Experimenting with Degree

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Research Questions

What notion of **degree**, if any, underlies the interpretation of (relative) gradable adjectives in their positive form?

- How do speakers' judgments of gradable adjectives change across contexts (comparison classes C)?
- On the basis of what <u>measures</u> can these judgments be described?
  - **Rank Order**
    <u>Example</u>: ⟦ *Fred is tall* ⟧^{C} =1 iff **Fred ∊ tallest 1/3 of Cs**
  - **Ordinal Degree (derived from ordering on C)**
    <u>Example</u>: ⟦ *Fred is tall* ⟧^{C} =1 iff **HEIGHT(Fred) ∊ top 1/3 of heights of Cs**
  - **Measurement Degree (scale with distance metric)**
    <u>Example</u>: ⟦ *Fred is tall* ⟧^{C} =1 iff **HEIGHT(Fred) > mean$_{x\in C}$HEIGHT(x)**

NB: Truth conditions are for purposes of illustration; no account of vagueness of GAs

	Delineation (strong)	Degree as...		
		Equiv. class	Abstraction	Eq. class w/measures
Rank Order	Yes	Yes	Yes	Yes
Ordinal Degree	No	Yes	Yes	Yes
Measurement Degree	No	No	Yes	Only adj. w/num. measure

Theories of Gradability

<u>Delineation</u> (Klein 1980)
Gradable adjectives denote partial functions that induce a three-way <u>partition</u> on a comparison class C

not tall	extension gap	tall	C

- Not explicitly based on degrees
- Strongest version: no notion of degree at all involved

<u>Degree</u> (Cresswell 1976; von Stechow 1984; Kennedy 2007; a.o.)
Gradable adjectives relate individuals to <u>degrees on a scale</u>

⟦ *tall* ⟧ = λdλx.HEIGHT(x) ≥ d

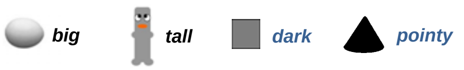
⟦ *Fred is tall* ⟧ = 1 iff HEIGHT(fred) > d_{Std}, where d_{Std} = f(C)

- Degree as **Equivalence Class** (Cresswell 1976; Klein 1991)
  Relation on domain: $x \gtrsim_{HEIGHT} y$ 'x has as least as much height as y'
  HEIGHT(fred) = {x: $x \sim_{HEIGHT}$ fred} - ordinal scale only
- Degree as **Abstraction** (von Stechow 1984)
  HEIGHT(fred) = $n \in \mathbb{R}$ (a number) - scale with distance metric
- Degree as **Equivalence Class w/Numerical Measures** (Bale 2008)
  - For adjectives with corresponding numerical measurement systems, measurements (e.g. *6 feet*) participate in relation as individuals
  - Derived scale isomorphic to that associated w/measurement system

Experiment 1

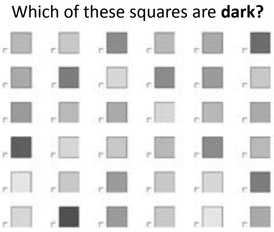
Methodology: Adjective/Picture Matching (Barner & Snedeker 2008; Schmidt et al. 2009)

- 4 adjectives evaluated in context of 4 picture arrays (36 pictures/11 degrees)

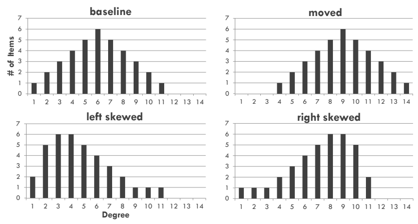


Numerical measure
No numerical measure

Which of these squares are **dark**?



Distribution of items over degrees

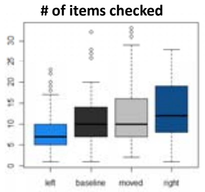


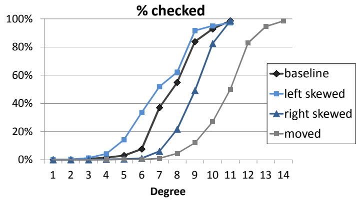
- n=194 (mean age: 35.7, 124 female); 1 adjective/distribution per subject (rotated)
- Online via Amazon Mturk (U.S. IP address; screened for native English)

Predictions

If **rank order** alone sufficient: - **# of items checked** same across conditions
If **ordinal degree** alone sufficient: - **'cut-off'** same for baseline/left/right; higher for moved

Results





<u>Linear mixed effects models</u>: Adjective & distribution as fixed factors; subject as random factor

# of Items: left < baseline (p<0.05)
tall > *big* (p<0.01); *pointy* > *big* (p<0.05)
pointy x moved, right (p<0.001)
– effects more pronounced

Cut-off: left < baseline (p<0.05)
right, moved > baseline (p<0.001)
tall < *big* (p<0.05)
pointy x moved (p<0.001), right (p<0.01)
– effects weaker

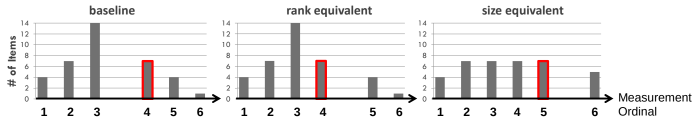
- ➢ Neither rank order nor ordinal degree alone sufficient
  - Does not rule out combination of two
- ➢ Judgments of non-numerical *pointy* more absolute/less dependent on C

<u>REFERENCES</u>: Bale, A.C. (2008). A universal scale of comparison. *Linguistics &Philosophy 31, 1-55.* **Barner, D. & Snedeker, J. (2008).** Compositionality and statistics in adjective acquisition. *Child Development* 79, 594-608. **Kennedy (2007).** Vagueness and grammar. *Linguistics & Philosophy 31, 1-45.* **Klein, E. (1980).** A semantics for positive and comparative adjectives. *Linguistics & Philosophy 4, 1-45.* **Klein, E. (1991).** Comparatives. In: A. *von Stechow* & D. Wunderlich (eds.), *Semantik: Ein Internationales Handbuch der Zeitgenossischen Forschung*, 673-691. Berlin: Walter de Gruyter. **Schmidt, L.A., Goodman, N.D., Barner, D. & Tenebaum, J.B. (2009).** How *tall* is *tall*? Compositionality, statistics and gradable adjectives. *Proceedings of the 31st Annual Conference of the Cognitive Science Society.* **Cresswell, M.J. (1976).** The semantics of degree. In: B.H. Partee (ed.), *Montague Grammar,* 261-292. New York: Academic Press. **Stechow, A. von (1984).** Comparing semantic theories of comparison. *Journal of Semantics* 3, 1-77.

Experiment 2

Methodology: As in Experiment 1

- 3 adjectives (*big, tall, dark*); 3 distributions
  - ➢ Designed to distinguish **ordinal degree** vs. **measurement degree**



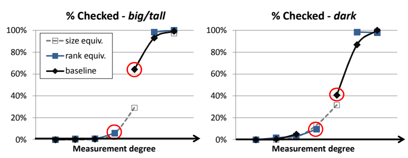
- n=170 native English speakers (mean age: 30.4, 111 female)

Predictions

If **ordinal degree** sufficient: **baseline = rank equivalent**
- If not, must infer abstract **measurement degree**

If measurement degree depends on numerical measure: **dark ≠ big/tall**

Results



<u>Linear mixed effects model</u>: Adjective & numerical as fixed factors; subject as random factor

% critical item checked:
rank < baseline (p<0.001)
non-numerical x rank, size (p<0.001)
- effects less pronounced
- but rank < baseline also for non-numerical (p<0.001)

- ➢ Ordinal degree not sufficient; require abstract notion of degree independent of the structure of C
  - Also for adjective without measurement system

Conclusions

- Interpretation of gradable adjectives in their positive form involves degrees organized into a scale with a distance metric
  - Supports abstract theory of degree over one in which scales are derived from an ordering relation on a comparison class
- Some interadjective differences -- but no evidence that scale structure depends on presence/absence of measurement system
- For the future ...

... More adjectives (numerical/non-numerical; evaluative)
... Overt comparison classes (*tall <u>for a boy</u>*)

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