Kennedy and McNally (2005), "Scale structure, degree modification, and the semantics of gradable predicates"

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1 Introduction

Differences in the distribution of modifiers with gradable predicates (for instance, *very*, *well*, and *much*). Corpus data (see section 1 in the paper) back these intuitions up as well.

(1) a. Beck is well/??very/??much acquainted with the facts of the case.
b. We'll be surrounded by dozens of people—you'll be well/??very/??much protected.
c. By the time it reached the Manchester Palace, it had become a well/??very/??much documented tour.

(2) a. When the results for beech trees were disclosed, they were nearly identical to the much/??well/??very criticised FoE survey of 1985.
b. Even at the then much/??well/??very praised Alfort school, their four-year course was considered to be too long.
c. Fortunately, with much/??well/??very appreciated financial help . . . the workshop was organised and held successfully.

(3) a. A very/??well/??much surprised face peered out of the window.
b. Kim was very/??well/??much worried by the diagnosis.
c. Ron Weasley is very/??well/??much frightened of spiders.

Goals:

- Develop a typology of gradable expressions, dependent on two semantic properties.
  - Structure of the scale used (in particular, whether the scalar endpoints are open or closed).
  - Nature of the standard of comparison (whether it is contextually determined or fixed)
- Demonstrate that gradable properties are determined by the nature of the individuals or events a gradable expression is associated with (e.g., how gradability and scale structure are manifested across different syntactic categories). Since the discussion here will take a lot of time, we won't go into this for the moment.

2 Semantic type of gradable predicates

Fundamental property of gradable expressions: context-dependence.

- What might count as *expensive* or *tall* can vary from context to context.
- Characterize truth-conditionally by making reference to a contextually defined standard of comparison.

(4) a. Michael Jordan is tall.
b. The Mars Pathfinder mission was expensive.

(5) a. Michael Jordan's height exceeds a standard of tallness.
b. The cost of the Mars Pathfinder mission exceeded a standard of expensiveness.

Standard of comparison determined relative to a comparison class:

- For space missions, possibly other space missions, or government programs.
- For people, other people in the same profession, age, gender, and so on.
- Determines truth or falsity in a context.

Kennedy & McNally make use of measure functions, functions that map an individual to a degree. Measure along a scale, a set of ordered degrees associated with a dimension of measurement (HEIGHT, COST, TEMPERATURE, etc). More or less the following:

(6) **expensive**$(x) \stackrel{\text{def}}{=}$ the maximal degree d along the COST dimension that holds of x

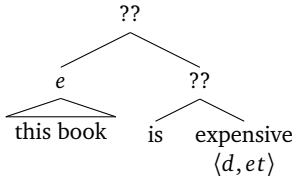
Gradable adjectives for Kennedy & McNally are taken to be relations between degrees and individuals, making use of this measure function.

(7) $[\![\textit{expensive}]\!] = \lambda d \lambda x.\textbf{expensive}(x) = d$

But, we immediately run into a problem: what do we do with the degree argument in a sentence like (8)?

(8) This book is expensive.

(9)



To keep things compositional, a silent morpheme POS (for "positive form") is taken to close off the degree argument. Some unpacking (this is largely review now, though):

- Existential quantification over degrees, in order to saturate the d argument of the adjective.
- Since the adjective is entailed to hold of the subject in absolutive/positive sentences, a predicate **standard** is used.[1]
- A standard is the cut-off degree for some gradable property. (e.g., maybe 1.8m is the cut-off degree in order to be considered tall)
- **standard** says d meets the standard for gradable predicate G in context C.[2]

(10) $[\![\text{POS}]\!] = \lambda G \lambda x . \exists d [\textbf{standard}(d)(G)(C) \wedge G(d)(x)]$

(11) $[\![\text{POS } \textit{expensive}]\!] = \lambda x . \exists d [\textbf{standard}(d)([\![\textit{expensive}]\!])(C) \wedge [\![\textit{expensive}]\!](d)(x)]$

References to contextually-determined standards allow us to shift the standard depending on the context.

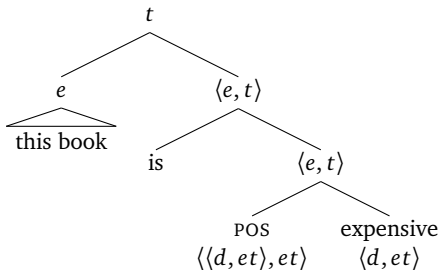
(12) a. 40 euros is expensive for a book.
b. Airplanes are expensive.
c. 40 euros is expensive for an airplane.

The order of combination in the syntax:

[1] Note that in our in-class version, **standard** was actually a measure function. It had a gradable adjective as an argument, and returned the standard degree, making it type $\langle\langle d, et\rangle, d\rangle$.

[2] Whatever it means to meet a standard. Is it simply exceed? Greatly exceed? Stand out relative to the things not meeting the standard? They cite Fara (2000) for more discussion.

(13)



3 Scale structure

Measurement is defined relative to a scale.

Three crucial properties in a scale: a set of degrees representing measurement values, a dimension indicating the kind of measurement, and an ordering relation. This means adjectives can vary from each other in three ways:

- In terms of properties of the set of degrees.
- In terms of the dimensional parameter.
- In terms of the ordering relation.

Changing the ordering relation gets antonymic pairs.

(14) Ordering relation
a. tall/short
b. empty/full
c. expensive/inexpensive

(15) The Sears Tower is taller than the Empire State Building if and only if the Empire State Building is shorter than the Sears Tower.

Dimensional parameter differences are pretty obvious: simply what the scale measures.

(16) Dimensional parameter
a. tall v. flexible
b. expensive v. wet

Also has an empirical basis from incommensurability: can do a comparison with different adjectives so long as they measure along the same dimension.

(17) a. They call him 'The Bus' because he's kind of as wide as he is tall. (National Public Radio broadcast, 1/26/02)

b. [This comparison] is unfair both to him and the quarterbacks like Dan Marino and John Elway who excelled for almost as long as [Peyton] Manning is old. (Chicago Tribune, 11/2/00)

Examples where the dimensions are incompatible are pretty difficult to understand.

Conclusion: comparative is sensitive to whether the things being compared lie on the same scale.

(18) a. ??They call him 'The Bus' because he's kind of as wide as he is punctual.
b. ??These quarterbacks excelled for almost as long as Peyton Manning is talented.

But, do we find places where the structure of the set of degrees itself makes a difference? Kennedy & McNally concentrate on one parameter.

- Whether the scale is open (lacks a minimal and/or maximal element)
- Whether the scale is closed (has minimal and maximal elements)

Whether the scale is open or closed is relevant to understanding the adjectives in (19).

(19) a. full, closed, invisible (have maximal/minimal values)
b. long, expensive, old (no maximal/minimal values)

Evidence from proportional modifiers (*half*, *mostly*, *most of the way*).

(20) Closed scale adjectives
a. The glass is half/mostly full.
b. Her eyes were half/most of the way closed.
c. These images are half/mostly invisible.

(21) Open scale adjectives
a. ??The rope is half/mostly long.
b. ??A 15-year-old horse is half/mostly old.
c. ??That car was half/mostly expensive.

These patterns can be accounted for if we assume representations that are sensitive to scalar minima/maxima.[3]

- **diff** is a function that returns the difference between two degrees.
- **max** and **min** are functions that return the maximum and minimum on some scale S_G (and are undefined for scales without minimal and maximal elements).

[3]This should be intuitively clear: *half*, for instance, should obviously should care about there being a halfway point.

- Undefined without minimum and maximums.

(22) a. $[\![half]\!] = \lambda G \lambda x . \exists d [\mathbf{diff}(\mathbf{max}(S_G))(d) = \mathbf{diff}(d)(\mathbf{min}(S_G)) \wedge G(d)(x)]$
b. $[\![mostly]\!] = \lambda G \lambda x . \exists d [\mathbf{diff}(\mathbf{max}(S_G))(d) < \mathbf{diff}(d)(\mathbf{min}(S_G)) \wedge G(d)(x)]$

A scale is constructed from a set of degrees D, an ordering relation R, and a dimension Δ.

- Degrees are isomorphic to the real numbers between 0 and 1.
- An ordering relation is some way of ordering two degrees with respect to one another (e.g., $\geq$ or $\leq$).
- A dimension is what the degrees measure: COST, PHYSICAL-SIZE, WEIGHT, etc.

The following are all possible scales.

(23) A typology of scale structures
a. $\langle D_{(0,1)}, R, \Delta \rangle$ (totally open scale)
b. $\langle D_{[0,1)}, R, \Delta \rangle$ (lower closed scale)
c. $\langle D_{(0,1]}, R, \Delta \rangle$ (upper closed scale)
d. $\langle D_{[0,1]}, R, \Delta \rangle$ (totally closed scale)

Predict the following patterns for combinations of positive (increasing degree) and negative (decreasing degree) adjectives with endpoint-oriented modifiers. Endpoint modifiers should be good with positive adjectives only if they have a scale with a maximal element, and negative adjectives only if they have a scale with a negative element.

- Positive adjectives: endpoint oriented modifier only good if there is a maximal degree.
- Negative adjectives: we flip the scale, so the "maximal" degree is now what used to be the minimal degree.

(24)

	open	lower-closed	upper-closed	closed
A_{pos}	??	??	ok	ok
A_{neg}	??	ok	??	ok

Positive and negative adjective examples (mainly antonyms, but some derived):

(25) a. hot/cold
b. tall/short
c. full/empty
d. deep/shallow
e. loud/quiet
f. famous/unknown
g. certain/uncertain
h. pure/impure

i. safe/dangerous
j. open/closed
k. visible/invisible

Modifiers sensitive to maximality can be used to pick out closed scales. Types of scales can be discovered by looking at antonyms, which related to degrees on the same scale, but with different scalar orderings.

(26) Open scale pattern
a. Her brother is completely ??tall/??short.
b. The pond is 100% ??deep/??shallow.
c. Max is fully ??eager/??uneager to help.

(27) Lower closed scale pattern
a. The pipe is fully ??bent/straight.
b. The room became 100% ??loud/quiet.
c. That author is completely ??famous/unknown.

(28) Upper closed scale pattern
a. We are fully certain/??uncertain about the results.
b. This product is 100% pure/??impure.
c. The treatment is completely safe/??dangerous.

(29) Closed scale pattern
a. The room was 100% full/empty.
b. The flower was fully open/closed.
c. The figure was completely visible/invisible.

Sometimes *slightly* or *a little bit* is also used as a test for lower closed scales (Rotstein & Winter 2004). But, I (and others) don't think this test is airtight, since the judgements vary a little bit.

(30) a. The work is slightly incomplete/*complete.
b. The argument is slightly imperfect/*perfect.
c. The jar is slightly cracked/*whole.
d. The line is slightly curved/*straight.
e. The child is slightly sick/*healthy.
f. The claim is slightly unclear/*clear.
g. Köln is slightly unsafe/*safe.

4 Scale structure and the standard of comparison

4.1 Relative and absolute gradable adjectives

Close/open scale distinction matters in areas as well. One such area is total versus partial predicates (Rotstein & Winter 2004).

- Total predicates are true just in case the scalar maximum has been reached.

(31) The plates are clean. → The plates are completely clean.

- Partial predicates are true in case any degree has been reached.

(32) The plates are dirty. → The plates have some amount they are not clean.

So... why?

- Scale structure influences the standard of comparison.
- For many gradable predicates, the standard of comparison is determined contextually (*tall*, *expensive*).
- But, other predicates (partial predicates) require only some minimum degree of the gradable property (as in (33)).

(33) Minimum standards
a. The baby is awake.
b. The spot is visible.
c. The door is open.
d. The rod is bent.

Likewise, the guys in (34) require a maximal degree of the gradable property, not an arbitrary context-dependent standard.

(34) Maximum standards
a. The glass is full.
b. The road is flat.
c. The door is closed.
d. The rod is straight.

Adjectives with context-dependent standards are called relative adjectives, while those with standards at the scalar endpoints are called absolute adjectives.

4.2 Truth-conditions of absolute adjectives

Make assumption that absolute adjectives are specified lexically to have their degree set to a scalar endpoint.

(35) a. $[\![AP_{min}]\!] = \lambda x.\exists d[d > \mathbf{min}(S_A) \wedge \mathbf{m_A}(x) = d]$
b. $[\![AP_{max}]\!] = \lambda x.\exists d[d = \mathbf{max}(S_A) \wedge \mathbf{m_A}(x) = d]$

Predicts denying the adjective should assert that no degree of the gradable property holds. This seems to be true.

For a minimal standard adjectives, *not adj* should assert that no degree of *adj* holds.

(36) a. #My hands are not wet, but there is some water on them.
b. #The spot is not visible, but I can see a little bit of it.

Also predicts that asserting the adjective should mean that no greater degree of the gradable property can hold. This is true, with caveats.[4]

For maximal standard adjectives, *adj* should assert that there is no greater degree that *adj* can hold.

(37) a. #The plant is dead, though one part of it still appears to be alive.
b. #The paper is complete, I just have to write the conclusion.

Entailment test like this can be used to determine whether the standard for an absolute adjective is at the bottom of the scale.

Antonymic absolute adjectives also show something similar. Negation of one in the pair entails the other.

(38) a. The door is not open (closed). ⊨ The door is closed (open).
b. The table is not wet (dry). ⊨ The table is dry (wet).
c. The baby is not awake (asleep). ⊨ The baby is asleep (awake).

(39) a. The door is not large (small). ⊭ The door is small (large).
b. The table is not expensive (inexpensive). ⊭ The table is inexpensive (expensive).
c. The baby is not energetic (lethargic). ⊭ The baby is lethargic (energetic).

One thing to note: it's **standard** that gives the minimal/maximal values for the standard, based on the adjective. The standard isn't writen into the meaning of the adjective as such, but rather is derived from the meaning of the adjective by **standard**.

[4] Caveat is that we allow a certain amount of sloppiness with exactness, called "imprecision". Need to test with predicates where imprecision is difficult.

4.3 What to make of imprecision?

What do we want to do about cases like these? Seem to suggest absolute adjectives are not so absolute.

(40) a. I'm not awake yet.
b. The gas tank is full, but you can still top it off. It's not completely full yet.
c. The theater is empty tonight.

One idea: come up with a theory of ignorable differences or "loose talk" in order to accommodate these in the theory. Ways of doing imprecise things with language. Some people (including the authors) gives this the term "imprecision," which is a technical referring to cases of loose talk about a measurement that can be precise.

4.4 Summary

Final thoughts:

- Semantic distinction between adjectives with relative and absolute standards.
- Is there a connection between the scale structure of an adjective (closed/open scale) and its standard value? It appears so.
  - Gradable adjectives with open scales have relative standards.
  - Gradable adjectives with closed scales have absolute standards.
- Why should this be? Possible functional explanation: endpoints provide a way of fixing context-independent truth conditions to gradable adjectives. Perhaps languages prefer to minimize context-dependence when possible?

5 Degree modifiers (building off of K&McN)

5.1 Semantics of degree modification

Basic template for a degree morpheme is as in (41). They take the denotation of the gradable adjective and saturate the degree argument. What distinguishes different degree morphemes from each other is the restriction on the degree encoded by R. For instance, with POS, R asserts that the degree exceeds the standard.

(41) $[\![Deg(P)]\!] = \lambda G\lambda x.\exists d[R(d) \wedge G(d)(x)]$

Measure phrases can also be thought of as degree terms.

(42) a. $[\![two\ meters]\!] = \lambda G\lambda x.\exists d[d \geq \mathbf{two\ meters} \wedge G(d)(x)]$
b. $[\![two\ meters\ tall]\!]$

$$= [\![\textit{two meters}]\!]([\![\textit{tall}]\!]) = \lambda x.\exists d[d \geq \textbf{two meters} \wedge \textbf{tall}(x) = d]$$

Comparatives also can be handled in this way, by simply introducing an ordering relation. But some interesting complications:

- Need to assume that the comparative morpheme (*-er*) and the comparative clause form a constituent (cf. Bresnan 1973).
- Interesting questions about how the comparative degree (d_c) is derived, which K&McN set aside.

(43) a. $[\![\textit{er/more than } d_c]\!] = \lambda G \lambda x.\exists d[d > d_c \wedge G(d)(x)]$
b. $[\![\textit{less than } d_c]\!] = \lambda G \lambda x.\exists d[d < d_c \wedge G(d)(x)]$
c. $[\![\textit{as as } d_c]\!] = \lambda G \lambda x.\exists d[d \geq d_c \wedge G(d)(x)]$

5.2 Endpoint-oriented modifiers

How to handle endpoint-oriented modifiers?

(44) a. The door is completely open.
b. The steak is fully cooked.
c. The assignment is 100% completed.

Fully can be handled in a similar way, too, which also makes it looks similar to proportional modifiers like *half*.

(45) a. $[\![\textit{fully}]\!] = \lambda G \lambda x.\exists d[d = \textbf{max}(S_G) \wedge G(d)(x)]$
b. $[\![\textit{fully}]\!] = \lambda G \lambda x.G(\textbf{max}(S_G))(x)$

5.3 *Very*

K&McN: *expensive* and *very expensive* differ in that the latter denotes a property which has a meaning exact like the former, except the standard of comparison has been raised.

(46) a. The international space station is very expensive. (for space projects; large increase from contextual standard of comparison)
b. The coffee at the airport is very expensive. (for coffee; small increase from contextual standard)

How to understand this?

- Klein (1980) suggests that *very A* is analyzed just as *A* is, but whereas *A* is evaluative relative to an arbitrary comparison class, *very A* is evaluated relative to those things that *A* is true of.
- In a system like K&McN's, analyze *very* in terms of the **standard** relation.
- **standard** relation takes as its comparison class argument the set of individuals the gradable property is true of.

(47) $[\![\textit{very}]\!]^c = \lambda G \lambda x.\exists d[\textbf{standard}(d)(G)(\lambda y.[\![\textit{pos}(G)(y)]\!]^c) \wedge G(d)(x)]$

Some other options, from various sources (not K&McN):

(48) $[\![\textit{very}]\!]^c = \lambda G_{\langle d,et\rangle} \lambda x \exists d[G(d)(x) \wedge d \gg_c \textbf{standard}_c(G)]$

Another option: predicate of the difference.

(49) $[\![\textit{very}]\!] = \lambda G_{\langle d,et\rangle} \lambda x \exists d\big[G(d)(x) \wedge \textbf{large}_c(d - \textbf{standard}_c(G))\big]$

Very seems to be restricted to relative adjectives; it's odd with absolute adjectives, as in (50). Representation above predicts this, since *pos A* and *very A* have equivalent truth conditions; *very* has no effect with absolute adjectives.

(50) a. ??I always leave the door to my office very open. (cp. wide open)
b. ??That drug is currently very available. (cp. widely available)

6 Final thoughts

Many things remain unexplored in this paper. Here's two.

- Lexical semantics of other degree modifiers besides *very*, *fully/completely*
- How are scales encoded across different categories (e.g., verbs and nouns)?

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