    It's possible this is a quirk of English, however. Mandarin Chinese does in fact work exactly the way we would predict (Kai Chen, p.c.):

(34)   *John bi   Paul gao san bei.*
            John compare Paul tall three multiples.
            "John is four times as tall (*lit.* 'three times taller') than Paul."

Thus it's clear that additional work still needs to be done, but hopefully we've taken a step into the analysis of factor phrases.

7   A final remark

To summarize, we observed that percentage phrases in equatives are, unexpectedly, interpreted differently from ones in comparatives. Alongside this, we noted differences in the overt structure of percentage phrases between the two constructions and restrictions on measure phrases in equatives. We proposed an account in which bare percentage phrases like *80%* denote what we called relational degrees, functions of type $\langle d, d \rangle$. These are higher-order abstract degree-like objects. Being type-theoretically different from ordinary degrees, they have a different distribution.

    The only other innovation necessary to account for the behavior of percentages was leaving the equative degree morpheme uninterpreted. Coupled with standard assumptions about degree semantics, this derives all the relevant generalizations—though, perhaps importantly, only on the small DegP view of degree constructions. If our approach is on the right track, it is further support for the proposition that comparatives and equatives aren't nearly as similar to each other as one might have thought, at least in English. It remains to be seen, of course, to what extent the specific claim can be maintained that the difference between them is that the equative degree morpheme makes no semantic contribution of its own.

Certainly, we wouldn't expect this to be the case across languages. One satisfyingly surprising consequence of this approach, though, is that it makes English equatives look like Japanese comparatives. In Japanese, the overt indication of a comparative is the standard marker *yori*, the counterpart to *than*, and it's that element probably that does most of the semantic work. Many other languages pursue this compositional strategy (Stassen 1984, 1985, 2006), so it would be not only satisfyingly surprising to discover that English equatives employ it—it would also be, in another respect, satisfyingly unsurprising.

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