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RESEARCH ARTICLE

A universal scale of comparison

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Abstract Comparative constructions form two classes, those that permit direct comparisons (comparisons of measurements as in *Seymour is taller than he is wide*) and those that only allow indirect comparisons (comparisons of relative positions on separate scales as in *Esme is more beautiful than Einstein is intelligent*). In contrast with other semantic theories, this paper proposes that the interpretation of the comparative morpheme remains the same whether it appears in sentences that compare individuals directly or indirectly. To develop a unified account, I suggest that all comparisons (whether in terms of height, intelligence or beauty) involve a scale of *universal degrees* that are isomorphic to the rational (fractional) numbers between 0 and 1. Crucial to a unified treatment, the connection between the individuals being compared and universal degrees involves two steps. First individuals are mapped to a value on a primary scale that ranks individuals with respect to the gradable property (whether it be height, beauty or intelligence). Second, the value on the primary scale is mapped to a universal degree that encodes the value's relative position on the primary scale. Direct comparison results if measurements such as *seven feet* participate in the primary scale (as in *Seven feet is tall*). Otherwise the result is an indirect comparison.

Keywords Comparison · Scales · Degrees · Linear orders · Gradable Adjectives

1 Introduction

Comparative constructions allow individuals to be compared according to different properties. Such comparisons form two classes, those that permit

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direct comparisons (comparisons of measurements as in *Seymour is taller than he is wide*) and those that only allow indirect comparisons (comparisons of relative positions on separate scales as in *Esme is more beautiful than Einstein is intelligent*). Traditionally, indirect comparisons have been treated separately from direct comparisons, often as vague and metaphorical extensions of a more concrete degree analysis (see Cresswell 1976; Bierwisch 1987).

In this paper, I present a unified theory of direct and indirect comparison. The key conceptual tool for this unified account is a Universal Scale called 'Ω'. This scale contains degrees (hereon *universal degrees*) that are isomorphic to the rational numbers between 0 and 1 (inclusive). The comparative morpheme compares two individuals through these degrees, however these degrees are not simply measurements. Rather, they represent the position an individual occupies on a more primary scale such as beauty, intelligence, height or width. The higher an individual is in the primary scale, the closer the universal degree is to the highest degree in the universal scale. The lower an individual is in the primary scale, the closer the universal degree is to the lowest degree in the universal scale.

One of the more interesting properties of comparing individuals through universal degrees is that comparisons can be made directly even when the primary scales for two individuals are completely different. For example, there are two primary scales in the sentence *Esme is more intelligent than Sidney Crosby is talented*: one is associated with intelligence, the other with talent. According to the semantics that I develop in this paper, a truth value will be assigned to this sentence based on whether Esme occupies a higher position in the scale of intelligence than Sidney Crosby occupies in the scale of talent. If Esme occupies a higher position, then the universal degree that represents this position will be closer to the highest degree in the scale (that is, closer than the degree assigned to Sidney Crosby). Hence the universal degree assigned to Esme will be strictly greater than the one assigned to Sidney Crosby.

As should be evident, indirect comparisons are easily accommodated into such a semantics. The interpretation of such sentences is almost equivalent to paraphrases that accurately reflect speaker intuitions. A sentence such as *Medusa is more beautiful than I am intelligent* is true if Medusa occupies a higher position in the scale of beauty than I occupy in the scale of intelligence. Otherwise it is false.

The interpretation of direct comparisons such as *Seymour is taller than he is wide* are slightly more complicated. As I discuss in Sect. 5, the rankings associated with adjectives like *tall* and *wide* have more structure than those associated with adjectives like *beautiful* and *intelligent*. *Tall* and *wide* are connected to the same (non-linguistic) measurement system (a scale of inches and feet). This measurement system affects the composition of the primary scales associated with *tall* and *wide* in two ways. First it adds measurements such as *2 feet* to both of the primary scales. The degrees associated with these measurements will be ordered in the primary scales in the same way that they are ordered in the non-linguistic measurement system: the degree associated with *3 feet* will be greater than the one associated with *2 feet* which will be greater than the one associated with *1 foot*, so on and so forth. Second, the measurement system ensures that the measurements in the primary scales define the cardinality of the scalar domain. In other words, every individual's width and height is equivalent to some measurement and this measurement determines the individual's position in the primary scale. As a result, the scales for *tall* and *wide* will be structured in the exact same way, even though the measurements of certain individuals will be quite different.

Considering the influence of the measurement systems on the primary scales, sentences such as *Seymour is taller than he is wide* can receive the same kind of analysis as indirect comparisons. The truth of such sentences can be determined by comparing the universal degree that represents Seymour's position relative to the scale of *heights* to the universal degree that represents his position relative to the scale of *widths*. The only difference from indirect comparisons is that the position of Seymour in the scale of *heights* is determined by the measurement of his height. Similarly, the position of Seymour in the scale of *widths* is determined by the measurement of his width. If the measurement of Seymour's height is greater than the measurement of his width, then the universal degree associated with Seymour's height will be greater than the one associated with his width.

Additional support for this unified account comes from overt restriction of comparison classes. According to the theory explored in this paper, direct comparison is an artifact of measurement systems. The influence of measurements on the primary scales structure these scales in identical ways. However, if the primary scales did not contain measurements then direct comparisons should be impossible. The scales of *widths* and *heights* should no longer be structured in the same way nor should the position of individuals within the scale be dependent on their measurements. Prepositional phrases such as *for a boy* restrict the comparison class of a gradable adjective. By restricting the comparison class one also restricts the primary scale. Thus *tall for a boy* is associated with a primary scale that contains degrees only related to boys. There are no degrees associated with measurements. Sentences such as *Seymour is taller for a boy than he is wide for a boy* are evaluated with primary scales that are not influenced by measurements. Interestingly, such sentences do not permit direct comparisons. The sentence is false if Seymour is quite wide at 4 feet but only of average height at 5 feet: this despite the fact the measurement of his height is greater than the measurement of his width.

2 The empirical landscape

In this section, I present some of the more significant empirical aspects of direct and indirect comparisons. I first discuss how to differentiate between the two types of readings and also how cross linguistic analysis supports the idea that these two readings should be linked to one interpretation of the comparative morpheme. Next, I discuss how indirect readings differ from comparisons of deviation and metalinguistic comparisons. It is important to establish that indirect comparisons are semantically and empirically distinct from such interpretations.

2.1 Cross-linguistic evidence

The most convincing argument that direct and indirect comparisons are the result of one interpretation stems from the fact that the same morpheme is present in both kinds of comparison. Although this may be a coincidental homophony within a single language, the coincidence seems doubtful when it involves a variety of languages. Below, I first review how to differentiate the two types of comparison in English. I then demonstrate that these two different methods of comparison exist in a variety of languages, and in each language both types of comparison are associated with the same morphemes.

One way of characterizing the difference between direct and indirect comparisons is through entailment relations. For instance, consider the sentences below.

(1) a. Esme is more beautiful than Marie Curie was intelligent.
b. If Marie Curie was very intelligent, then Esme is (at least) very beautiful.

(2) a. Seymour is taller than he is wide.
b. If Seymour is very wide, then he is (at least) very tall.

The sentence in (1a), an indirect comparison, entails the sentence in (1b). In contrast (2a), a direct comparison, does not entail (2b). (2a) can be true even when Seymour is relatively short and yet very wide (as long as his height still exceeds his width). Such circumstances render (2b) false.

It is possible that these two kinds of comparisons with their different entailment relations are associated with two different types of interpretation, the shared phonological and morphological forms being somewhat coincidental. However there is a problem with this type of analysis. Indirect and direct comparisons are available in a variety of different languages and in each of these languages the two readings are associated with the same comparative morpheme.

For example, consider the following sentences from Italian, German, (Québec) French, and Romanian.

(3) ITALIAN
a. Maria è piú bella di quanto Marie Curie sia intelligente.
Maria is more beautiful than how much Marie Curie is intelligent.
'Maria is more beautiful than Marie Curie is intelligent.'
b. La porta è piú alta di quanto sia larga.
The door is more high than how much is wide.
'The door is higher than it is wide.'

(4) GERMAN

a. Eva ist schöner als Einstein intelligent war.
Eva is more beautiful than Einstein intelligent was.
'Eva is more beautiful than Einstein was intelligent.'

b. Die Tür ist höher als sie breit ist.
The door is higher than it wide is.
'The door is higher than it is wide.'

(5) FRENCH (Québec)

a. Charlotte est plus belle que Marie Curie est intelligente.
Charlotte is more beautiful than Marie Curie is intelligent.
'Charlotte is more beautiful than Marie Curie is intelligent.'

b. La table est plus longue qu' elle est large.
The table is more long than it is wide.
'The table is longer than it is wide.'

(6) ROMANIAN

a. Elena e mai frumoasa decit cit de inteligenta e Marie Curie.
Elena is more beautiful than how of inteligent is Marie Curie.
'Elena is more beautiful than Marie Curie is intelligent.'

b. Masa e mai lunga decit cit de lata e usa.
Table-the is more long than how-much of wide is door-the.
'The table is longer than the door is wide.'

The sentences in (a) (for each language) compare individuals with respect to two different gradable properties. As in English, these sentences have certain entailments, namely they entail that if the subject of the *than*-clause is very intelligent then the subject of the main clause must be more than very beautiful. In contrast, the (b) sentences have no such entailments. The truth or falsity of such sentences are simply based upon the measurements of the tables and/or doors in terms of their length, width or height. The evaluation of the sentence is not affected by how such measurements compare to other tables and doors in the domain. Although there is a contrast between the (a) and (b) sentences semantically, note there is no contrast morphologically. The comparative morpheme remains the same even when the interpretation differs. (In Italian this morpheme is expressed by *piú*, in German *-er*, in French, *plus*, and in Romanian *mai*.)

Even given this limited number of languages, the phonological and morphological similarities of direct and indirect comparisons seem to require a systematic explanation. There is clearly a common link between the two types of comparison: one that could possibly be reflected in the interpretation of the comparative morpheme.

2.2 Indirect comparisons are not comparisons of deviation nor metalinguistic comparisons

Bartsch and Vennemann (1972), McCawley (1976), Kennedy (1999) and Embick (2007) all discuss types of comparison that are very similar to indirect comparisons in that they involve sentences with two different adjectives. One of these types involves adjectives that are completely unrelated to each other, such as *lazy* and *stupid*, see (7a) and (7b). Embick (2007) in a recent paper has called these types of comparison *metalinguistic comparisons*. (Note, the [ADJ than ADJ] construction forces a metalinguistic interpretation. Other constructions do not.) Another type of comparison involves two adjectives that are polar opposites of one another, such as *tall* and *short*, see (7c). These have been called *comparisons of deviation* (see Bartsch and Vennemann 1972; Kennedy 1999).

(7) a. Seymour is more tall than he is wide.
 b. Seymour is more intelligent than devious.
 c. Seymour is more tall now than he was short before.

In this section I demonstrate that canonical comparisons of deviation and metalinguistic comparisons are quite different from indirect comparisons. They interact with morphology differently and they have different entailment relations.

One of the most noticeable characteristics of comparisons of deviation and metalinguistic comparisons is that they prefer (or even require) the independent morpheme *more* rather than the affix *-er*.[1] For example, all of the sentences in (7) involve the morpheme *more*, even when the adjective should, under normal circumstances, appear with the comparative affix *-er* (e.g., *taller*). In contrast, indirect comparisons allow for the comparative affix *-er* when the adjective has the correct phonological properties. Some examples are given in (8).

(8) a. Let me tell you how pretty Esme is. She's prettier than Einstein was clever.
 b. If Esme chooses to marry funny but poor Ben over rich but boring Steve, then there can be only one explanation. Ben must be funnier than Steve is rich.
 c. Although Seymour was both happy and angry, he was still happier than he was angry.
 d. Seymour is taller for a man than he is wide for a man.

Another characteristic of comparisons of deviation and metalinguistic comparisons is that they imply the truth of certain propositions that are not implied by regular comparisons. For example, as discussed in Kennedy (1999), the sentence in (7c) implies that Seymour is tall now and was short before. Regular comparisons with *tall* such as *Seymour is taller than I thought* have no such implications. Similarly, as discussed by McCawley (1976), the sentence in (7a) implies that Seymour is tall and wide just as the sentence in (7b) implies that he is intelligent and devious. Other comparative constructions with *intelligent*, such as *Seymour is more intelligent than Mary*, do not.

These types of implications fall out naturally from the semantics given for these constructions. According to Bartsch and Vennemann (1972) and Kennedy (1999), the truth conditions for a comparison of deviation requires comparing the positive deviation from some standard on one gradable scale to the positive

[1] See Embick (2007) for a possible explanation of this fact. Also see Bartsch and Vennemann (1972).

deviation from some standard on another gradable scale. If the so-called *standard* is the contextually determined standard for the positive form of the adjective, then the truth conditions for such sentences presuppose that the subject can be truly predicated of the positive form. Similarly, according to Embick (2007), the truth conditions for metalinguistic comparisons are based on evaluating whether it is more appropriate to attribute to the subject the positive form of one gradable adjective as opposed to the other. If such sentences are true, then they imply that it is appropriate to attribute the positive form of the adjective to the subject.[2]

Unlike comparisons of deviation and metalinguistic comparisons, indirect comparisons do not imply that the subject of the main clause has any positive properties like being intelligent, tall or beautiful. In fact, given the right context, indirect comparison can be used to express the fact that the subject does not have these properties. For example, consider the context where Mary is quite stupid. In describing my unflattering appearance, I could say the following sentence.

(9) Unfortunately, Mary is more intelligent than I am beautiful.

Similarly, in the context where the view is quite ugly, I can express my diminutive intelligence as follows.

(10) Unfortunately, the view is more beautiful than I am intelligent.

Comparisons of deviation and metalinguistic comparisons sound odd in similar contexts (although they are not completely deviant). For example, it would be strange[3] for me to express my diminutive intelligence with the sentence in (11a), although I could with (11b).

(11) a. ?I'm more pretty than intelligent, although unfortunately I'm quite ugly.
b. I'm prettier than I am intelligent, although unfortunately I'm quite ugly.

The sentence in (11a) implies that I am pretty. This implication is inconsistent with the context. In contrast (11b) has no such implications. Clearly, indirect comparisons such as the one in (11b) should not be analyzed in the same way as comparisons of deviation or metalinguistic comparisons.

3 Building a foundation

This section provides the foundations for a unified account of direct and indirect interpretations. The outline is as follows. In Sect. 3.1, I discuss how primary scales can be created from relations between individuals that are

[2] I am assuming here that to even be on the scale of appropriateness, the subject must have the gradable property to some degree equal to or higher than the standard. If this requirement is weakened, then the metalinguistic analysis ceases to get the appropriate implications.

[3] The degree to which the sentence is acceptable seems to depend on the degree to which speakers accept the sentence *I am more pretty than Mary is*. If a normal comparison does not require *-er* then indirect comparison should not require *-er*.

associated with gradable adjectives. For example, the adjective *beautiful* will be associated with the relation *x has as much beauty as y*. Employing Cresswell's (1976) methodology, I demonstrate how a linear order of equivalence classes can be formed from such a relation. In Sect. 3.2, I define the Universal Scale Ω. This scale will consist of degrees that are isomorphic to the set of rational numbers between 0 and 1. Also in this section, I develop a function that can map a degree in a primary scale to a universal degree in Ω. This mapping preserves the underlying order established by the primary scale. In Sects. 3.3 and 3.4, I present my interpretation of the gradable adjectives and the comparative morpheme. As a result of these interpretations, the truth conditions for comparative constructions will depend on a comparison of positions that two individuals occupy in their respective primary scales. As I discuss in Sects. 4 and 5, these interpretations account for both direct and indirect comparisons.

3.1 The primary scale

The hypothesis that gradable adjectives are associated with binary relations has often been discussed in the literature on comparison (see Klein 1991, and Cresswell 1976), however I believe no one actually proposes that the interpretation of such adjectives explicitly involves this type of relation. In this section, I outline the details of such a proposal. I suggest that underlying the interpretation of every gradable adjective is a relation between individuals. The scales that are more relevant to the interpretation of comparative sentences can be formed from these relations. Like other theories (Bartsch and Vennemann 1972; Cresswell 1976; Kennedy 1999), the interpretation of gradable adjectives will still directly relate individuals to degrees, however they only do so by manipulating a primary relation between individuals. In what follows, I demonstrate how such an interpretion of adjectives defines the right kind of semantics that can be used to account for direct and indirect comparisons.

I begin by reviewing Cresswell's proposal for developing an ontology of degrees for abstract scales. As I discuss, Cresswell creates such degrees from a base relation and then uses these degrees to form a scale.

3.1.1 Scales from an underlying relation

As observed by Cresswell (1976), if one has the conceptual abilities to determine who has more of a certain quality than another, then one can develop a scale based on this distinction. For example, most people are able to determine whether one individual has as much beauty as another. From this conceptual ability one can define the following relation, where D is a contextually limited domain of individuals:

$$\langle D, \{\langle x, y\rangle \colon x, y \in D \;\&\; x \text{ has as much beauty as } y\}\rangle$$

This relation has some interesting properties. First, it is transitive. For any z, w, and v, if $\langle z, w\rangle$ and $\langle w, v\rangle$ are in the graph of the relation, then so is $\langle z, v\rangle$. This follows from the transitive properties of the concept *has as much beauty as*. Second, it is reflexive. Given any individual, z, it follows almost tautologically that z has as much beauty as z has. Thus for all $z \in D$, $\langle z, z\rangle$ is in the graph of the relation. Third it is connected. Given any two individuals, z and w, one can compare their beauty. Hence either $\langle z, w\rangle$ or $\langle w, z\rangle$ is in the graph of the relation.[4]

Since the relation is transitive, reflexive and connected, it fits the criteria of being a connected quasi order (or pre-order). In what follows, I review how one can create scales from an underlying connected quasi order. Although this analysis in linguistics was first proposed by Cresswell (1976), such a derivation is well-known in mathematics where the resulting structure is often called a *quotient algebra* (for discussion and examples see Bell and Slomson 1969; Bell and Machover 1977). Although this term has been used in linguistics (see Klein 1991), I prefer the term *quotient structure*.[5,6]

There are two basic steps in developing a scale based on a quasi order. First, one must define equivalence classes over the individuals in the quasi order. All the individuals within a single equivalence class must be similar to each other in terms of their behavior in the relation. Second, one must create a relation between equivalence classes that is congruent to the original quasi order of individuals. Below I discuss the details of each step.

3.1.2 Equivalence classes

The first step in forming a scale is to define equivalence classes that serve as the degrees in the scale. To do this, one can develop an equivalency relation between members in the domain of the original relation and then group into sets all the individuals that are equal to each other according to this relation. These sets define the equivalence classes.

As presented in Cresswell (1976), an equivalency relation can be defined based on how individuals are related to others in the domain. Two individuals a and b are equivalent to each other if and only if every individual to which a is related, b is also related and vice versa. This is stated more precisely below, where the equivalency relation is symbolized by '$\sim$'. (Like Klein 1991, I will use the symbol 'ζ' to represent the underlying relation.)

$$a \sim b \quad \text{iff } \forall x(\zeta(a,x) \leftrightarrow \zeta(b,x) \text{ and } \zeta(x,a) \leftrightarrow \zeta(x,b))$$

A more intuitive definition of this equivalency relation can be restated in terms of substitution. Two individuals are equivalent in terms of the relation ζ if and

[4] See Hellan (1981) for a discussion of issues concerning connectivity.

[5] Technically, an algebra has operations as well as an ordering relation. These simple quotient structures only have an ordering relation.

[6] Krantz et al. (1971) discuss such structures with respect to measurement theory. Landman (1991) discusses some application of such structures with respect to ordering equivalence classes of events across possible worlds. However he called such structures *equivalence structures*.

only if they can substitute for one another without changing the truth values of statements involving ζ.[7]

With this equivalency relation, equivalence classes can be formed by grouping all the individuals that are equivalent to each other into the same set. One way to do this is to define a function from the individuals in the domain of the relation ζ onto a set. Consider the following definition.

Let $^{-\zeta}$ be a function from D_ζ to POW(D_ζ) such that
$\forall x \in \zeta\ (\bar{x}^\zeta = \{y : y \in D_\zeta\ \&\ x \sim y\})$.

With this function the set of equivalence classes can be defined as follows.

The set of equivalence classes E_ζ for ζ:
$\{X \subseteq D_\zeta : \exists x \in D_\zeta\ (X = \bar{x}^\zeta)\}$

This set contains all the subsets of D_ζ such that every individual in the subset is equivalent to all the other individuals in the subset but not to any member of any other subset.

3.1.3 A linear order

The next step in creating a scale is to introduce a linear order on the set of equivalence classes. A linear order has all the properties of the greater-than-or-equal relation with regard to numbers. It is connected, transitive, reflexive and anti-symmetric. So, to linearly order the equivalence classes one needs to develop a relation that has these four properties. This can be done by basing the relation on the underlying connected quasi order between individuals. For example, for any quasi order ζ that defines a set of equivalence classes E_ζ, one can define a linear order $\succeq_\zeta$ in the following way:

Defining a linear order on E_ζ:
$\forall X, Y \in E_\zeta\ (X \succeq_\zeta Y) \quad \text{iff } \exists x, y[(x \in X)\ \&\ (y \in Y)\ \&\ \zeta(x, y)]$

This linear order can also be defined using the function $^{-\zeta}$ as below.

Defining a linear order on E_ζ:
$\forall x, y \in D_\zeta\ ((\bar{x}^\zeta \succeq_\zeta \bar{y}^\zeta) \quad \text{iff } \zeta(x, y))$

As a result of either definition, an equivalence class X is greater-than or equal to an equivalence class Y iff the members of x bear the relation ζ to the members of Y. To give a more relevant example, if ζ were the relation *has as much beauty as*, then the equivalence class X would be greater-than or equal to the equivalence class Y if and only if the members of X have as much beauty as the members of Y.

It is simple to show that $\succeq_\zeta$ has all the properties of a linear order: it is connected, transitive, reflexive and antisymmetric. I will not go through the

[7] Cresswell's definition of the equivalency relation is equivalent to Klein's (1991) in terms of quasi orders, although the two definitions are different for strict orders.

details of a proof here (see Klein 1991; Cresswell 1976; or Bale 2006), rather I will simply note that connectivity, transitivity and reflexivity are inherited by $\succeq_\zeta$ from underlying quasi-order ζ. In contrast, antisymmetry is derived by collapsing individuals into equivalence classes.

3.1.4 Questions of circularity & redundancy

Before discussing other issues concerning the construction of scales from quasi orders, I would like to address a potential confusion. On the surface, it seems as if such a derivation might be open to an accusation of circularity or redundancy. Scales of beauty used to analyze sentences such as *Esme is as beautiful as Morag is* are based on a relation that encodes whether Esme has as much beauty as Morag. I do not think that such an analysis is either circular or redundant. Below I briefly outline why.

3.1.5 Creating scales from relations is not circular

In constructing scales from quasi orders, it seems as if one is defining a semantics for comparatives using a relation specified in terms of comparative and equative sentences. However, there is a difference between the concept of comparison and the semantics of how comparative and equative sentences are given truth values.

The underlying quasi order does not require an analysis of comparatives to define the relation. All it assumes is that given two individuals, speakers can tell if one has as much of a certain property as the other. Stated otherwise, the underlying relation requires that speakers have the conceptual ability to compare individuals in terms of beauty, height, width, intelligence etc., without necessarily using language to make this comparison.

Let me clarify this point by discussing conceptual abilities outside the limited realm of language. I assume that even those without language (monkeys, cats, dogs) are able to compare two objects or individuals in terms of a certain property (to tell which food bowl has more, or which potential mates are more suitable/beautiful). Clearly, such individuals have the conceptual ability to compare without the linguistic ability. All that is needed to build the underlying relation is this conceptual ability. It is an unfortunate burden of presentation that it is difficult to express this concept without using some type of comparative or equative construction.

3.1.6 Creating scales from relations is not redundant

Having dispensed with the idea that deriving scales from quasi orders is circular, there still remains the potential that it is redundant. If one has a relation that can distinguish who has as much intelligence as another, why would one need to convert such a relation into degrees to provide an analysis for the sentence below?

(12) Esme is more intelligent than Morag.

Clearly such a sentence can be provided with truth conditions defined solely through the underlying relation. For example, suppose that 'ι' is the underlying relation that encodes who has as much intelligence as another. The formula below accurately describe the truth conditions of the sentence above.

(13) $\iota(e, m)$ & $\neg\iota(m, e)$, where e is Esme and m is Morag.

The formula in (13) is true if and only if Esme has as much intelligence as Morag but Morag does not have as much intelligence as Esme. With this possible representation of the truth conditions, the question becomes why should one construct a scale in order to provide an analysis of comparatives when such a scale does not seem to be necessary?

This critique would be warranted except that it is factually mistaken. Although the non-degree approach works for the sentences above, it becomes problematic when there are two different adjectives in the main clause and the *than*-clause, as with the sentence below.

(14) a. Seymour is taller than he is wide.
b. Esme is more beautiful than she is intelligent.

Without degrees and scales (or some equivalent structure such as delineations cf. Klein 1980, 1982, 1991), it is not obvious how one would deal with comparisons involving two different adjectives. In contrast degrees and scales allow some interesting avenues of exploration. As Cresswell (1976) demonstrated with regard to direct comparisons, degrees can help provide a semantics for sentences with two different adjectives that is identical to an analysis of sentences with only one. The goal of Sect. 4 is to do the same for indirect comparisons.

To summarize, building scales from quasi orders is not redundant since such quasi orders do not contain a sufficient amount of structure to provide an adequate analysis of all types of comparison. The addition of degrees and scales provides the necessary structure for a unified account.[8]

3.2 The universal scale

In this section, I develop a function that is able to map degrees onto rational numbers that encode the position of the degree in its scale. For now, I only define the function for degrees that are in the domain of a finite linear order.[9] It is unclear whether a similar function could be created for infinite cardinalities.[10]

[8] As is evident in this section, the empirical justification for degrees depends on comparisons with two different adjectives. Many languages (Japanese, for example) prohibit such comparisons. Thus, it remains an open question whether the semantics of gradable adjectives in these types of languages involve degrees or not.

[9] In other words, linear orders that have a finite domain.

[10] Fox and Hackl (2006) propose that scalar density is relevant when considering certain implicatures. They claim that all scales are dense. Although it may seem that my analysis would be contrary to this claim, in actuality it is not. The domain of universal degrees is dense and this is the only relevant linguistic scale. All the facts that Fox and Hackl derive from scalar density can be derived from the density of the universal degrees.

I begin by defining the Universal Scale. To limit confusion about the claims I am making in this section, let me distance myself slightly from the term *rational number*. Instead, I will define a linear order called Ω that is isomorphic to the linear order on the rational numbers between zero and one, inclusive.[11]

The Universal scale Ω:

Let Ω be the pair $\langle D_\omega, \succeq \rangle$, where D_ω is defined as a set of degrees in a one-to-one relation with the set of rational numbers between 0 and 1 inclusive. Each d in D_ω will be labeled with the rational number with which it is in a one-to-one correspondence. For example, $d_{\frac{1}{3}}$, $d_{\frac{3}{20}}$, and $d_{\frac{25}{116}}$ will be the degrees in one-to-one correspondence with $\frac{1}{3}$, $\frac{3}{20}$, and $\frac{25}{116}$ respectively. The linear order $\succeq$ orders elements in D_ω in the same way that $\geq$ orders the rational numbers. Thus for all d_x and d_y in D_ω, $d_x \succeq d_y$ if and only if $x \geq y$.

With this definition of the Universal Scale, I can now define a function that maps every element in a scale onto an element in the Universal Scale that encodes its relative position. Since the mapping changes as different kinds of scales are considered, I relativize this function to the scale under consideration. To do this, I develop a function called $\mathfrak{H}$ (Gothic 'H') that takes scales as arguments and yields homomorphisms.

I begin by specifying the domain of this function.

The domain of $\mathfrak{H}$: Let the set of all possible scales with a finite domain be denoted by Σ. Each member of Σ is an ordered pair whose first coordinate is the domain of the scale and whose second coordinate is the linear order on that domain.

Next I will define the co-domain of the function.

The co-domain of $\mathfrak{H}$: Let $\mathcal{H}$ be the set of functions such that for each member h of $\mathcal{H}$ there is a finite linear order, call it γ, such that h is a homomorphism from γ to Ω. In other words, for all x and y that are members of γ, $x \geq_\gamma y$ if and only if $h(x) \succeq h(y)$.

With the domain and co-domain so specified, I can state the function $\mathfrak{H}$ as follows:

The Universal Homomorphism $\mathfrak{H}$: Let $\mathfrak{H}$ be a function from Σ to $\mathcal{H}$ such that for each member γ of Σ, $\mathfrak{H}(\gamma)$ has the following properties (For simplicity, let me represent this function as $\mathfrak{H}_\gamma$):

1. For all x and y in D_γ, $x \geq_\gamma y$ if and only if $\mathfrak{H}_\gamma(x) \succeq \mathfrak{H}_\gamma(y)$.
2. For all x in D_γ, $\mathfrak{H}_\gamma(x) = d_{\frac{z}{y}}$, where $z = |\{y : y \in D_\gamma \;\&\; x \geq_\gamma y\}|$ and $y = |D_\gamma|$

[11] von Stechow (1984) claims that the infelicity of *John is taller than Bill isn't wide* follows from the fact that the scale of height is not closed, contrary to my claims here. However, this cannot be the reason for the anomaly. Kennedy and McNally (2005) argue convincingly that even if *tall* is not associated with a closed scale, *full* is. Yet *This collection is more complete than this glass isn't full* is just as odd.

According to this function, each element d in a linear scale γ is mapped to the degree in the Universal Scale that is in one-to-one correspondence with the rational number with the following two properties: first, its numerator is equal to 1 plus the number of elements less than d in the original linear order γ. Second, its denominator is equal to the cardinality of the domain of γ.

An example of how this function works might help clarify these properties. Consider the linear order $\delta = \langle D_\delta, \geq_\delta \rangle$, where D_δ is the set $\{a, b, c, d, e, f, g\}$. Suppose that the ordering of these elements by $\geq_\delta$ is reflected in the Hasse diagram in Fig. 1. The result of applying the function $\mathfrak{H}$ to this linear order is the function $\mathfrak{H}_\delta$. This function when applied to the elements of δ yields the results represented in Fig. 2.

Note the parallelism between the original scale and the Universal Degrees in the range of the function $\mathfrak{H}_\delta$. Just as the following relations are true with regard to δ,

$$\begin{gathered} a \geq_\delta b, \\ c \geq_\delta g, \\ b \geq_\delta f, \end{gathered}$$

... so too are the counterparts with regard to Ω,

Fig. 1 Hasse diagram representing the ordering provided by $\geq_\delta$.

$$\begin{array}{c} a \\ | \\ b \\ | \\ c \\ | \\ d \\ | \\ e \\ | \\ f \\ | \\ g \end{array}$$

Fig. 2 Homomorphism between δ and Ω

$$\begin{aligned} \mathfrak{H}_\delta(a) &= d_{\frac{7}{7}}, \\ \mathfrak{H}_\delta(b) &= d_{\frac{6}{7}}, \\ \mathfrak{H}_\delta(c) &= d_{\frac{5}{7}}, \\ \mathfrak{H}_\delta(d) &= d_{\frac{4}{7}}, \\ \mathfrak{H}_\delta(e) &= d_{\frac{3}{7}}, \\ \mathfrak{H}_\delta(f) &= d_{\frac{2}{7}}, \\ \mathfrak{H}_\delta(g) &= d_{\frac{1}{7}}. \end{aligned}$$

$$d_{\frac{7}{7}} \succeq d_{\frac{6}{7}},$$
$$d_{\frac{5}{7}} \succeq d_{\frac{1}{7}},$$
$$d_{\frac{6}{7}} \succeq d_{\frac{2}{7}}.$$

The function $\mathfrak{H}_\delta$ preserves the ordering established by $\geq_\delta$. As demonstrated in the sections below, the function $\mathfrak{H}$ will play an important role in the interpretation of gradable adjectives.

3.3 The interpretation of gradable adjectives

Like Kennedy (1999), I interpret adjectives as functions from individuals to degrees: so-called measure functions. However, unlike Kennedy I hypothesize that every gradable adjective is a measure function onto universal degrees. Furthermore, how the adjectives map individuals to degrees crucially depends on quasi orders. Note that this *measure function* interpretation is not crucial for providing a unified account of direct and indirect comparisons (in fact see Bale 2006 for an alternative). I adopt this interpretation for ease of exposition since most readers are familiar with this type of degree analysis. The crucial aspect of the interpretation offered here is the association of individuals with universal degrees. This being duly noted, let me outline how universal degrees can be incorporated into measure functions.

The first necessary ingredient of my proposed interpretation involves associating each adjective with an underlying quasi order. These quasi orders provide a very basic ordering of the domain of individuals in terms of the relevant gradable property. As a notational mnemonic, I will represent the quasi-order associated with each gradable adjective by writing the adjective in all-caps. Thus, the quasi-order associated with *beautiful*, *intelligent*, *wide* and *tall* will be represented as *BEAUTIFUL*, *INTELLIGENT*, *WIDE* and *TALL* respectively. The nature of these quasi-orders will vary from adjective to adjective, however they will always be binary relations between individuals in the domain. For example, we can define *BEAUTIFUL*, *INTELLIGENT*, *WIDE* and *TALL* as follows:

Definition of some adjectival quasi-orders:
$BEAUTIFUL =_{def} \langle D, \{\langle x, y\rangle : x \textit{ has as much beauty as } y\}\rangle$
$INTELLIGENT =_{def} \langle D, \{\langle x, y\rangle : x \textit{ has as much intelligence as } y\}\rangle$
$WIDE =_{def} \langle D, \{\langle x, y\rangle : x \textit{ has as much width as } y\}\rangle$
$TALL =_{def} \langle D, \{\langle x, y\rangle : x \textit{ has as much height as } y\}\rangle$

With these types of quasi orders in mind, the following interpretation can be given gradable adjectives.

Interpretation of gradable adjectives (to be revised): Where x is a variable that ranges over individuals and where ADJ is the quasi order that is associated with the gradable adjective *adj*,
$[\![\text{adj}]\!] = \lambda x\ (\mathfrak{H}_{ADJ_{/\sim}}(\bar{x}^{ADJ}))$

This interpretation is a measure function from individuals to universal degrees. The universal degree is derived in three steps. First, a primary scale is constructed from the quasi-order associated with the gradable adjective (symbolized as $ADJ_{/\sim}$). Second, the individual x is mapped to its equivalency class in the primary scale (symbolized as $\bar{x}^{ADJ}$). Finally, the primary scale combines with $\mathfrak{H}$ to create a homomorphism between the primary scale and the universal scale. This homomorphism maps the equivalency class $\bar{x}^{ADJ}$ to a degree in the universal scale, a degree that represents the position of the equivalency class in the primary scale. Note, eventually I will revise the interpretation of gradable adjectives in Sect. 4. However, this revision will only be superficial. The character of the measure functions will remain the same.

3.4 The interpretation of the comparative morpheme

For simplicity, I adopt an interpretation of the comparative morpheme that is quite similar to Kennedy's interpretation (Kennedy 1999). The two most important differences are that (1) the degree arguments are universal degrees (members of Ω) and (2) the relevant relation between the degrees is the strict linear order $\succ$ that is associated with Ω. As with the interpretation of the gradable adjective, the choice of interpretation for the comparative morpheme (at least in terms of its functional type) is not crucial to the proposal developed in this paper. Other functional types and interpretations could have served equally as well (see Bale 2006 for an alternative). With this caveat in mind, I propose the following interpretation for comparative morpheme.

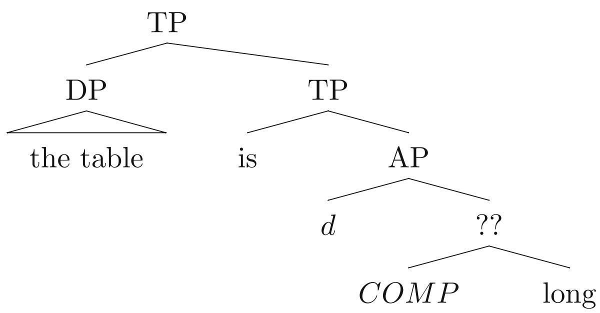
Interpretation of the comparative morpheme: Where μ, d and x are variables that range over measure functions, universal degrees and individuals respectively.
$[\![MORE]\!] = \lambda\mu\ \lambda d\ \lambda x\ (\mu(x) \succ d)$

According to this interpretation, the comparative morpheme is a function that first combines with a measure function (the function specified by the adjective), then with a degree argument (the degree supplied by the *than*-clause), and then finally with a subject-argument to yield a truth value. The resulting truth value is based upon whether the measure function applied to the subject argument yields a degree that is strictly greater than the degree argument provided by the *than*-clause.

As for the interpretation of the *than*-clause, once again I will adopt somewhat standard assumptions. I will assume that *than* takes a full sentential complement (see Bresnan 1973, 1975; Cresswell 1976; Kennedy 1999 among others).[12] Like other analyses of comparatives, I will also assume that the *than*-clause contains a covert function that takes the adjective as an argument. This covert operator is needed in order to abstract out a degree argument from the *than*-clause: namely the degree argument that will eventually serve as the argument for the

[12] There are syntactic arguments for this hypothesis that I will not review here since the issue is rather secondary. For a full discussion and defense, see Bresnan (1975), Kennedy (1999), and Bale (2006).

Fig. 3 Syntactic structure of *than the table is long*



comparative morpheme in the main clause. I label this hidden function *COMP* for *comparative*.[13]

With these assumptions about the *than*-clause, the phrase *the table is long* in the *than*-clause *than the table is long* will have the structure depicted in Fig. 3. An important feature of this construction is the free degree variable within the adjectival phrase. Taking into consideration the presence of this variable, *COMP* can be given the following interpretation.

> *The interpretation of COMP*: Where μ, d and x are variables that ranges over measure functions, universal degrees, and individuals respectively, $[\![COMP]\!] = \lambda\mu\ \lambda d\ \lambda x(\mu(x) \succeq d)$

With this interpretation of *COMP*, a set of degrees can be abstracted from the sentence in the *than*-clause and then the largest degree in this set can be chosen. This is exactly what I propose. I will represent the set abstraction explicitly with an operator called OPERATOR. This operator forms a set consisting of all the degrees that would make the sentential complement of OPERATOR true if they were substituted for the degree variable. I will represent the selection of the largest degree from this set explicitly by interpreting the word *than* as a supremum operator (the largest element in any ordering is called the supremum). The function that chooses the supremum is represented as *sup*. The head of the *than*-clause will simply be identified with this function: $[\![\text{than}]\!] = sup$.

With all of these hidden elements inserted into the structure, *than*-clauses such as those in (15a) and (16a) have the structure in (15b) and (16b).

(15) a. …than Esme is intelligent.
b. … [than [OPERATOR$_d$ [Esme [is [d [*COMP* intelligent]]]]]]

(16) a. …than he is wide.
b. … [than [OPERATOR$_d$ [he [is [d [*COMP* wide]]]]]]

[13] Kennedy calls this function *ABS* for absolute. The function bears this label since it is the same function that is used to analyze constructions where there is no overt comparative morpheme, such as the sentence *The boat is long*. I do not discuss such constructions in this paper, however see Bale (2006) for details.

Since the hidden operator forms a set of degrees and since *than* selects a degree from this set, the interpretation of the *than*-clause ends up being a degree. It is this degree that serves as an argument to the comparative morpheme.

4 An account of indirect comparison

The interpretation of the comparative given in Sect. 3 provides a useful and robust semantics for indirect comparison. The basic account is simple. The interpretation of the comparative morpheme compares the positions two individuals occupy on their respective primary scales. The Universal Scale is able to encode positions and order them linearly. Thus, positions can be compared in much the same way that two rational numbers can be compared.

In this section, I explore the predictions of this theory with respect to sentences and situations that yield clear and systematic truth value judgments. As I hope to show, a theory with universal degrees accurately accounts for speaker intuitions.

4.1 Controlling comparison classes

In building a degree account of indirect comparison, I follow the general practice of first considering sentences that yield clear judgments with respect to a given situation. I then discuss examples where judgments are not so well defined.[14] Such a strategy entails temporarily ignoring the most prototypical examples of indirect comparison such as in (17).

(17) Esme is more beautiful than Einstein was intelligent.

With such a sentence, Esme's beauty is evaluated in terms of the beauty of all contextually relevant people. Such a comparison class varies among speakers and changes from context to context. Similarly, Einstein's intelligence is evaluated in terms of the intelligence of people in general (or perhaps in certain contexts physicists in general). Once again such a comparison class might be different for different speakers and might also depend on the life experience of the speaker or audience. The indeterminate nature of the comparison classes in these sentences make them less than ideal for building a semantic theory.

To correct for the variability of comparison classes, I propose using sentences that overtly restrict the comparison class in both the main and *than*-clause. For example, consider the sentences below.

[14] This strategy of basing a theory on clear examples before considering more controversial sentences is discussed in Chomsky (1957).

(18) a. Esme is more beautiful for a committee member than Seymour is intelligent for a committee member.
b. Esme is more beautiful for a committee member than Seymour is intelligent.
c. Sidney Crosby is more talented for a hockey player than Medusa is ugly for a Gorgon.
d. Sidney Crosby is a more talented hockey player than Medusa is an ugly Gorgon.

In (18a) to (18c) a *for*-clause restricts the comparison class in both the main clause and the *than*-clause. Often the same *for*-clause restricts both clauses, whether it is specified twice as in (18a) or only once as in (18b). (Note, (18a) and (18b) are basically synonymous.) However, sometimes two different *for*-clauses can appear in a comparative where one restricts the main clause and the other the *than*-clause. This is demonstrated with the sentence in (18c) where a *for*-clause appears in both the main clause and *than*-clause. As demonstrated in (18d), not only can comparison classes be restricted by *for*-clauses, but they can also be restricted by the nominals that the adjectives modify. Even though such nominals are not identical to the comparison classes, they still influence the value of such classes. The comparison class is usually a subset of the denotation of the nominal. Considering this fact, it is rather unsurprising that the sentence in (18d) paraphrases (18c).

In assessing the viability of a theory with universal degrees, I use sentences that either contain a *for*-clause or a modified nominal. Such sentences yield less variable truth value judgments and reveal a deeper systematicity with regard to the judgments about indirect comparison.

4.1.1 Interpreting comparison classes

As is apparent from the previous section, the semantics of comparison classes plays a central role in my theory of indirect comparison. In this section I specify how I treat such classes and the *for*-clauses that modify them. Like Klein (1980), I will assume that there is a contextually determined variable C that interacts with the adjective to influence the domain of comparison.[15] Below I outline how such a variable can be integrated into a theory with universal degrees and how *for*-clauses can influence the value of such a variable.

To begin, recall that all gradable adjectives are associated with a relation. Each relation ζ can be represented as an ordered pair consisting of a domain and a graph (a set of ordered pairs): $\zeta = \langle D_\zeta, G_\zeta \rangle$. These relations serve as the basis for the primary scale. I propose that the comparison class restricts such underlying relations. As a result of this restriction, the domain of the relation will only consist of elements from the comparison class while the graph will only consist of ordered pairs whose members are also elements in the comparison class.

[15] I accept Klein's analysis with little argument and implicitly reject Ludlow's (1989). Ludlow argues that comparison classes are determined grammatically by prepositional phrases and modified nouns. I actually do not think there is a strong argument for either position.

To formalize this idea more precisely, I use the typical restriction operator '$\restriction$'. This operator takes a relation and a set as arguments and yields a restricted relation. The result of this restriction can be specified as follows: $R \restriction A = \langle (D_R \cap A),\ (G_R \cap (A \times A)) \rangle$. One can account for the effect of comparison classes by always interpreting gradable adjectives as if they combine with a comparison class that restricts the underlying relation. This is exactly what I propose. I use the comparison class variables C and C' as the restricting sets. Each adjective combines with one of these variables as soon as it enters into the derivation.

In order to combine gradable adjectives with comparison classes, the interpretation of such adjectives must be revised. The following revision takes comparison classes into consideration.

Interpretation of gradable adjectives (Final version): Where C and x are variables that ranges over comparison classes and individuals respectively and where ADJ is the quasi order that is associated with the gradable adjective *adj*,
$[\![adj]\!] = \lambda C\, \lambda x\, (\mathfrak{H}_{(ADJ \restriction C)_{/\sim}}(\bar{x}^{(ADJ\ \restriction\ C)}))$

The only difference between this interpretation and the interpretation provided in Sect. 3.3 is that under this interpretation, gradable adjectives are functions from comparison classes to measure functions. The resulting measure functions have all the same properties as the measure functions in Sect. 3.3 except with one crucial difference. The quasi order associated with the gradable adjective is restricted by the comparison class. As a result the quasi order is a relation that only involves members of the comparison class. Also since the comparison class restricts the quasi order, it also indirectly determines the nature of the elements in the primary scale (the equivalence classes) and how those elements relate to one another (the linear order).

Having introduced the idea of a contextually determined variable, it remains to be shown how an optional *for*-clause influences the value assigned to this variable. In the remainder of this section I outline one possibility that is consistent with known facts.

To keep the representation of comparatives simple, I suggest that *for*-clauses do not affect the semantic values of comparative sentences directly. Rather, I propose that they introduce a presupposition that each member of the comparison class has a certain property and that each member of the contextual domain that has that property is a member of the comparison class. To implement the semantic vacuity of such phrases, I simply interpret them as identity functions (functions that map every element to itself). As a result, *for*-clauses do not have any effect on the interpretation of a sentence other than influencing the value of the comparison class.[16]

[16] Note, this is only one possibility. The content of the variable could also be fixed semantically and could become part of the propositional content of the sentence. Empirically this option is not much different from the one proposed here. Normally presuppositional information projects but a test for whether comparison class values project is difficult to find.

The details of the presuppositional theory are as follows. First there must be a separate *for* preposition that specifically relates to comparison classes. Let's call this preposition for_{cc}, where *cc* stands for comparison class. For_{cc} takes two arguments: a comparison class variable C and a set. The variable has no overt correlate. As for the set, its value is fixed by the NP complement.[17]

Given that for_{cc} takes a variable and a set as an argument, the semantics for the prepositional phrase can be stated as follows.

Interpretation of for_{cc}: For all predicates P, comparison classes C and sets A,
$[\![for_{cc}(\mathrm{C})(\mathrm{A})]\!](\mathrm{P}) = \mathrm{P}$,
and is defined if and only if $(C = A)$.[18]

With this interpretation of the *for*-clause, an AP such as *tall* for_{cc} *a boy* has the following interpretation:

$[\![\text{tall for}_{cc} \text{ a boy}]\!] = [\![\text{tall}(C)\text{for}_{cc} \text{ a boy}]\!]$
(Spelling out the hidden variable in the AP)
$= ([\![\text{for}_{cc}]\!](C)([\![\text{a boy}]\!]))([\![\text{tall}(C)]\!])$
$= [\![\text{tall}(C)]\!]$, **Presupposition**: $C = [\![\text{a boy}]\!]$,
where $[\![\text{a boy}]\!]$ is the set of boys in the model.

In terms of non-presuppositional interpretation, *tall* for_{cc} *a boy* is equivalent to the AP *tall*. However, the presupposition restricts the value of the comparison class to the set of boys and this comparison class affects the value assigned to *tall*. As a result, the value assigned to *tall* for_{cc} *a boy* can be quite different from the value assigned to *tall*.

4.2 Examples of indirect comparison

To demonstrate how the semantics given above can account for indirect comparison, I present two situations where the truth or falsity of cross-scalar comparisons seems rather clear. I then demonstrate how the interpretation of gradable adjectives and *MORE* correctly accounts for these judgments. For the sake of simplicity, I restrict the domain to rather small numbers. Such a restriction simplifies graphical representations and sharpens linguistic judgments. Also in the first situation, I limit the domain so that no two people have a gradable property to the same extent. As a result, the underlying quasi orders are isomorphic to the primary scales. I feel that this makes the situation a little more accessible. In the second situation, I allow for individuals to have a gradable property to an equal extent. As a result, the quasi orders are quite

[17] I assume that the indefinite NP in this construction is interpreted as a predicate in the same way that such NPs are interpreted when appearing after *is* or *was*. In fact, *for*-clause indefinites and predicative indefinites share many syntactic properties. See Bale (2006) for details.

[18] Actually, a more accurate definedness condition would be to make C the largest possible subset of A. Recall that when modified nominals and *for*-clauses appear in the same sentence, then the comparison class is not identical to the nominal complement of the *for*-clause. This is due to the restriction that the value of the comparison class must be a subset of the modified nominal. I use this definition to simplify the representation.

different from the quotient structures. Although this situation is a little more complex, judgments are still quite clear.

I begin by constructing the simpler situation. To create such a context I will invent a fictitious committee consisting of ten members. In our model, each member will be associated with a letter from a through j. All the sentences I use involve statements that compare certain members of the committee: namely *Betty*, *Heather*, and *Evelin*. The letter b will represent the interpretation of *Betty*, the letter h the interpretation of *Heather* and the letter e the interpretation of *Evelin*. An important characteristic of this fictitious committee is that each member differs from the others in terms of beauty and intelligence. In fact, the order from the most beautiful to the least is as follows:

$$a \rightarrow b \rightarrow c \rightarrow d \rightarrow e \rightarrow f \rightarrow g \rightarrow h \rightarrow i \rightarrow j.$$

The individual a has more beauty than b who has more beauty than c and so on and so forth. In contrast, the order from the most intelligent to the least is as follows:

$$i \rightarrow f \rightarrow j \rightarrow g \rightarrow h \rightarrow a \rightarrow d \rightarrow b \rightarrow e \rightarrow c.$$

The individual i has more intelligence than f who has more intelligence than j and so on and so forth.

There are two quasi orders that are relevant in this context. The first is the quasi order *BEAUTIFUL* whose domain consists of people and whose graph consists of all the ordered pairs $\langle x, y\rangle$ such that x has as much beauty as y. I will shorthand this quasi order as β. The second quasi order is *INTELLIGENT* whose domain also consists of people and whose graph consists of all the ordered pairs $\langle x, y\rangle$ such that x has as much intelligence as y. I will shorthand this quasi order as ι. In all of the sentences presented in this section, the comparison class C will be overtly limited to the set of committee members.

The context, as it is currently constructed, determines the graphical representation in Fig. 4 of the quasi order $(\beta \upharpoonright C)$ and the quotient structure $(\beta \upharpoonright C)_{/\sim}$. Furthermore, Fig. 4 provides the degrees in Ω assigned by the homomorphism $\mathfrak{H}_{(\beta \upharpoonright C)_{/\sim}}$. The degrees on the far right represent the position of the committee members in a scale of beauty.

Similar to the effects on β, such a context also determines the graphical representation in Fig. 5 of the quasi-order $(\iota \upharpoonright C)$ and the quotient structure $(\iota \upharpoonright C)_{/\sim}$. Also, Fig. 5 provides the degrees in Ω assigned by the homomorphism $\mathfrak{H}_{(\iota \upharpoonright C)_{/\sim}}$. The degree on the far right represent the position of the committee members in the scale of intelligence.

With these scales in mind, consider the sentences listed below.

(19) a. Betty is more beautiful for a committee member than Heather is intelligent.
b. Betty is more intelligent for a committee member than Evelin is beautiful.

Given the situation specified above, most speakers consider the sentence in (19a) to be true. Since Betty is the second most beautiful among the committee

Fig. 4 From left to right: the quasi order for *beauty* ($\beta \upharpoonright C$), the derived linear order $(\beta \upharpoonright C)_{/\sim}$, and the associated universal degrees

$$
\begin{array}{ccc}
\underline{\beta \upharpoonright C} & \underline{(\beta \upharpoonright C)_{/\sim}} & \underline{\Omega} \\
a & \{a\} & d_{\frac{10}{10}} \\
| & | & | \\
b & \{b\} & d_{\frac{9}{10}} \\
| & | & | \\
c & \{c\} & d_{\frac{8}{10}} \\
| & | & | \\
d & \{d\} & d_{\frac{7}{10}} \\
| & | & | \\
e & \{e\} & d_{\frac{6}{10}} \\
| & | & | \\
f & \{f\} & d_{\frac{5}{10}} \\
| & | & | \\
g & \{g\} & d_{\frac{4}{10}} \\
| & | & | \\
h & \{h\} & d_{\frac{3}{10}} \\
| & | & | \\
i & \{i\} & d_{\frac{2}{10}} \\
| & | & | \\
j & \{j\} & d_{\frac{1}{10}}
\end{array}
$$

members whereas Heather is only the fifth most intelligent, it follows that Betty is more beautiful for a committee member than Heather is intelligent.

In contrast to this sentence, most speakers consider (19b) to be false. Betty is the third least intelligent committee member whereas Evelin is in the fifth most beautiful, hence Betty is not more intelligent for a committee member than Evelin is beautiful.

These empirical results are consistent with predictions of the theory presented in Sect. 3. To demonstrate this, let's consider how these sentences would be interpreted. Note that to make the derivation slightly more readable I leave out the compositional integration of the prepositional phrase *for a committee member*. Recall that this phrase simply passes up the value of its sister (via the identity function) and presupposes that the variable C is equal to the set of committee members. I will assume throughout the derivation that $C = \{a, b, c, d, e, f, g, h, i, j\}$. Also, I ignore the interpretation of tense or any other modal elements for the time being.

Below I present the derivation of the truth value for (19a) in several steps. First I derive the value of the *than*-clause *than Heather is intelligent*. Then I derive the value for the entire sentence *Betty is more beautiful for a committee member than Heather is intelligent*.

The *than*-clause contains many elements that are not overtly represented: the degree variable 'd', the degree operator 'OPERATOR$_d$', the function *COMP* and

$\iota \upharpoonright C$	$(\iota \upharpoonright C)_{/\sim}$	Ω
i	$\{i\}$	$d_{\frac{10}{10}}$
f	$\{f\}$	$d_{\frac{9}{10}}$
j	$\{j\}$	$d_{\frac{8}{10}}$
g	$\{g\}$	$d_{\frac{7}{10}}$
h	$\{h\}$	$d_{\frac{6}{10}}$
a	$\{a\}$	$d_{\frac{5}{10}}$
d	$\{d\}$	$d_{\frac{4}{10}}$
b	$\{b\}$	$d_{\frac{3}{10}}$
e	$\{e\}$	$d_{\frac{2}{10}}$
c	$\{c\}$	$d_{\frac{1}{10}}$

Fig. 5 From left to right: the quasi order for *intelligent* ($\iota \upharpoonright C$), the derived linear order $(\iota \upharpoonright C)_{/\sim}$, and the associated universal degrees

the comparison class C. When all the hidden elements are spelled out, the *than*-clause ends up having the following syntactic structure:

(20) [than [OPERATOR$_d$ [Heather is [d *COMP* [intelligent C]]]]]

The interpretation of this *than*-clause is as follows.

$$\begin{aligned}
&[\![\text{than OPERATOR}_d \text{ Heather is } d \textit{ COMP} \text{ intelligent } C]\!]\\
&= sup(\text{OPERATOR}_d)([\![\text{Heather}]\!]([\![d \textit{ COMP} \text{ intelligent } C]\!]))\\
&= sup(\{d : ([\![\text{intelligent } C]\!](h) \succeq d)\})\\
&= sup(\{d : (\mathfrak{H}_{(\iota\upharpoonright C)_{/\sim}}(\bar{h}^{(\iota\upharpoonright C)}) \succeq d)\})\\
&= sup(\{d : (d_{\frac{6}{10}} \succeq d)\}) = \mathbf{d}_{\frac{6}{10}}
\end{aligned}$$

The interpretation of this *than*-clause is equivalent to the universal degree that represents Heather's position in the scale of intelligence restricted to committee members. Since she is the fifth most intelligent out of ten people, her position is represented by the degree $d_{\frac{6}{10}}$.

With this interpretation of the *than*-clause, the following meaning can now be assigned to the entire sentence *Betty is more beautiful for a committee member than Heather is intelligent*. (Recall that C is equal to the set $\{a, b, c, d, e, f, g, h, i, j\}$.)

$$
\begin{aligned}
&[\![\text{Betty is more beautiful for a committee member than Heather}\\
&\text{is intelligent}]\!]\\
&= ([\![\text{Betty}]\!](([\![\mathit{MORE}]\!]([\![\text{beautiful } C]\!]))([\![\text{than Heather is intelligent}]\!])))\\
&= ([\![\text{beautiful } C]\!](b) \succ d_{\frac{6}{10}})\\
&= (\mathfrak{H}_{(\beta\upharpoonright C)_{/\sim}}(\bar{b}^{(\beta\upharpoonright C)}) \succ d_{\frac{6}{10}})\\
&= (d_{\frac{9}{10}} \succ d_{\frac{6}{10}}) \ = \mathbf{1}
\end{aligned}
$$

As is apparent from the second last line of the derivation, the truth conditions of the sentence are derived from a comparison of two universal degrees: one that represents Betty's position on a scale of beauty (for a committee member) and another that represents Heather's position on a scale of intelligence (for a committee member). Since Betty's relative position is higher, the sentence is true.

The derivation of (19b), *Betty is more intelligent for a committee member than Evelin is beautiful*, is almost identical to the derivation of (19a). The *than*-clause is interpreted as a universal degree, one that represents Evelin's position in the scale of beauty, and the truth or falsity of the entire sentence depends on the comparison of two universal degrees. The derivation is given below.

Interpretation of the than-clause:

$$
\begin{aligned}
&[\![\text{than } \textsc{operator}_d \text{ Evelin is } d \ \mathit{COMP} \text{ beautiful } C]\!]\\
&= \mathit{sup}(\textsc{operator}_d)([\![\text{Evelin}]\!]([\![d \ \mathit{COMP} \text{ beautiful } C]\!]))\\
&= \mathit{sup}(\{d : ([\![\text{beautiful } C]\!](e) \ \succeq \ d)\})\\
&= \mathit{sup}(\{d : (\mathfrak{H}_{(\beta\upharpoonright C)_{/\sim}}(\bar{e}^{(\beta\upharpoonright C)}) \ \succeq \ d)\})\\
&= \mathit{sup}(\{d : (d_{\frac{6}{10}} \succeq d)\}) = \mathbf{d}_{\frac{6}{10}}
\end{aligned}
$$

Interpretation of the entire sentence:

$$
\begin{aligned}
&[\![\text{ Betty is more intelligent for a committee member than Evelin}\\
&\text{is beautiful}]\!]\\
&= ([\![\text{Betty}]\!](([\![\mathit{MORE}]\!]([\![\text{intelligent } C]\!]))([\![\text{than Evelin is beautiful}]\!])))\\
&= ([\![\text{intelligent } C]\!](b) \succ d_{\frac{6}{10}})\\
&= (\mathfrak{H}_{(\iota\upharpoonright C)_{/\sim}}(\bar{b}^{(\iota\upharpoonright C)}) \succ d_{\frac{6}{10}})\\
&= (d_{\frac{3}{10}} \succ d_{\frac{6}{10}}) = \mathbf{0}
\end{aligned}
$$

The truth conditions of the sentence reduce to a comparison of two universal degrees. The first represents Betty's position with regard to intelligence (for a committee member) and the second represents Evelin's position with regard to beauty (for a committee member). Since Betty is lower on the scale of intelligence than Evelin is on the scale of beauty, the sentence is false.

Note that when the *than*-clause only contains a simple absolutive sentence, the truth of such sentences can often be evaluated by comparing two universal degrees, namely the universal degrees derived from applying the adjectival measure functions to the relevant equivalence classes. For example, the truth conditions for (21a-i) and (21b-i) can be reformulated as in (21a-ii) and (21b-ii). (To simplify matters even more I have left the superscript on $\bar{b}$ and $\bar{e}$ implicit.)

(21) a. i. Betty is more beautiful for a committee member than Heather is intelligent.

ii. $(\mathfrak{H}_{(\beta\restriction C)_{/\sim}}(\bar{b}) \succ \mathfrak{H}_{(\iota\restriction C)_{/\sim}}(\bar{h}))$

b. i. Betty is more intelligent for a committee member than Evelin is beautiful.

ii. $(\mathfrak{H}_{(\iota\restriction C)_{/\sim}}(\bar{b}) \succ \mathfrak{H}_{(\beta\restriction C)_{/\sim}}(\bar{e}))$

In the rest of this paper, I will sometimes take advantage of this equivalency to avoid recalculating the compositionally derived interpretation.

In summary, a theory with universal degrees accurately accounts for the truth conditions of comparative sentences when considering simple situations where the domain of people is limited and equality is not an issue. However, a question still remains about whether a more complex situation would yield different results. As I demonstrate below, adding more complexity to the situation does not significantly change either the truth value judgments of the speakers nor the truth value assignments of the semantic theory.

Let's consider one example. Let me expand the committee mentioned above so that it contains five additional members on top of the original ten. Let's denote these individuals as a', b', c', d', and e'. Suppose that a' and b' are equally as beautiful as Betty (denoted by b). Suppose that c' is equally as beautiful as c, d' is equally as beautiful as d, and e' is equally as beautiful as e (*Evelin*). Keeping the relations between the original ten members the same, the diagram in Fig. 6 represents the expanded quasi order associated with beauty. Since, b, b' and a' all have as much beauty as each other, they occupy the same level in the

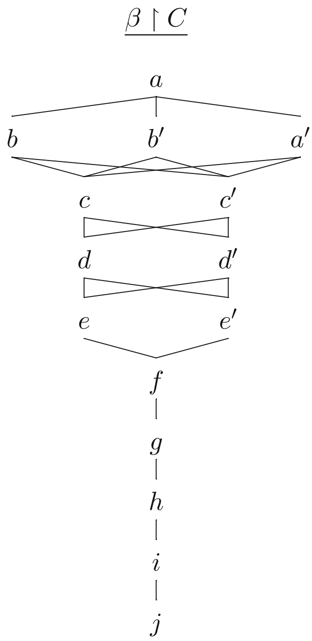


Fig. 6 The quasi order associated with *beauty* with larger equivalence classes

diagram. Similar reasoning explains why c and c' are on the same level: likewise for d and d' and e and e'.

The quotient structure collapses the individuals that are equally as beautiful into equivalence classes. These equivalence classes can then be associated with a degree in the universal domain that represents their position in the quotient structure. The scale of equivalence classes and the associated degrees in Ω are given in Fig. 7. Although the expanded quasi order changes the composition of the equivalence classes, it does not change how the individuals are mapped to universal degrees. Betty's beauty and Evelin's beauty (for committee members) are still represented by the universal degrees $d_{\frac{9}{10}}$ and $d_{\frac{6}{10}}$ respectively.

Similar affects can be demonstrated with the quasi order associated with intelligence. Suppose out of the five extra members, a' is equally as intelligent as Heather (h), while b' and c' are equally as intelligent as Betty (b). Also suppose that d' is equally as intelligent as f and e' is as equally intelligent as e (Evelin). Keeping the relations between the original ten members the same, the diagram in Fig. 8 represents the expanded quasi order associated with intelligence. Since b, b' and c' have as much intelligence as each other, they occupy the same level in the diagram. Likewise for f and d', h and a', and e and e'.

The quotient structure of this quasi order has the same amount of equivalence classes as the reduced quasi order. The only difference is in the

$$
\begin{array}{cc}
\underline{(\beta \restriction C)_{/\sim}} & \underline{\Omega} \\
\{a\} & d_{\frac{10}{10}} \\
| & | \\
\{b, b', a'\} & d_{\frac{9}{10}} \\
| & | \\
\{c, c'\} & d_{\frac{8}{10}} \\
| & | \\
\{d, d'\} & d_{\frac{7}{10}} \\
| & | \\
\{e, e'\} & d_{\frac{6}{10}} \\
| & | \\
\{f\} & d_{\frac{5}{10}} \\
| & | \\
\{g\} & d_{\frac{4}{10}} \\
| & | \\
\{h\} & d_{\frac{3}{10}} \\
| & | \\
\{i\} & d_{\frac{2}{10}} \\
| & | \\
\{j\} & d_{\frac{1}{10}}
\end{array}
$$

Fig. 7 From left to right: the linear order derived from *beauty* ($\beta \restriction C_{/\sim}$) and the associated universal degrees

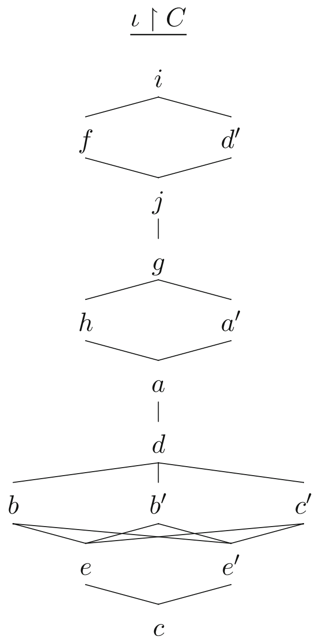


Fig. 8 The quasi order associated with *intelligent* with larger equivalence classes

composition of the equivalence classes. In Fig. 9. I give the quasi order and the associated degrees in Ω. The addition of the five members does not effect the value of the universal degrees that are assigned to the original ten members of the committee as long as the additional five are equivalent to one of the original ten. The quotient structure absorbs the new members of the committee into the equivalence classes. The assignment of the universal degree is based on the number of equivalence classes in the domain rather than the number of individuals in the quasi order. As a result, the values of the four sentences interpreted above remain the same in the expanded model as they were in the reduced model. Interestingly, speaker judgments do not seem to change with the addition of individuals equivalent to others already in the domain.[19]

4.3 Extending the analysis

The same kind of analysis given for the sentences above can be extended to more typical examples of cross-scalar comparisons such as those in (22).

(22) a. Unfortunately Medusa is more beautiful than I am intelligent.
b. Sidney Crosby is more talented than Einstein was intelligent.

[19] There is one qualification: the size of the equivalence classes must remain significantly smaller than the number of equivalence classes in the quotient structure. This complication is discussed in more detail in Bale (2006).

Fig. 9 From left to right: the linear order derived from *intelligent* ($\iota \restriction C_{/\sim}$) and the associated universal degrees

$$
\begin{array}{cc}
\underline{(\iota \restriction C_{/\sim}} & \underline{\Omega} \\
\{i\} & d_{\frac{10}{10}} \\
| & | \\
\{f, d'\} & d_{\frac{9}{10}} \\
| & | \\
\{j\} & d_{\frac{8}{10}} \\
| & | \\
\{g\} & d_{\frac{7}{10}} \\
| & | \\
\{h, a'\} & d_{\frac{6}{10}} \\
| & | \\
\{a\} & d_{\frac{5}{10}} \\
| & | \\
\{d\} & d_{\frac{4}{10}} \\
| & | \\
\{b, b', c'\} & d_{\frac{3}{10}} \\
| & | \\
\{e, e'\} & d_{\frac{2}{10}} \\
| & | \\
\{c\} & d_{\frac{1}{10}}
\end{array}
$$

The only difference between these sentences and the ones presented in the previous sections is that these sentences do not have any overt restriction on the comparison classes. As a result, the comparison class for such sentences are possibly (even probably) quite large and hard to determine. In making claims about my intelligence, I am generally limiting the scale to only include human beings. In making claims about Sidney Crosby's talent (a famous Canadian hockey player) I am generally limiting the scale to other hockey players. These types of scales might include hundreds or thousands of relevant members instead of the five or ten in the example sentences discussed above. Such comparison classes would also be highly variable on speaker experience. If someone only met individuals that were highly skilled at hockey, they might not consider Sidney Crosby to be all that talented. (Alternatively these comparison classes might be constituted by prototypes. Such a possibility might be more psychologically plausible.)

The size and indeterminacy of the comparison classes in these sentences make it hard to provide a complete analysis. However, in principle, the interpretation of the comparative morpheme specified above should yield the same kind of analysis for these sentences as it did for the more restricted examples. The truth conditions of such sentences depend on a comparison between two universal degrees: one that represents the position of the main clause subject in its primary scale and another that represents the position of the *than*-clause subject in its primary scale. The only difference is in the size of the primary scale and hence the size of the denominators in the fractions.

5 An account of direct comparison

The most notable property of adjectives that permit a direct comparison is their association with measurement systems. For example, heights, lengths and widths all can be measured in terms of inches, feet, centimeters, and meters. Every author who provides an account of direct comparison takes advantage of this property, either by using the common measurement system to justify a scale independent of the adjectives (see Cresswell 1976; Kennedy 1999; Bartsch and Vennemann 1972) or by using the existence of such a measurement system to explain the semantics of degree modifiers such as *three feet*, *two inches*, and *four hours* (see Klein 1982). Like these theories, I base my explanation of direct comparison on the existence of measurements; however there are some key differences. First, unlike Cresswell (1976), Kennedy (1999), and Bartsch and Vennemann (1972), I do not hypothesize that these measurements constitute degrees or name degrees. Rather measurements will have the same ontological status as individuals. Second, unlike Klein (1982), I do not analyze direct comparisons by manipulating the effect of degree modifiers. Rather, I suggest that measurement systems affect the composition of the primary scales which in turn affect the assignment of universal degrees. It is this influence on the assignments of the universal degrees that explains direct comparisons.

In this section, I describe the influence of measurements on the primary scale and universal degrees. This influence stems from allowing measurements to participate in the underlying quasi orders in the same way that other individuals participate in these relations. As I discuss in Sect. 5.4, quasi orders that contain measurements produce quotient structures that are isomorphic to the measurement system. Such a result has interesting consequences when two gradable adjectives are associated with the same measurement system. For example, *tall* and *wide* both permit a modification by phrases referring to feet or inches. If both of the quasi orders associated with *tall* and *wide* contain measurements of inches and feet, then both of the quotient structures associated with *tall* and *wide* will be isomorphic to a measurement system of inches and feet and hence isomorphic to each other as well. The two quasi orders will still differ in terms of how they order individuals (one individual might be taller than another but the opposite might hold in terms of width) and how they relate individuals to measurements (most individuals have different measurements for their width and height), but they will be the same in that each individual will be equivalent to one and only one measurement. It is this aspect of the quasi order that establishes the isomorphism to the measurement system. One of the consequences of this isomorphism is that the assignment of equivalence classes to universal degrees will be systematically related to the measurement that is contained within the equivalence class. For example, an equivalence class containing the measurement *3 inches* will be mapped to the same universal degree whether the equivalence class belongs to the quotient structure associated with *tall* or the one associated with *wide*. Hence, a comparison of universal degrees is equivalent to a comparison of measurements. The effect of the measurements on the quasi orders and quotient structures derives direct comparisons without changing the semantic interpretation of the comparative morpheme.

A prediction of this theory is that direct comparisons depend on measurements. This prediction is confirmed by the effects of comparison class restrictors. Prepositional phrases that restrict measurements from the underlying quasi order force indirect comparisons.

5.1 Measurements in language

Before addressing the issue of direct comparisons, it might be useful to discuss terms like *three feet*, *three years*, *three minutes*, and *three degrees*. Such terms are generally called measure phrases in the literature and I will follow this tradition here. In what follows, I draw attention to two different uses of measure phrases. As I discuss, their interpretation is different when they appear in subject position as opposed to when they are used as degree or differential modifiers.

Distributionally measure phrases fall into two categories. They appear in the same position as degree modifiers like *very*, *somewhat*, and *a little* and they also appear in subject positions like other nominals such as *Seymour*, *Esme* and *the boy*. Consider the sentences in (23) compared to those in (24).

(23) a. Mary is [*very/somewhat/a little/seven feet*] tall.
b. Mary is [*somewhat/a little/seven feet*] taller than Esme.
c. Despite what you say, I believe that [*Esme/Seymour/the boy/six feet*] is tall.
d. Mary is somewhat taller than [*Esme/Seymour/the boy/seven feet*].

(24) a. *Mary is [*Esme/Seymour/the boy*] tall.
b. *Mary is [*Seymour/the boy*] taller than Esme.
c. *Mary is taller than [*very/somewhat/a little*].
d. *Despite what you say, I believe that [*very/somewhat/a little*] is tall.

As demonstrated by these sentences, measure phrases pattern with degree modifiers and noun phrases (as shown in (23)) even though noun phrases and degree modifiers are otherwise in complementary distribution (as shown in (24)). Such facts point to two different roles for measure phrases. Not only do such phrases have an interpretation that is similar to degree modifiers such as *somewhat*, they also have an interpretation similar to noun phrases. For direct comparisons, the role of measure phrases as noun phrases is particularly important. Let me address some of the syntactic characteristics of this role in more detail.

An interesting fact about the nominal behavior is that measure phrases are singular even when the nouns that refer to them have plural morphology. Furthermore measure phrases cannot contain determiners. Consider the sentences in (25).

(25) a. Seven feet is tall.
b. ??Seven feet are tall.
c. Those seven feet are wide.
d. *Those seven feet is wide.

In these sentences, only (25a) is a statement about measurements. When there is plural agreement as in (25b) and (25c), the phrase *seven feet* refers to actual feet. The same result occurs when a determiner is added. In fact, to refer to measurements, the nominal must have singular agreement and must never be modified by a determiner. In this respect, measure phrases in the subject position are exactly like names. The only noticeable difference is that measure phrases refer to measurements rather than to people or institutions. These syntactic facts are relevant to the arguments presented in Sect. 5.3.2 where I suggest that measurements have the same ontological status as individuals.[20]

5.2 Measurement systems as well-ordered systems

To provide a complete analysis of direct comparisons, it is important to discuss the nature of the measurement systems that are involved in such comparisons. I should qualify that by *measurement systems* I am literally referring to the invented scales that are shared by a society and that provide objective measurements. For example, scales of feet and inches or meters and centimeters provide measurements of length or distance. One quality that is particularly relevant for direct comparisons concerns how speakers treat measurement systems of linear space. Such measurement systems are often treated as if they were well ordered: that is, as if they had a minimal measurement that was ordered below all others and as if every measurement in the system had a unique successor.[21] In this section, I discuss this property in more detail.

The idea that measurement systems involving space have a starting point is rather uncontroversial. Any measurement system that applies to linear distance usually has a smallest measurement (whether it be zero, one centimetre, one inch, etc.). Hopefully anyone who has knowledge of such scales would concede at least this fact.[22] A more controversial property involves the claim that people

[20] The syntax and semantic implications of measure phrases will only be touched upon in this section. For a more detail discussion of the various issues the reader is referred to Schwarzschild (2002) and Nakanishi (2003).

[21] That is to say, every measure has a successor other than the largest measure if one exists.

[22] Note, this is not a fact about all scales. For example, measurements of temperature do not necessarily have a starting point: despite the existence of an absolute zero point. In principle such a scale is isomorphic to the integers (positive and negative), so there is no smallest degree that is below all others.

(at least sometimes) conceive of measurements as being limited in fine-grainedness. Below I try to justify this claim.

Measurements are often used as if they were limited in terms of how small the basic unit can be. For example, heights are normally given in terms of inches and feet, but not in terms of quarter inches. Similarly, distances between cities are normally given only in miles. Units of measurement below the mile are not relevant.

Not only are reports rounded off to a basic unit, but judgments are affected by this rounding off. For example, if Seymour and Brad report their heights as being six feet and two inches, most people would accept the following two statements in (26) as true.

(26) a. Seymour is as tall as Brad and Brad is as tall as Seymour.
b. Seymour and Brad are equally as tall.

People would accept these statements even if they knew that Seymour and Brad's heights differed by an eighth of an inch.

Examples like this are common. Two mountains can be talked about as having the same height despite differing by a few inches. The distances between two sets of cities can be talked about as being equal despite the fact that they might differ by several feet. These kinds of examples demonstrate what I mean by the claim that people treat measurement systems as if they are limited in their fine-grainedness. The fact that people round off measurements to a certain unit and then also (at least sometimes) treat comparisons as if they are only relevant according to these (rounded off) measurements is an interesting characteristic of the way we use the concept of measurement. To be clear, I am not claiming that measurement systems of distance need to be objectively limited, rather I am only claiming that in practice people often conceive or use measurements systems as if they were limited in their precision.

One way to account for this evidence is to hypothesize that people think of (or are able to think of) these measurement systems as well ordered systems with a base unit: a well ordered system is a system that is isomorphic to a subset of the natural numbers.[23] For example, in terms of height the base unit is an inch which also serves as the smallest measurement. All other measurements are (natural number) multiples of this inch. Hence after an inch, the next measurement is two inches, then three inches, and so on and so forth. For any measurement, the next measurement is defined by an increase in the multiple: for a measurement of n inches, the successor could be defined as $n + 1$ inches.

Further support for this concept of measurement systems can be demonstrated by the creation of novel bases. As discussed by Bierwisch (1987), almost anything that can be predicated of *tall*, *wide* or *long* can become a measurement of height, width and length. For example, consider the sentences in (27).

[23] The system is discrete and has a minimal element.

(27) a. Matchsticks are not very long.
b. Apples are not very tall.

In (27) I give two arbitrary examples of nouns that can be used in the subject position for the predicates *to be long* and *to be tall*. The objects named by these nouns can also be used as a base for a new measurement system. For example, in taking the length of a prototypical matchstick one can define a measurement system in terms of matchsticks. The base measurement will be the height of one matchstick. Other measurements will be multiples of this height. Like the intuitive treatment of inches, this measurement system is well ordered: it has a base unit and for any measurement there is a unique successor (the next measurement in the scale). The first measurement is named by *one matchstick*. The next by *two matchsticks*, followed by *three matchsticks* and so on and so forth. In the same way, one can define a measurement system based on the height of a prototypical apple.[24] With these novel measurement systems, the sentences in (28) involving more conventional measurement systems can be rephrased as in (29).

(28) a. An apple is three inches tall.
b. Jon is six inches taller than Seymour is.
c. The new tiles are six inches narrower than the old tiles.

(29) a. An apple is two matchsticks tall.
b. Jon is four matchsticks taller than Seymour is.
c. Jon is one apple taller than Seymour is.
d. The tiles are six matchsticks (two apples) narrower than the old tiles.

In using the novel measurement systems there is no change in truth conditions. Once one knows how to use one matchstick to measure height, one also knows the meaning of *four matchsticks*, *five matchsticks*, etc. Furthermore, one knows that an object that is four matchsticks long is shorter than an object that is five matchsticks long. Note that unlike more conventional measurement systems, there is no question about in-between measurements. The fine-grainedness of the measurement system is dependent on the size of the base.

In summary, the way people treat established and novel measurement systems of linear space supports the idea that such systems are considered to be well-ordered and limited in their fine-grainedness. Furthermore, this limit in fine-grainedness often determines how people judge comparisons.

[24] In fact, there is some precedence for this kind of measurement system. The cartoon characters called *Smurfs* are reportedly three apples tall. Also, *haut de trois pommes* is an idiom in French.

5.3 Two assumptions about measurements

There are two assumptions about measurements that facilitate an extension of the interpretation of the comparative morpheme to direct comparisons. First, for any context the domain of measurements must be finite (although arbitrarily so). Second, measurements must participate in the underlying quasi orders as if they were individuals. In other words, they must be able to have as much height as certain individuals or not have as much height. In this section I explain why these assumptions are required while also attempting to provide some independent justifications.

5.3.1 Domain of measurements is finite

As I demonstrate in Sect. 5.4, measurement systems influence the composition of certain quotient structures by placing each measurement in a unique equivalence class. Also, as explained above, the function that maps equivalence classes to universal degrees crucially involves calculating the cardinality of the domain of the quotient structure. This cardinality becomes the denominator of the fraction that is isomorphic to the assigned universal degree.

These two facts create a potential problem. If the domain of measurements is infinite, then the domain of the quotient structure would be infinite.[25] This entails that the denominator will also be infinite. However, it is not clear that a rational number with an infinite denominator is definable. To eliminate this problem I will assume that the domain of measurements is always finite within any given context.

This assumption is arbitrary. Obviously the actual domain of measurements is infinite and there is no non-linguistic reason to limit this domain. However, in any context, the infinite nature of a measurement system is never needed to justify a comparison nor is it needed to calculate the truth conditions of non-technical statements. Thus, there is no theoretical disadvantage to adopting this assumption. In contrast, by adopting this assumption, a unified account of direct and indirect comparison becomes possible.

5.3.2 Measurements as individuals

As noted by Cresswell (1976) there seems to be something different about the way we talk about measurements of height, width and length as opposed to beauty, talent and intelligence. For example, measurements of width, height and length can be denoted by nouns such as *inches* and *feet*. There are no corresponding nouns for beauty, intelligence or talent. Furthermore, measurements of width, height and length can be predicated by adjectival phrases. Below I address each of these differences in more detail.

[25] This fact is a contingent property related to how I treat measurement systems and how I construct quotient structures. In general this property does not hold. For example, the quotient structure based on mod *n* can convert an infinite set of natural numbers to a finite quotient structure (a quotient structure with *n* elements in the domain).

To begin, there is a certain class of nouns that can be used to refer to measurements. Furthermore these measurements generally belong to scales involved in direct comparison. For example, nouns such as *inches*, *feet*, and *meters* can refer to measurements of width and height. Perhaps not surprisingly, adjectives such as *tall* and *wide* permit direct comparisons.

Like Klein (1982), I do not believe it is a coincidence that adjectives involved in direct comparison are associated with nouns that can refer to measurements. Unlike Klein (1982), who exploits the ability of such nouns to form measure phrases, I believe the explanation is much more fundamental. Nouns are generally interpreted as denoting individuals in the domain of discourse (the domain of the model). If measurements of height (such as inches) and age (such as days) belong to the domain then it would be expected that nouns would be able to denote such measurements. If within the semantic model, measurements have the same ontological status as doors, birthday parties, tables, boys, girls, men and women, then nouns would be expected to denote these measurements in the same way the noun *table* denotes the set of tables or the noun *boys* denotes the set of boys.

In contrast, the lack of nominal correlates for measurements of beauty, intelligence and talent could be explained by the fact that there are no measurements for these gradable properties. Thus in hypothesizing that measurements of height have the same ontological status as individual men or women while measurements of beauty and intelligence do not, one can explain why nouns are able to refer to the former but not the latter.[26]

Further support for the close connection between individuals and measurements comes from predicative facts. Like noun phrases that refer to individuals, noun phrases that refer to measurements of height, width and length can appear as subjects of adjectival predicates such as *is tall* and *is short*. Some examples are given in (30).

(30) a. ...I thought Seymour was six feet and five inches tall, but it turns out that he is only six feet and four inches. Still, six feet and four inches is quite tall.

b. ...I know that Jon is more than three feet tall. In fact, he is five feet. But, five feet is still quite short.

In each of these conversational snippets, a measure phrase serves as a clausal subject. These examples suggest that the individuals denoted by measure phrases participate in the predicates in much the same way as the individuals denoted by names such as *Seymour* and *Jon*. In other words, the predicates *is quite tall* and *is quite short* apply to measurements as if they were individuals.

In summary, the fact that measurements of width, height and length are associated with certain kinds of nouns and the fact that measure phrases can be

[26] To be clear, by *ontological status* I mean the status entities have within the semantic theory rather than the actual world. See, Bach (1986) for a discussion about the difference between the ontology of a semantic model versus the ontology of the real world.

subjects of adjectival phrases support the hypothesis that measurements have the same status as individuals within the semantic model.

5.4 Explaining direct comparisons

The assumptions presented above about measurement systems yield direct comparisons when paired with a semantics involving universal degrees. In what follows, I demonstrate how measurement systems can have such an effect. I first set up a situation that involves a comparison of height and width. I then contrast how the measurement system adds to the complexity of quasi orders that are relevant to such a situation. As I hope to show, the semantic analysis for the comparative morpheme yields the right truth conditions for a variety of sentences where direct comparison is involved.

To begin, let me specify a situation involving seven individuals: six will be represented by the letters a through f. The seventh will be called *Seymour* and will be represented by the letter s. In this situation, Seymour is quite short at five feet and two inches but quite wide at three feet. The other six individuals are all taller than Seymour: a is the tallest at six feet and three inches, b the second tallest at six feet and two inches, and c the third tallest at six feet, while the individuals d, e and f are all five feet and ten inches tall. Given these individuals and these height specifications, the quasi order that encodes the relation *has as much height as* (if it were limited to individuals) would have the graphical representation in Fig. 10. Note, I will use τ as shorthand for the quasi order TALL. This diagram shows a quasi ordering of seven elements. However, given the assumptions outlined above about measurement systems, the quasi order should be much more complex. Measurements should be represented in the quasi order just like the individuals. Thus, measurements such as *five feet* should have as much height as individuals that are five feet and under. Similarly, individuals that are taller than or as tall as five feet should have as much height as the measurement *five feet*. Also, in accordance with how people usually treat measurements of height (of people), the measurement system under consideration should normally be limited to inches.

With these additions, the number of elements in the domain of the quasi order increases significantly. At a minimum, all the measurements from one

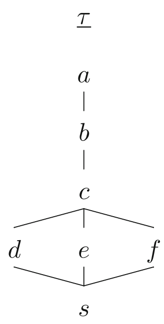


Fig. 10 Quasi order associated with *tall* when limited to individuals

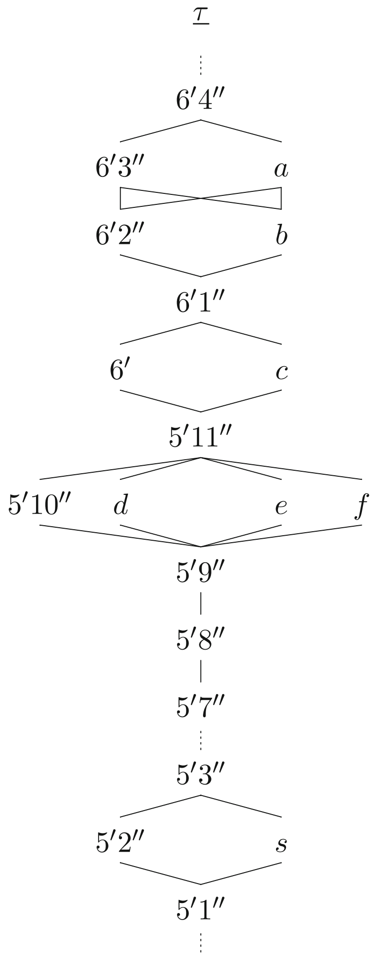


Fig. 11 Quasi order associated with *tall* including measurements. Note that dotted lines indicate a gap in the representation

inch to six foot and three inches should be included in the domain (75 extra individuals). This increase in the number of elements changes the composition of the quasi order. As can be seen in the diagram in Fig. 11, the number of levels in the graphical representation of the quasi order increases from 5 to a number that extends beyond the confines of the page. In contrast to the diagram without measurements, there is an increase in the number of levels and also an increase in the degree of separation between certain individuals. For example, in Fig. 11, five levels separate *s* from *d*, *e*, and *f* whereas in Fig. 10 these individuals are only separated by one level. Also, in Fig. 11 each individual is on the same level as one and only one measurement (but not vice versa).

This kind of effect with measurement systems can also occur with the quasi order associated with *wide*. For example, suppose that in the current situation, Seymour is the widest at three feet, *f* is the second widest at two feet and five inches, followed by *b* at two feet and two inches. The remaining individuals are all equally as wide at

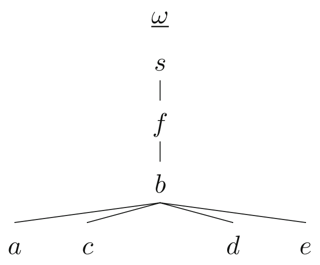


Fig. 12 Quasi order associated with *wide* when limited to individuals

two feet and one inch. Limiting the quasi order WIDE (shorthanded as ω) to people, the relation *has as much width as* would maintain the order depicted in Fig. 12. The diagram shows a quasi ordering of seven elements.

With measurements participating in the quasi order, the graphical representation changes significantly. Consider the diagram in Fig. 13. (Once again, I only partially represent the diagram since there is not enough space for a full representation.) As with τ, the number of elements in the quasi order increases significantly. Furthermore, every individual is on the same level as a measurement.

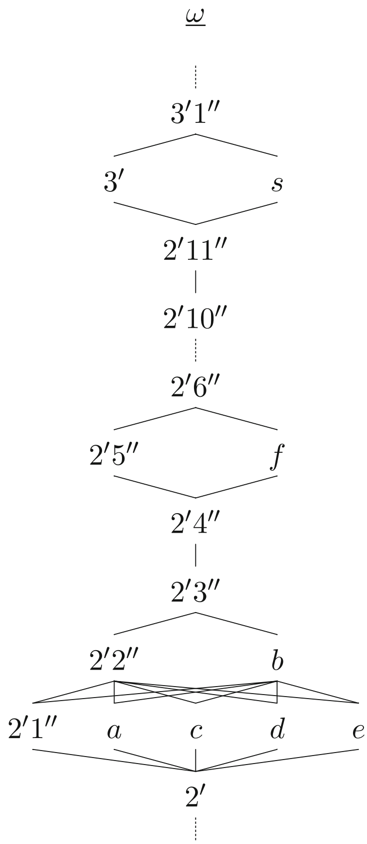


Fig. 13 Quasi order associated with *wide* with measurements. Note that dotted lines indicate a gap in the representation

These more complex quasi orders are useful for providing an account of direct comparison. However, as mentioned earlier in this section they are useful insofar as a limit is put on the number of measurements in the domain of discourse. This limit can be set by arbitrarily choosing an upper bound. For present purposes, I will set the upper bound at six feet and eight inches (eighty inches), although there is nothing important about this choice. As long as the upper bound is taller than the tallest person then a direct comparison will be possible.[27] (Recall that sentences that prefer a direct comparison also have an indirect interpretation. Failure to create the right conditions for a direct comparison simply results in this indirect comparison. Thus, in explaining how to get direct comparisons, I need to only outline how such an interpretation could be possible rather than outlining why it is necessary.) With this arbitrary upper bound, the quasi orders associated with height and width will only involve measurements that are equal to or below six feet and eight inches.

One of the consequences of having this upper bound is that it defines the number of equivalence classes in the resulting quotient structure. Recall that, given the way people usually treat measurements, every individual will be equivalent in height and width to some measurement in inches. Since equivalence classes contain all the individuals that are equal in height (for the quotient structure based on height) or width (for the quotient structure based on width), then each equivalence class will contain at least one measurement. Also, since no two measurements have the same height or width, it follows that each equivalence class will only contain one measurement. As a result, every measurement forms its own equivalence class and every individual is a member of an equivalence class that contains one measurement.

This one to one correspondence to the measurement system has some interesting consequences with respect to the assignment of universal degrees. Recall that each equivalence class Z in a quotient structure $\langle E, \geq \rangle$ is mapped to a universal degree $d_{\frac{x}{y}}$ where x is equal to one plus the number of equivalence classes Z dominates $(|\{Y : Z \geq Y\}|)$ and where y is equal to the number of equivalence classes in the domain of the quotient structure $(|E|)$. Consider the quotient structures $\tau_{/\sim}$ and $\omega_{/\sim}$. Both quotient structures have equivalence classes that contain at least one and only one measurement. As a result, the cardinality of the domain of each quotient structure is defined by the number of measurements in the domain. With six foot eight (or eighty inches) set as the upper bound for the measurement system, the cardinality of both domains is 80. Furthermore, for both of the quotient structures the order of equivalence classes is isomorphic to the order of measurements in the measurement system. For any two measurements, x and y, if x is greater than y in the measurement system then the equivalence class that contains x will be above the equivalence class that contains y in the quotient structure. This holds for $\tau_{/\sim}$ and $\omega_{/\sim}$. As a consequence, for any equivalence class Z that contains the measurement x, the number of equivalence

[27] The setting of an arbitrary upper bound could be accomplished with the comparison class variable or the contextually limited domain of discourse. In any given context the comparison class or the domain of discourse might only contain a subset of possible measurements.

classes Z dominates will be equal to the number of measurements below x in the measurement system. Considering all these facts, the end result is that for any measurement x, the equivalence class that contains x in the quotient structure $\tau_{/\sim}$ will be mapped to the same universal degree as the equivalence class that contains x in the quotient structure $\omega_{/\sim}$. In other words, the two quotient structures are isomorphic to each other despite the fact that the content of the equivalence classes (in terms of people, not measurements) differs quite significantly.

This assignment pattern with respect to measurements and universal degrees affects the truth conditions for comparative sentences. According to the interpretation given in section Sect. 3, the truth conditions for comparatives are equivalent to a comparison of two universal degrees. Comparative sentences are true if and only if the universal degree associated with the main clause is greater than the one associated with the *than*-clause. Furthermore, the universal degrees represent the relative positions of the equivalence classes containing the clausal subjects in their respective quotient structures. The quotient structures are created from the quasi orders associated with the adjectives in the main and *than*-clauses. If the adjectives in the main and *than*-clauses are *tall* and *wide* and if these adjectives are affected by the measurement system in the appropriate way, then the universal degrees for both the main and *than*-clause will be isomorphic to the position of the measurement contained in the equivalence class. As a consequence, if the measurement in the equivalence class containing the subject of the main clause is greater than the measurement in the equivalence class containing the subject of the *than*-clause, then the universal degree associated with the main clause will be greater than the one associated with the *than*-clause. A comparison in terms of universal degrees is equivalent to a comparison in terms of measurements. This is exactly what is wanted to account for direct comparisons.

To understand this parallelism in more detail let's consider some examples. The sentences in (31) allow for direct comparisons.

(31) a. Seymour is taller than he is wide.
b. Seymour is wider than he is tall.

In the current situation, where Seymour is five feet and two inches tall but three feet wide, the sentence in (31a) is true where as (31b) is false. At least this is the case for the more salient reading of these sentences.[28] Given the interpretation for the adjectives specified in Sect. 3.4, the truth conditions of these three sentences will be based upon a comparison of the universal degrees that represent the positions of Seymour's equivalence classes in the quotient structures associated with heights and widths. The Universal Homomorphism yields a function that maps Seymour's equivalence classes to the universal degrees that represents these positions. In Figs. 14 and 15, I show some of the more relevant equivalence classes in the quotient structures

[28] As noted earlier, it is possible (although a little difficult) to have an indirect comparison with these sentences. However, I will temporarily ignore this possibility for now.

Fig. 14 From left to right: the quotient structure derived from *tall* and the associated universal degrees

$$\begin{array}{cc}
\underline{\mathcal{T}/\sim} & \underline{\Omega} \\
\{6'8''\} & d_{\frac{80}{80}} \\
\vdots & \vdots \\
\{6'4''\} & d_{\frac{76}{80}} \\
| & | \\
\{6'3'', a\} & d_{\frac{75}{80}} \\
| & | \\
\{6'2'', b\} & d_{\frac{74}{80}} \\
| & | \\
\{6'1''\} & d_{\frac{73}{80}} \\
| & | \\
\{6', c\} & d_{\frac{72}{80}} \\
| & | \\
\{5'11''\} & d_{\frac{71}{80}} \\
| & | \\
\{5'10'', c, e, f\} & d_{\frac{70}{80}} \\
| & | \\
\{5'9''\} & d_{\frac{69}{80}} \\
\vdots & \vdots \\
\{5'3''\} & d_{\frac{63}{80}} \\
| & | \\
\{5'2'', s\} & d_{\frac{62}{80}} \\
\vdots & \vdots \\
\{3'\} & d_{\frac{36}{80}} \\
\vdots & \vdots \\
\{2'6''\} & d_{\frac{30}{80}} \\
\vdots & \vdots \\
\{0'1''\} & d_{\frac{1}{80}}
\end{array}$$

of heights and widths on the left hand side while also giving the relevant universal degrees on the right-hand side. Recall that for this context, the number of measurements has an arbitrary upper bound, namely 6’8” (or 80 inches). As a result of the upper bound, each equivalence class in both of the quotient structures is mapped to a universal degree that is isomorphic to a fraction of the form $\frac{x}{80}$, where x is a natural number. Due to the effect of the measurements on the quasi order (and hence the quotient structure) each equivalence class will contain only one measurement, let’s call this measurement m. Furthermore, each equivalence class will be placed above n

Fig. 15 From left to right: the quotient structure derived from *wide* and the associated universal degrees

$\omega_{/\sim}$	Ω
$\{6'8''\}$	$d_{\frac{80}{80}}$
$\{5'10''\}$	$d_{\frac{70}{80}}$
$\{5'2''\}$	$d_{\frac{62}{80}}$
$\{3'1''\}$	$d_{\frac{37}{80}}$
$\{3', s\}$	$d_{\frac{36}{80}}$
$\{2'11''\}$	$d_{\frac{35}{80}}$
$\{2'6''\}$	$d_{\frac{30}{80}}$
$\{2'5'', f\}$	$d_{\frac{29}{80}}$
$\{2'4''\}$	$d_{\frac{28}{80}}$
$\{2'3'', g\}$	$d_{\frac{27}{80}}$
$\{2'2'', b\}$	$d_{\frac{26}{80}}$
$\{2'1'', a, c, d, e\}$	$d_{\frac{25}{80}}$
$\{2'\}$	$d_{\frac{24}{80}}$
$\{0'1''\}$	$d_{\frac{1}{80}}$

other equivalence classes, where n is the number of measurements that m is greater than. Thus, the value of x will always equal $n+1$, no matter which quotient structure the equivalence class is in. Stated otherwise, for all X and Y such that X is a member of the quotient structure $\tau_{/\sim}$ and Y is a member of the quotient structure $\omega_{/\sim}$, if a measurement m is a member of both X and Y then $\mathfrak{H}_{\tau_{/\sim}}(X)$ will be identical to $\mathfrak{H}_{\omega_{/\sim}}(Y)$. X and Y will be mapped to the same universal degree. For example, if X contained the measurement $3'$ and Y also contain the same measurement, then both equivalence classes would be mapped to $d_{\frac{36}{80}}$.

This mapping has consequences for the interpretation of (31a). If the comparison class is broad enough (i.e., if it is larger than D_τ and D_ω), then $(\tau\upharpoonright C)$ and $(\omega\upharpoonright C)$ will simply be equivalent to τ and ω. The comparison class will have no effect on the quasi order or the quotient structure. (Note that this possibility is left open since there is no *for*-clause that overtly restricts the comparison class.) As a result, the truth conditions in (32) represent the interpretation of (31a).

(32) Truth conditions for *Seymour is taller than he is wide*:
$$\mathfrak{H}_{(\tau\upharpoonright C)_{/\sim}}(\bar{s}) \succ \mathfrak{H}_{(\omega\upharpoonright C)_{/\sim}}(\bar{s})$$
$$= \mathfrak{H}_{\tau_{/\sim}}(\bar{s}) \succ \mathfrak{H}_{\omega_{/\sim}}(\bar{s}) \text{ (since } (\tau\upharpoonright C) = \tau \text{ and } (\omega\upharpoonright C) = \omega)$$
$$= d_{\frac{62}{80}} \succ d_{\frac{36}{80}} = \mathbf{1}$$

The truth of the sentence is based on a comparison of two universal degrees. Since Seymour is five feet and two inches tall, the measurement $5'2''$ is a member of his equivalence class for height. Thus, the universal degree that represents Seymour's position in the quotient structure is $d_{\frac{62}{80}}$. Furthermore, since Seymour is three feet wide, the measurement $3'$ is a member of the equivalence class for width. As a consequence, the universal degree that represents Seymour's position in the quotient structure is $d_{\frac{36}{80}}$. The sentence is true since $d_{\frac{62}{80}}$ is greater than $d_{\frac{36}{80}}$. This holds despite the fact that Seymour is quite wide and yet not tall.

Like (31a) the truth conditions for (31b) will be based upon a comparison of two universal degrees (one that represents Seymour's height and another that represents his width). The truth conditions for (31b) are given in (33).

(33) Truth conditions for *Seymour is wider than he is tall*:
$$\mathfrak{H}_{(\omega\upharpoonright C)_{/\sim}}(\bar{s}) \succ \mathfrak{H}_{(\tau\upharpoonright C)_{/\sim}}(\bar{s}) = \mathfrak{H}_{\omega_{/\sim}}(\bar{s}) \succ$$
$$\mathfrak{H}_{\tau_{/\sim}}(\bar{s}) \text{ (since } (\tau\upharpoonright C) = \tau \text{ and } (\omega\upharpoonright C) = \omega)$$
$$= d_{\frac{36}{80}} \succ d_{\frac{62}{80}} = \mathbf{0} \text{ \label{e16a}}$$

The sentence in (31b) is false. The universal degree that represents Seymour's width is less than the one that represents his height.

In summary, measurement systems affect quasi orders in such a way that a comparison of universal degrees becomes equivalent to a comparison of measurements. This is what leads to the characteristics that define direct comparisons. Interestingly, the semantics for the comparative morpheme (that were developed to account for indirect comparison) do not change. Direct comparisons can simply be derived from the nature of the quasi orders.

I should highlight before concluding this section that a direct comparison depends on three contingent properties being met. First, the comparison class variable must not exclude measurements from the underlying quasi orders. As I discuss in Sect. 5.5, it is possible for such an exclusion to occur and when it does a direct comparison is not available. Second, both equivalence classes must have the same upper bound. Note that this is not a necessary fact about the semantic system. In principle, two quasi orders need not share the same upper bound, although I should qualify that it is extremely probable for the same upper bound to be specified in both quasi orders since both of their domains are based on the same model in the same context. Third, every individual must be equivalent to a member of a discrete set of measurements. Once again, it is possible for people to treat an individual as if he is not equivalent to any measurement, although, as noted earlier, people normally do not treat measurements in this way. Without these three contingent properties a direct comparison would be impossible. However, the contingency of these properties is not empirically problematic since indirect comparisons, although strained, are possible for these types of sentences. Hence, all that is needed to explain direct comparisons is the possibility of a comparison that is equivalent to one based on measurements. This kind of interpretation should not be forced by the semantic system.

5.5 Further support

In Sect. 5.4, I demonstrated the plausibility of a universal interpretation for direct and indirect comparison. By manipulating the effect of measurement systems on quasi orders, a uniform interpretation of the comparative morpheme can be maintained. In this section I discuss additional empirical support for this theory of direct comparison that involves manipulating grammatical structure to force indirect comparisons. According to the theory described above, direct comparisons are only possible when measurements are part of the underlying quasi order. Hence, such comparisons should be impossible when measurements are overtly excluded from the quasi order. Prepositional phases such as *for a man* specify a comparison class that does not contain any measurements (only men). As I discuss below, when such overt specifications are used, direct comparisons are impossible.

Let me introduce an example sentence to facilitate a discussion about how *for*-clauses interact with adjectives such as *tall* and *wide*. Consider the sentence in (34) below.

(34) Seymour is taller than he is wide.

The sentence in (34) prefers a direct comparison. Seymour is taller than he is wide as long as the measurement of his height exceeds the measurement of his width. This holds even if Seymour is wider and shorter than most other men. Interestingly, the addition of prepositional phrases changes the truth conditions for these sentences. This is demonstrated with the sentence in (35).

(35) Seymour is taller for a man than he is wide for a man.

Unlike the sentence in (34), the sentence in (35) can be false even when the measurement of Seymour's height is greater than the measurement of his width. In particular, if Seymour is quite short at four feet and quite wide at three feet then he is taller than he is wide but he is not taller for a man than he is wide for a man.

A semantics with universal degrees predicts this kind of effect with *for*-clauses. Recall that a *for*-clause basically sets the value of the comparison class for the main and *than*-clause. As a consequence, the comparison class for the main clause and the *than*-clause in (35) will be equal to the set of all men in the context. This comparison class value contrasts with (34) where no restriction is overtly present. In other words, the comparison class for (34) can contain degrees whereas the comparison class for (35) cannot. Such a difference leads to different truth conditions.

The effect of *for*-clauses is probably best understood with an example. Consider the following situation. Suppose that the individuals a through s represent the men in the current context. The letter s will represent Seymour. For the sentence in (34) the comparison class can be the entire domain. Thus, restricting the underlying quasi order by the comparison class does not change the composition of the quasi order. If τ were the quasi order associated with *tall* and ω the quasi order associated with *wide*, then $(\tau\restriction C)$, and $(\omega\restriction C)$ would be equivalent to τ and ω respectively. As a result, the quotient structures associated with *tall* and *wide* would be isomorphic to the measurement system used to measure width and height. Also, since Seymour is five feet tall, he would be grouped into an equivalence class with the measurement $5'$ in $\tau_{/\sim}$. Furthermore, since Seymour is three feet wide, he would be grouped into an equivalence class with the measurement $3'$ in $\omega_{/\sim}$. Since the quotient structures $\tau_{/\sim}$ and $\omega_{/\sim}$ are both isomorphic to the measurement system, it follows that the Seymour's equivalence class with respect to height will be mapped to a greater universal degree than his equivalence class with respect to width. This fact makes the sentence in (34) true.

Now consider a situation where the quasi orders are restricted by comparison classes containing only men. Let's assume that the other men in this situation (represented by the letters a through r) are all taller than Seymour. Also, let's assume that Seymour is wider than most of the men (perhaps there is one gentleman, call him i, that is as wide as he is). The quasi orders in on the left in Figs. 16 and 17 are consistent with these assumptions, where C is equal to the set of men in the context. Since measurements are not men, the resulting quotient structures will not contain equivalence classes that involve measurements. As a result, the quotient structures do not have an isomorphic relationship with the measurement system. This changes how the equivalence classes are mapped to universal degrees. (In Figs. 16 and 17, the three quotient structures appear in the middle while the associated universal degrees appear to the far right.) These assignments of universal degrees contrast sharply with the unrestricted quasi orders. With the restricted quasi orders, the universal degree assigned to the equivalence class containing Seymour with respect to height is no longer greater than the universal degree assigned

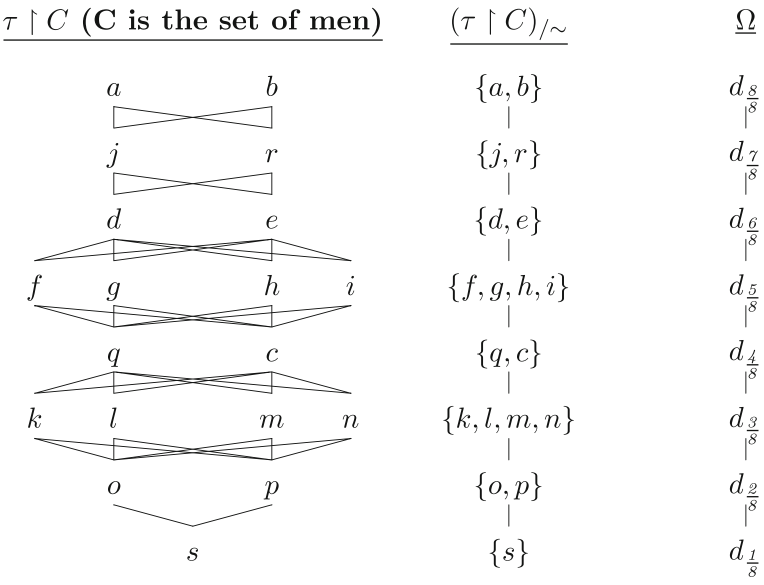


Fig. 16 From left to right: the quasi order for *tall* restricted to men, the derived linear order and the associated universal degrees

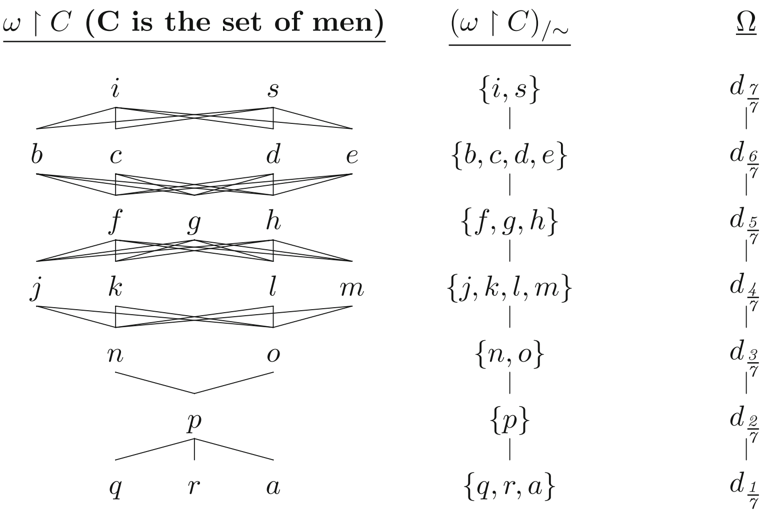


Fig. 17 From left to right: the quasi order for *wide* restricted to men, the derived linear order and the associated universal degrees

to his equivalence class with respect to width. The first is $d_{\frac{1}{8}}$ while the second is $d_{\frac{7}{7}}$. A formula representing the truth conditions for the sentence in (35) is given below.

(36) Truth conditions for *Seymour is taller for a man than he is wide for a man*:
$\mathfrak{H}_{(\tau\restriction C)_{/\sim}}(\overline{s}) \succ \mathfrak{H}_{(\omega\restriction C)_{/\sim}}(\overline{s})$
$= (d_{\frac{1}{8}} \succ d_{\frac{7}{7}})$
$= 0$ (where $C = \{a, b, c, d, e, f, g, h, i, j, k, l, m, n, o, p, q, r, s\}$)

As shown, (35) is false despite the fact that the measurement of Seymour's height is greater than his width.

This kind of result carries over to other constructions without prepositional phrases. Nominals to which the gradable adjectives serve as modifiers often pragmatically restrict the comparison class. In general, the comparison class must be a subset of the denotation of the nominal. With this assumption in mind, consider the sentence in (37).

(37) Seymour is a taller man than he is a wide man.

Like (35) and unlike (34), the sentence in (37) is false in a situation where Seymour is quite short at five feet but quite wide at three feet. This fact can be explained by assuming that the comparison classes for both the main and *than*-clause only contain men. In this sentence, the quasi-orders and quotient structures are the same as the ones employed in the derivation of (35). The only difference with such a sentence is that the adjective is used attributively rather than as a predicate. As a result, the complex adjectival phrase containing the comparative, the gradable adjective and the *than*-clause combines with the nominal through intersection. However, this does not change the overall truth conditions of the sentence. The derivation of the interpretation for (37) is given below. (Note, I will assume that the indefinite in the predicate position is interpreted as a set.)

Interpretation of the than-clause:
$[\![$than $\{\text{OPERATOR}\}_d$ he is a [d *COMP* wide C] man$]\!]$,
(where C is equal to the set of men)
$= sup\{d : ([\![d \text{ COMP wide } C]\!] \cap [\![\text{man}]\!])])(s)\}$
$= sup\{d : (\mathfrak{H}_{(\omega\restriction C)_{/\sim}}(\overline{s}) \succeq d)\ \&\ \text{MAN}(s))\} = \mathbf{d}_{\frac{7}{7}}$

Interpretation of the entire sentence:
$[\![$Seymour is a taller man than he is a wide man$]\!]$
$= ([\![\text{Seymour}]\!](([\![\ MORE]\!]([\![\text{tall}]\!]C) \cap [\![\text{man}]\!])([\![\text{than he is wide for a man}]\!])))$,
(where C is equal to the set of men)
$= (\mathfrak{H}_{(\tau\restriction C)_{/\sim}}(\overline{s}) \succ d_{\frac{7}{7}})\&\text{MAN}(s)$
$= ((d_{\frac{1}{8}} \succ d_{\frac{7}{7}})\ \&\ MAN(s))$
$= 0$, since $(d_{\frac{1}{8}} \succ d_{\frac{7}{7}}) = 0$

The truth conditions for (37) are based on a comparison of two universal degrees. Since the nominal restricts measurements from the comparison classes, the result is an indirect comparison.

In summary, the theory presented in Sect. 3 is able to explain why a restriction in comparison classes would result in indirect comparisons. Direct comparisons depend on measurements participating in quasi orders and quotient structures in much the same way that other individuals participate in the quasi orders and quotient structures. By restricting the comparison classes to men, the resulting quasi orders will only contain men. They will no longer contain measurements. As a result, direct comparisons are no longer possible. This aspect of the current theory is quite important. No other theory of comparison adequately explains why both prepositional phrases and nominal modification force indirect comparisons. Theories such as those presented in Bartsch and Vennemann (1972), Seuren (1973), Cresswell (1976), von Stechow (1984a), and Kennedy (1999) all treat adjectives like *tall* and *wide* as if they directly relate individuals to measurements. As their theories currently stand, there is no obvious way for comparison classes to interfere with this relation. In a theory such as Klein's (1980, 1982) that is based on degree modifiers, no explanation is given of why degree modifiers in attributive instances of the adjectival phrases should be different from the degree modifiers in predicative instances of adjectival phrases.

6 Residual issues

6.1 Other constructions

This paper has focused on constructions where there are different adjectives in the main clause and the *than*-clause. Other comparative constructions such as *John is more beautiful than Mary is*, *John is taller than Mary is*, and *John is taller for a man than Mary is for a woman* have not been discussed. However, the semantics given for direct and indirect comparisons extends quite easily to these constructions. The only difference between these constructions and the others is that the same adjective is being used in each clause (I adopt the standard assumption that the *than*-clause in these types of constructions has an adjectival value identical to the adjective in the main clause, whether due to ellipsis, movement or functional application). The semantics of such sentences would still involve comparing the positions of individuals in the primary scale. However in contrast to direct and indirect comparisons discussed in this paper, the same underlying quasi order is relevant for both individuals involved in the comparison. Otherwise the analysis is identical.

Note, if the comparison class is the same for both clauses as in sentences such as *John is more beautiful than Fred is*, such sentences end up having completely isomorphic primary scales associated with each clause. Hence, such sentences are more akin to direct comparisons despite the fact that most of them would not involve measurements. Measurements are only needed to derive direct comparisons when the attributes described by the adjective in the main clause are different from the ones described by the adjective in the *than*-clause. In contrast, when the comparison class is different for the main clause compared to the *than*-clause, as in sentences such as *John is more beautiful for a man than Mary is for a woman*, the two primary scales associated with each clause are not isomorphic. Hence, such sentences are more akin to indirect comparisons.

Beside these other comparative sentences, one can also use a similar type of analysis to provide truth conditions for absolutive constructions like *John is tall*. In fact, one can adopt the same semantics as Kennedy (1999) where the adjective (as a measure function) combines with the phonetically null *COMP* morpheme and some standard degree. The only difference is that the standard degree would be a universal degree (something like $d_{\frac{1}{3}}$). See Bale (2006) for details.

6.2 Klein's theory

Having described my account of direct and indirect comparisons, I would like to address the one other theory that does provided such an analysis, namely Klein (1980, 1982, 1991). Although much of my own theory builds off of Klein's observations, there are problems for Klein's unified analysis that are overcome by my proposal.

In Klein's theory, the analysis of sentences such as *John is taller than he is wide* and *John is more intelligent than he is beautiful* are based upon truth conditions that range over degree modifiers such as *very*, *somewhat*, *two inches* etc. Thus, the sentence *John is taller than he is wide* is true according to Klein iff there is some degree modifier (call it *D*) such that John is *D* tall but not *D* wide. If John were five feet tall and two feet wide, then the existence of the degree modifier *five feet* would render the sentence true.

Similar to the sentence with direct comparisons, the sentence *John is more intelligent than he is beautiful* is true iff there is some degree modifier *D* such that John is *D* intelligent but not *D* beautiful. The difference between this sentence and ones that allow for direct comparison is that measure phrases cannot apply to both of the adjectives *beautiful* and *intelligent*. Hence, only degree modifiers like *very* and *somewhat* could render the sentence true.

Although Klein exploits the quantification over degree modifiers with some success, there are still some problems. I discuss two of these problems below: one involving a lack of ambiguity and another involving the effect of comparison classes in inducing indirect readings.

To address the first, consider the sentences (38a) and (38b).

(38) a. Seymour is very wide but he is not very tall.
b. Seymour is wider than he is tall.

Given the situation where Seymour is five feet tall and four feet wide, the sentence in (38a) is true. In contrast the sentence in (38b) is not so easy to evaluate. It can be true although such a reading is not preferred. Normally direct comparisons are favoured over indirect when the adjectives are commensurable. Without contextual priming, most speakers would consider the sentence in (38b) to be false. Yet, according to Klein's interpretation, a false interpretation is not a possibility. The fact that a delineator like *very* can make the conjunct in (38a) true entails that the sentence in (38b) must be true. Klein's uniform interpretation of comparatives does not permit ambiguous truth conditions for a single sentence. Yet in the my proposal, ambiguity can arise depending on the contextually primed comparison class. Without contextual restriction, measurements would be a part of the comparison class and hence a direct comparison would be expected. With the appropriate contextual priming, the comparison class could be restricted to boys or men and hence an indirect comparison would be expected.

The second problem for Klein's theory involves the interaction between comparison classes and indirect comparison. Comparison classes can induce an indirect comparison when overtly appearing in both the main clause and the *than*-clause. Yet, in Klein's theory, direct comparisons should not be affected by comparison classes since such comparisons are based on degree modifiers. Consider (39),

(39) Seymour is a five foot tall man but he is not a five foot wide man.

This sentence is true given the circumstance where Seymour is five feet tall and four feet wide. In contrast, the following sentence is not true.

(40) Seymour is a taller man than he is a wide man.

Nothing in Klein's theory explains this contrast. The interpretation of the sentence in (40) should be true if there exists a degree modifier *D* such that Seymour is a *D* tall man but not a *D* wide man. As (39) demonstrates, such a degree modifier exists, namely *five foot*. Klein's theory suggests that sentences like (40) should permit direct comparisons. (This being said, it is possible that Klein would rule out such sentences based on syntactic considerations. If so, then the criticisms advanced here would be moot.) As demonstrated in Sect. 5.5, my proposal naturally accounts for this kind of restriction.

In summary, Klein's theory attempts to unify direct and indirect comparison, however he is unable to explain why certain ambiguities exist and why certain constructions do not allow direct comparisons.

6.3 Unified by coercion

A potential alternative to the one sketched out in this paper[29] would be to have a coercion operator that converts adjectives (regular measure functions that range over different kinds of measurements) into measure

[29] The general outline of this alternative was suggested to me by Chris Kennedy (p.c.). Although I believe I have represented the spirit of his proposal, the details (and errors) discussed in this section are completely my own.

functions that range over universal degrees. This conversion process would use a finite comparison class to map a Kennedy-style gradable adjective to an interpretation that is basically equivalent to the one I gave in Sects. 3 and 4.1.1. The derivation of a primary scale and the functioning of a universal homomorphism would still work in the same way but would only apply when adjectives were incommensurable. The advantage of such an analysis are two-fold: one would not have to put an arbitrary limit on the domain of measurements to make it finite and one could explain certain anomalies with respect to indirect comparison. Below I address each of these points while also discussing some potential problems with this kind of alternative.

The first advantage of such analysis concerns the arbitrariness of limiting the domain of measurements. This needs to be done in my theory or else the mapping of a scale to universal degrees would be impossible. In the alternative analysis, direct comparisons would not require any type of coercion since the adjectives *tall* and *wide* would be commensurable. However, although I acknowledge that this is a failing of my theory, I suspect that it is a failing of the formalism rather than the general idea. The general idea is that individuals are mapped to a proportion that represents their position in a scale. It just so happens that I use fractions to represent this position and that fractions require a finite denominator. However, if proportions could be represented without fractions then such an arbitrary restriction could be removed. It is only due to the limitation of my choice of metalanguage that forces the analysis to limit the domain of measurements. Perhaps a better choice could remove this ‘‘flaw’’ in the analysis.

The second advantage of the alternative analysis is that it predicts that conversion is only possible when a comparison class is specified or salient in the context. This is an advantage due to the fact that there are certain situations where indirect comparisons are awkward but where direct comparisons are not. For example, out of the blue, the sentence in (41a) seems a little awkward.

(41) a. John is more talented than Mary is beautiful.
b. The door is longer than the table is wide.

In contrast, the direct comparison in (41b) is not awkward out of the blue. At a glance, my theory does not seem to predict a contrast. With a unified analysis, both sentences in (41) would involve comparison classes to construct a scale and hence both should be awkward if the comparison classes are not salient in the context. The fact that comparison-class saliency is what causes the awkwardness of (41a) is supported by the fact that (42a) and (42b) are not awkward when uttered out of the blue.

(42) a. John is taller for a man than Mary is for a woman.
b. Mary is more intelligent than Marilyn Monroe was beautiful.

The sentence in (42a) specifies its comparison class overtly where as the use of a well-known prototype of beauty in (42b) introduces a comparison class of famous (or infamous) characters of history or popular culture (characters known for either there intelligence/beauty, or lack thereof).[30]

Now the alternative, coercion-based theory correctly predicts that the sentence in (41b) should not be awkward since it involves commensurable adjectives and hence its truth conditions need not involve a comparison class. However, although the contrast is real, I believe that one can also explain the contrast by hypothesizing that measurements are made salient by adjectives of length, width and height. This does not seem unreasonable to me. Since measurement systems are known to all speakers and since they are always relevant in calculating or estimating something's width or length, it seems likely that they would come to the foreground when adjectives like *long* and *wide* are mentioned. If this were true, then there would always be a ready set of measurements that would be able to participate in the comparison class for length or width even when no other contextual cues are present.[31] Since this line of reasoning is plausible, it is unclear whether the alternative really holds that much of an empirical advantage with respect to this type of contrast.

Before concluding this section, let me point out one potential advantage of my analysis over the alternative. My analysis predicts that sentences like *John is a taller man than Mary is a tall woman* are forced to have an indirect interpretation. Insofar as such sentences are grammatical, this prediction seems to be true. In the alternative analysis, it is not clear to me why an indirect comparison would be forced since the sentence obviously involves two commensurable adjectives. For this reason, I prefer to interpret indirect and direct comparison using the same type of interpretation rather than favouring a coercion-based analysis.

7 Conclusion

The main empirical hurdle set out at the beginning of this paper was to provide a unified interpretation for the comparative morpheme but yet still account for the differences between a direct and indirect comparison. In Sect. 3, I provided such an interpretation. I proposed that the comparative morpheme yields truth conditions that depend on a comparison of two

[30] In Bale (2006) it was suggested that indirect comparison often prefer the participant in the than clause to be at an extreme end of the primary scale, either very high or very low. However, the preference only occurred in sentences where prototypical characters are mentioned such as Marilyn Monroe or Medusa. I have now come to realize that this tendency is due to the fact that there are very few people or characters that are famous for having a quality to a very average extent.

[31] For other sentences such as *John is more intelligent than Bill is*, Wheeler (1972) has pointed out that minimally such sentences would induce a comparison class involving two people: in our example sentence this would be John and Bill. Such comparison classes are good enough to evaluate the truth or falsity of the sentence. In fact, the truth or falsity of such sentences with the minimal comparison class entail the truth or falsity of such sentences with larger comparison classes and vice versa. Hence, the hearer need not concern himself or herself with what comparison class the speaker has in mind.

universal degrees: one associated with the main clause and the other with the *than*-clause. The main clause is associated with the universal degree that encodes the position of the equivalence class containing the main-clause subject in a primary scale derived from an underlying relation. Similarly, the subordinate clause is associated with the universal degree that encodes the position of the equivalence class containing the subordinate-clause subject in a primary scale derived from an underlying relation. The comparative morpheme compares these two universal degrees by a strictly greater-than relation. As a result, a comparative sentence is true if and only if the position represented by the universal degree associated with the main clause is strictly greater than the one associated with the *than*-clause. These truth conditions are the same in any given context and with any given gradable adjectives. There is no difference in evaluating a direct comparison as opposed to an indirect comparison. Rather the only difference between direct and indirect comparisons arises in the composition of the primary scales.

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References

Bach, E. (1986). Natural language metaphysics. In R. Barcan Marcus, G. J. W. Dor, & P. Weingartner (Eds.), *Logic, methodology and philosophy of science VII* (pp. 573–595). Amsterdam, New York: Elsevier Science Publishers.

Bale, A. C. (2006). *The universal scale and the semantics of comparison*. Ph.D. Thesis, McGill University (www.alanbale.com).

Bartsch, R., & Vennemann, T. (1972). *Semantic structures: A study in the relation between semantics and syntax*. Frankfurt am Main: Athenaum.

Bell, J. L., & Alan, B. S. (1969). *Models and ultraproducts: An introduction*. Amsterdam: North-Holland Publishing Co.

Bell, J. L., & Machover, M. (1977). *A course in mathematical logic*. Amsterdam: North-Holland Publishing Co.

Bierwisch, M. (1987). Semantik der Graduierrung. In M. Bierwisch & E. Lang (Eds.), *Grammatische und Konseptuelle Aspekete von Dimensionsadjektiven* (pp. 91–286). Berlin: Akademie Verlag.

Bresnan, J. (1973). Syntax of the comparative clause construction in English. *Linguistic Inquiry, 4*(3), 275–344.

Bresnan, J. (1975). Comparative deletion and constraints on transformations. *Linguistic Analysis, 1*(1), 25–75.

Chomsky, N. (1957). *Syntactic structures*. The Hague, Netherlands: Mouton.

Cresswell, M. J. (1976). The semantics of degree. In B. Partee (Ed.), *Montague grammar* (pp. 261–292). New York: Academic Press.

Embick, D. (2007). Blocking effects and analytic/synthetic alternations. *Natural Language and Linguistic Theory, 25*(1), 1–37.

Fox, D., & Hackl, M. (2006). The universal density of measurement. *Linguistics and Philosophy, 29*(5), 537–586.

Hellan, L. (1981). *Towards an integrated theory of comparatives*. Narr, Tubingen.

Kennedy, C. (1999). *Projecting the adjective: The syntax and semantics of gradability and comparison*. New York: Garland.

Kennedy, C., & McNally, L. (2005). Scale structure and the semantic typology of gradable predicates. *Language, 81*, 345–381.
Klein, E. (1980). A semantics for positive and comparative deletion. *Linguistics and Philosophy, 4*(1), 1–46, 1980.
Klein, E. (1982). The interpretation of adjectival comparatives. *Journal of Linguistics, 18*, 113–136.
Klein, E. (1991). Comparatives. In A. von Stechow & D. Wunderlich (Eds.), *Semantik/semantics: An international handbook of contemporary research* (pp. 673–691). Berlin: Walter de Gruyter.
Krantz, D. H., Luce, R. D., & Tversky, A. (1971). *Foundations of measurement*. New York, London: Academic Press.
Landman, F. (1991). *Structures for semantics*. Dordrecht, Boston: Kluwer Academic Publishers.
Landman, F. (2004). *Indefinites and the type of sets*. Oxford: Blackwell.
Ludlow, P. (1989). Implicit comparison classes. *Journal of Linguistics, 12*, 519–533.
McCawley, J. D. (1976). Quantitative and qualitative comparison in English. In *Grammar and meaning* (pp. 1–14). New York: Academic Press.
Nakanishi, K. (2003). Semantics of measure phrases. In M. Kadowaki & S. Kawahara (Eds.), *The Proceedings of the 33rd Conference of the North East Linguistic Society* (pp. 225–244).
Schwarzschild, R. (2002). The grammar of measurement. In B. Jackson (Ed.), *Proceedings of SALT XII*. Ithaca: CLC Publications.
Seuren, P. A. M. (1973). The comparative. In F. Kiefer & N. Ruwet (Eds.), *Generative grammar in Europe* (pp. 528–564). Dordrecht: D. Reidel Publishing Company.
von Stechow, A. (1984). Comparing semantic theories of comparison. *Journal of Semantics, 3*, 1–77.
Wheeler III, S. C. (1972). Attributives and their modifiers. *Nous, 6*(4), 310–334.