The Cognitive Roots of Adjectival Meaning

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Goals for Today

- Explore how results from cognitive science can supplement our understanding of lexical meaning in truth-conditional semantics.
- Particularly, focus on meanings for gradable adjectives. (Verbs have been examined extensively by many.)
- Two parts.
  - Review a common approach to the (truth-conditional) semantics of adjectives, and see where it fails to tell us things we want to know.
  - Look at an appealing idea of how cognitive psychology might supplement our truth-conditional semantics.
    - Encounter some problems.
    - Try to solve them.
- In the end, suggest we might find two lexically different sorts of adjectives.

The Semantics of Gradable Adjectives

- Assume a degree analysis (Kennedy, 1997, 2007; Barker, 2002; Bartsch & Vennemann, 1973; Bierwisch, 1989; Cresswell, 1977; Heim, 1985; von Stechow, 1984).
- For example, the meaning of *tall* is given by a function to degrees on a scale (called a *measure function*):

  (1) $[\![\text{tall}]\!](x) = d$ a degree of tallness

- Makes the primary case the *comparative*:

  (2) a. Max is taller than Mary.

  b. $\textbf{tall}(\textbf{Max}) > \textbf{tall}(\textbf{Mary})$

  (Abstracting away from a lot of details about the comparative construction.)

Scales I

- The basic semantics for gradable adjectives is something like:

  (3) $[\![\text{tall}]\!](x) = d$ a degree of tallness

- Basic idea (Bartsch & Vennemann, 1973): Degrees are degrees on a scale.
- Basic structure of scales.
  - A scale is an ordered collection of degrees, with a *dimension* specifying what the degrees represent (e.g. Bartsch & Vennemann, 1973; Kennedy, 1997).
  - Unpacking, the codomain is really a complex object $\langle D_\delta, <_\delta \rangle$, where:
    - D_δ is the set of degrees of dimension δ.
    - Ordered by $<_\delta$.
    - δ can specify e.g. tallness, speed, etc.

Scales II

- So, a more explicit entry would be something like:

(4) a. $S_{\text{tall}} = \langle D_{\delta_{\text{tall}}}, <_{\delta_{\text{tall}}} \rangle$

b. $[\![\text{tall}]\!] : D_e \rightarrow S_{\text{tall}}$

- Order properties of scales:
  - Dense linear orderings (Bale, 2008, 2011; Fox & Hackl, 2006)
  - NB linearity is surprising.
  - Look like appropriate intervals in $\mathbb{Q}$.
  - Tempting idea: this strucure is fixed by grammar??
- Order topology on the scale indicates lexically and grammatically significant categories of adjectives (Kennedy & McNally, 2005; Winter & Rotstein, 2004).

Scales III

- More than order structure? Extensive magnitudes? Statistics on degrees? etc. (Barner & Snedeker, 2008; Krifka, 1989; van Rooij, 2011; Sassoon, 2010; Schmidt et al., 2009; Schwarzschild, 2002; Solt & Gotzner, 2012).
- Pretty clear that examining the kinds of scales involved, and their properties, has been fruitful.

Finding the Root I

- But does not help explain how distinct adjectives within the same class have distinct meanings.
  - E.g. will not explain the difference between *bright* and *loud*.
- In our structure $S = \langle D_\delta, <_\delta \rangle$, this job is done by δ.
- δ marks the degrees as degrees of e.g. brightness, which gives the adjective its distinctive meaning.
- So, *bright* means bright because it has scale $S_{\text{bright}} = \langle D_{\delta_{\text{bright}}}, <_{\delta_{\text{bright}}} \rangle$.
- So, we suppose that δ indicates the lexical root or 'remainder' of the meaning of a gradable adjective (Bartsch & Vennemann, 1973).

Finding the Root II

- Issues:
  - So far, δ is just a label.
  - Stipulates there is a difference between scales, but does not say what it is.
  - Does not seem to explain anything.
  - Does not tell us what if any semantic properties the roots might have.

Appeal to Cognition

- In many cases in lexical semantics, we try to enrich our accounts of meaning by looking to how people think.
- Great care! Many forms of this, with all kinds of linguistic, cognitive, and philosophical assumptions.
- I want to think of this 'conservatively' from the point of view of truth-conditional semantics. How can we ask about cognition and stick with the program?
- The huge temptation:
  - Lots of adjectives (in some languages) do seem to correspond to aspects of cognition that are fairly well understood in psychology.
  - Surely (!?!) this should help.
- Let's try to explore this.

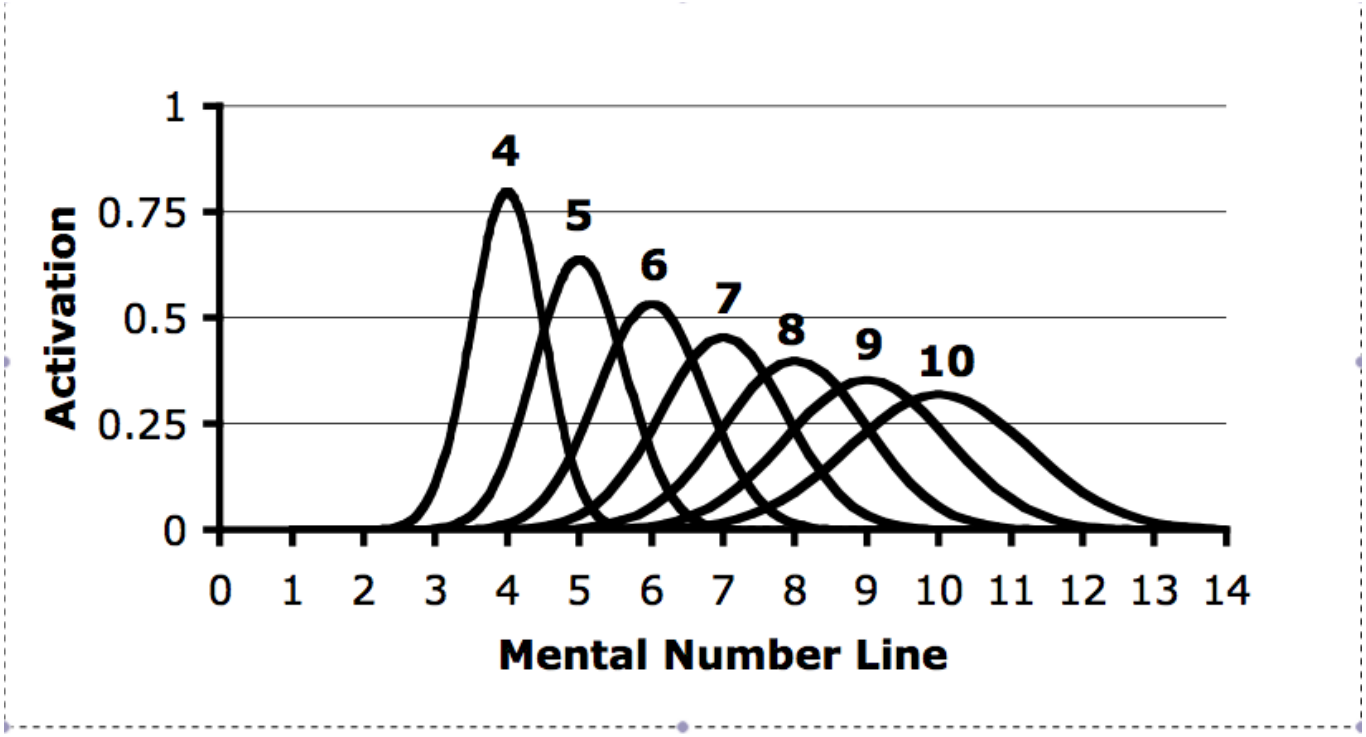
Magnitudes?

- It is well-established that humans and other animals represent a range of magnitudes (e.g. Cantlon et al., 2009; Feigenson, 2007; Meck & Chuch, 1983).
  - Well studied ones include length, time, pitch.
  - Also indications of magnitude-like representations for brightness, warmth, weight, etc.
  - And of course, number (e.g. Carey, 2009; Dehaene, 2011)!!!!
- So, will this tell us anything about δ that can help fix root meanings?
- Especially, can it for adjectives like *bright, warm, long*, etc?
- In the end, I think yes. But in fact, these kinds of representations are not going to simply hand us structures like $\langle D_\delta, <_\delta \rangle$.

A Brief Glance at Magnitude Represenation I

- Approximate or analog magnitude representation.
  - Well known that these sorts of magnitude representations are ‘analog’, in that they give continuous representations even when the underlying phenomena are discreet.
  - Very well explored for number.
  - Obey Weber’s law: discrimination of magnitudes is a function of their ratio.

A Brief Glance at Magnitude Represenation II



(Halberda, 2011)

- Models of these kinds of approximate magnitudes often make them Gaussian curves that reflect the approximate nature of the representation by having a spread of activation (e.g. Dehaene, 2011; Gallistel & Gelman, 2000; Halberda, 2011).

A Brief Glance at Magnitude Represenation III

  - For the case of number at least, substantial neural basis for these models
  - It is a debated issue currently whether there is a single general approximate magnitude system, or distinct ones for various magnitudes (e.g. Feigenson, 2007; Kadosh et al., 2008).
- But we can safely assume there are some approximate magnitude systems.
- Some of these correspond to adjectives like maybe *long*, or *large* or *bright*.

Get Used to Disappointment I

- Values in S are precise: measure function maps to one specific value.
- Look like values in $\mathbb{Q}$.
- But, this is not what we get from an AMS.
- They are not Gaussians, or anything like that.
- Not at all clear what we could do with scale values that might capture AMS structure and keep the scale structure we need.
- I will assume we cannot do that.

Get Used to Disappointment II

- We just bumped into a huge problem in cognitive psychology.
  - In some cases, we know that precise magnitude systems emerge, when there are early (core) approximate systems.
  - The much-studied case is again number.
    - Children do develop precise integer magnitude systems (around age 4).
    - Very controversial how.
    - Might be a mapping of symbols to approximate magnitudes, and then further development (Dehaene, 2011; Gallistel & Gelman, 2000).
    - Might be a very different process, e.g. the 'Quinean bootstrapping' of Carey (2009).
  - So, there might be a way that agents can start with an approximate system and move to a precise one.

Get Used to Disappointment III

- But, increasingly implausible when we come to the rationals.
  - Rationals come much later, maybe around 8–12? But full understanding varies.
  - A very significant conceptual change, according to Carey (2009).
- Even if we can make sense of it for rational numbers, not at all clear why we can assume we can always get precise values for the many different AMS roots we might want.
- So, if we think AMS cognition relates to adjectival meaning, we need to ask how we can understand this without asking AMS to provide dimensions.

Abstract Scales I

- Maybe a weak constraint: insist that scales respect observable differences in values.
- Do not try to fully identify a dimension.
- One implementation of this.

Abstract Scales II

- Work with an abstract scale: an ordering $\mathscr{A} = \langle D, < \rangle$ (e.g. Bale, 2008, 2011; Solt & Gotzner, 2012; von Stechow, 1984).
  - Presumably a dense linear ordering with an appropriate topology.
  - Assume provided (somehow) by grammar.
- Some adjectives meanings are given in terms of $[\![A]\!] : D_e \to \mathscr{A}$.
- Impose a perceptual constraint on $[\![\mathrm{A}]\!]$: if the agent discerns $x \succ_\delta y$, then $[\![A]\!](x) > [\![A]\!](y)$.

Abstract Scales III

- For AMS, we have a measure of just noticeable difference, $\Delta(x) = wx$ for Weber Fraction w, for a given subject.
  - So, typically $\Delta(x)$ is the amount you need to increase x to get recognition of difference in 75% of trials.
  - If our abstract scale allows some arithmetic, we can express a more direct constraint: $[\![A]\!](x) > [\![A]\!](y)$ if $x \succ y + \Delta(y)$.

Abstract Scales IV

- Mere perceptual constraint?
  - Many $[\![\mathrm{A}]\!]$ values consistent with constraint, if e.g. for large values agents become very bad at discerning differences.
  - Semantics seems to ask for a single measure function.
  - Fairly familiar situation: cognition seems not to fully fix extensional values.
  - Wish I had a good story about what to do in cases like this!
  - In this case, any of the scales consistent with the constraint seems as good as any other.
  - So, we might try to select a min or max?
  - Gets the right truth conditions when we have judgments?
  - Or posit more robust underspecification?
- One moral: in many cases, psychology hands us something related to, but not identical to, a word meaning.

Variety in Adjectival Roots I

- English contains a very broad, open class of adjectives.
- Not so for all languages.
  - Some have small, presumably closed classes of adjectives.
  - Unclear if all languages have adjectives (Dixon, 1977; Baker, 2003).)
- For languages like English, nothing special about AMS for cognition related to adjective meanings.
- Take one case: taste terms like *sweet, sour, spicy*, etc.
  - *Sweet, sour*. Linked to tastes: receptor in the tongue.
  - *Spicy*. Likely a multi-modal sensory experience, including taste, and also olfactory, trigmeninal, and other systems (Spence et al., 2014).
- Many complex cognitive abilities seem to relate to adjectives in languages like English.

Variety in Adjectival Roots II

- Lots of adjectives have meanings that seem to be tied to perceptual systems.
  - AMS systems.
  - Taste-related systems.
  - What else?
- All these can be treated by the abstract scale approach just reviewed.
- Not all adjectives are linked to perceptual abilities.
  - Example: *dense*.
  - Some evidence this might link to a concept stemming from 'folk physics', in the group with e.g. WEIGHT, DENSITY, VOLUME, etc. (Carey, 1991, 2009; Keil & Carroll, 1980).
  - No perceptual judgments of density (?).
  - So, on perceived difference constrain on adjectival meaning.

Cresswell Scales

- Suggestion: different way to constrain the root for an adjective like this.
- Scales constructed from relational concepts (Cresswell, 1977).
- Quick idea: build equivalence classes from relation.

(5) a. $D_{\delta_{\text{dense}}} = \{[a_e]_{\text{DENSER}}\}$

b. $a <_{\delta_{\text{dense}}} b$ iff b DENSER a

- If we start with a concept like DENSITY that yields a relational property, can build genuinely distinct scales with a precise marking of their root property.
  - NB working with the underlying category here! (Some externalism.)
  - Of course, can then map to an abstract scale if you like.
  - But I don't see any work done by this.

Variety in Adjectival Roots

- Variety in sources of adjectival roots.
- At least two:
  - Perceptual abilities, including AMS.
  - Concepts, often represented as theories (or other options, if you like), that fix relational properties.
- Have suggested different ways they fix adjective meanings.
  - Provide specific scales.
  - Provide constraints on an abstract scale.
- Question: *rough?* Have ability to feel, but not sure if this is responsible for the root meaning?

A Philosophical Application

- Philosophers sometimes complain about degree semantics that it seems implausible to assign precise degree values to gradable adjectives.
- E.g. no precise value of how big something is. (Better examples include e.g. *happy*, but these are multi-dimensional.)
- I can agree for perceptual cases.
- But insist scale structure is there (captures aspects of the grammar of comparison).
- And note that some adjectives do have more fully specified degree values.

Problems and Prospects

- Offered ways that cognition can interact with truth-conditional semantics for adjectives.
- Morals:
  - Rare that cognition simply hands us an appropriate lexical meaning.
  - Relations between cognition are often indirect, mediated by grammar.
- Actually, offered multiple ways.
- Would love more evidence this distinction is robust.
  - Any linguistic reflexes of the classes of adjectives root meanings?
  - Any behavioral evidence supporting the distinction?

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