The Semantics and Pragmatics of Multi-Head Comparatives

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Core data: Multi-head comparatives in English

- Examples of multi-head comparatives from von Stechow (1984):

(1) More silly lectures have been given by more silly professors – than I would have expected.
(p.42: (136a); originally from Chomsky 1981/1993: p.81, §2.4.4, (6ii))

(2) More dogs ate more rats than cats ate mice. (p.43: (140))

(3) Less land produces more corn than ever before. (p.46: (156))

(4) No airline saves you more money in more ways than Delta. (p.46: (157))

Core data: Multi-head comparatives in English

(1) More silly lectures have been given by more silly professors – than I would have expected.

(2) More dogs ate more rats than cats ate mice.

(3) Less land produces more corn than ever before.

(4) No airline saves you more money in more ways than Delta.

- Are these sentences really sensible?
  - Yes: von Stechow (1984), Meier (2001); see also Marques (2005), Oda (2008)
  - Not really: Hendriks (1994), Hendriks and De Hoop (2001)
- von Stechow (1984) (pp. 41–42):
  - '*These examples typically occur with plural nouns or mass nouns.*'
  - '*I don't think that these cases represent genuine semantic problems. They can essentially be treated with the methods we already have at our disposal.*'
  - '*But it took me quite a while to realize this, because the examples are conceptually rather complicated and are neglected in the literature.*'

Core data: Multi-head comparatives in English

- A multi-head comparative has multiple comparative expressions (that are typically plural or mass nouns), but only one *than*-clause.

(1) More silly lectures have been given by more silly professors – than I would have expected.

More silly lectures have been given by more silly professors: two comparative expressions that are plural nouns

than I would have expected: one *than*-clause

Research questions:

- What do multi-head comparatives mean, if they are sensible?
- How to provide a compositional analysis?
- Why are the comparative expressions involved typically plural or mass nouns?

Take-home messages: the semantics of multi-head comparatives

- Semantically, I propose that multi-head comparatives are (often) based on **cumulative-reading sentences**.

measurement sentence	$\rightsquigarrow$	**comparative sentence**
Mary is d-tall		Sue is taller than Mary is ~~d-tall~~
		(than Mary is ~~d-tall~~: how tall is Mary)
cumulative-reading sentence	$\rightsquigarrow$	**multi-head comparative**
m-many cats ate n-many mice		More dogs ate more rats than ~~m-many~~ cats ate ~~n-many~~ mice
		(than ~~m-many~~ cats ate ~~n-many~~ mice: how many cats ate how many mice)

Take-home messages: the pragmatics of multi-head comparatives

- Pragmatically, there is an **interplay** between the two comparative expressions in a multi-head comparative, and the entire sentence addresses **one underlying degree QUD** (Question under discussion).

(1) More silly lectures have been given by more silly professors – than I would have expected.
⇝ addressing 'how education is worse than I would have expected'

(2) More dogs ate more rats than cats ate mice.
⇝ addressing 'how dogs are more successful predators than cats are'

(3) Less land produces more corn than ever before.
⇝ addressing 'how corn productivity is better than before'

(4) No airline saves you more money in more ways than Delta.
⇝ addressing 'how Delta is more economical than other airlines'

Outline

1. Empirical observations
2. Inspiration from cumulative-reading sentences
3. Proposal
4. Discussion
5. Conclusion

Empirical observations

- Are multi-head comparatives all sensible?
- What do acceptable multi-head comparatives mean?
  - What do they not mean?
- What do unacceptable multi-head comparatives look like?
  - The requirement of plural/mass nouns?

What a multi-head comparative means

(2) More dogs ate more rats than cats ate mice.

- According to von Stechow (1984), what it means is **two comparisons**:
  - The number of dogs that ate rats > the number of cats that ate mice, and
  - the number of rats eaten by dogs > the number of mice eaten by cats.
- What is worthy of noting:
  - Parallelism
    - ★ between dogs and cats;
    - ★ between rats and mice
  - The restriction of dogs, cats, rats, mice
    - ★ Relevant dogs and rats are involved in eating events;
    - ★ Relevant cats and mice are involved in eating events
  - The two comparisons are mutually independent

What a multi-head comparative does not mean

(2) More dogs ate more rats than cats ate mice.

- According to von Stechow (1984), what it doesn't means is **one comparison**:
  - The number of pairs $\langle x, y \rangle$ > the number of pairs $\langle z, w \rangle$ where $\textsc{dog}(x), \textsc{rat}(y), \textsc{cat}(z), \textsc{mouse}(w), \textsc{eat}(x, y), \textsc{eat}(z, w)$

Felicitous vs. infelicitous multi-head comparatives

(2) More dogs ate more rats than cats ate mice.

(3) Less land produces more corn than ever before.

(5) *Fewer dogs ate more rats than cats ate mice.

(Hendriks and De Hoop 2001: p.10, (15))

- Hendriks (1994), Hendriks and De Hoop (2001) raise questions about whether multi-head comparatives make sense. Why is (5) bad? According to von Stechow (1984), (5) should be good and it should mean:
  - The number of dogs that ate rats < the number of cats that ate mice, and
  - the number of rats eaten by dogs > the number of mice eaten by cats.
- Hendriks (1994), Hendriks and De Hoop (2001): the two comparisons cannot be mutually independent

More examples that are unacceptable

(6) *More silly lectures have been given by more boring professors than I met yesterday. (Chomsky 1981/1993: p.81, §2.4.4, (6iii))

(7) *A greater man would be a better man than Otto. (von Stechow 1984: p.46, (158))

- The requirement of plural/mass nouns is not sufficient to make a multi-head comparative acceptable.
- von Stechow (1984): we need to associate the *than*-clause with both comparative expressions in the matrix clause, and this is syntactic rather than semantic
- von Stechow (1984) suggests that a similar syntactic constraint is behind the generalization that multi-head comparatives are restricted to plural/mass nouns.

However, here are more examples that are acceptable ...

(8) Nowadays, more goods are carried faster (than before).
(Hendriks and De Hoop 2001: p.10, (13))

- The requirement of plural/mass nouns is not necessary to make a multi-head comparative acceptable.

Interim summary

(2) More dogs ate more rats than cats ate mice.

(8) Nowadays, more goods are carried faster (than before).

- von Stechow (1984): a good multi-head comparative involves **two comparisons**.
- Hendriks (1994), Hendriks and De Hoop (2001): the two comparisons are mutually independent
- The multiple comparative expressions are typically plural/mass nouns, but it's not always the case.
  - The requirement of plural/mass nouns is neither sufficient nor necessary.

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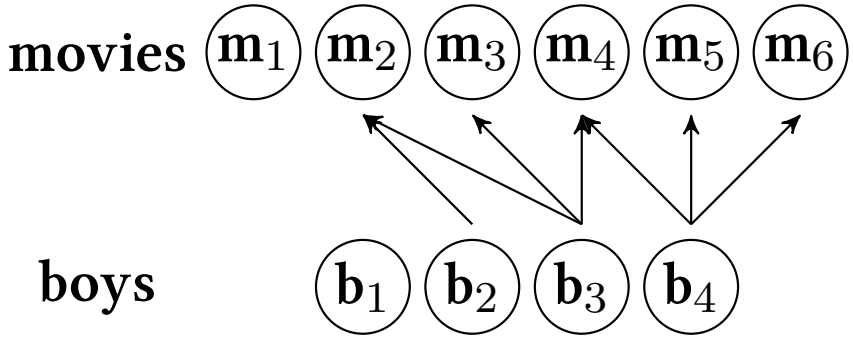
Cumulative-reading sentence



(9) Exactly three boys saw exactly five movies. (see Brasoveanu 2013)

- The intuitive interpretation of (9):
  - *exactly three boys* denotes and counts the totality of boys who saw movies.
  - *exactly five movies* denotes and counts the totality of movies seen by boys.
- Mutual restriction and mereology-based relative maximality

(2) More dogs ate more rats than cats ate mice.
Num. dogs that ate rats > Num. cats that ate mice, and
Num. rats eaten by dogs > Num. mice eaten by cats

Another kind of cumulative-reading sentences

(10) In Guatemala, at most 3% of the population own at least 70% of the land.

- Krifka (1999): the simultaneous mereology-based maximization strategy

> *'would lead as to select the alternative* ***In Guatemala, 100 percent of the population own 100 percent of the land****, which clearly is not the most informative one among the alternatives – as a matter of fact, it is pretty uninformative.'*

Krifka (1999)'s discussion

(10) In Guatemala, at most 3% of the population own at least 70% of the land.

- Krifka (1999):

  'What is peculiar with sentences like (10) is that they want to ***give information about the bias of a statistical distribution****. One conventionalized way of expressing* ***particularly biased distributions*** *is to select a small set among one dimension that is related to a large set of the other dimension.'*

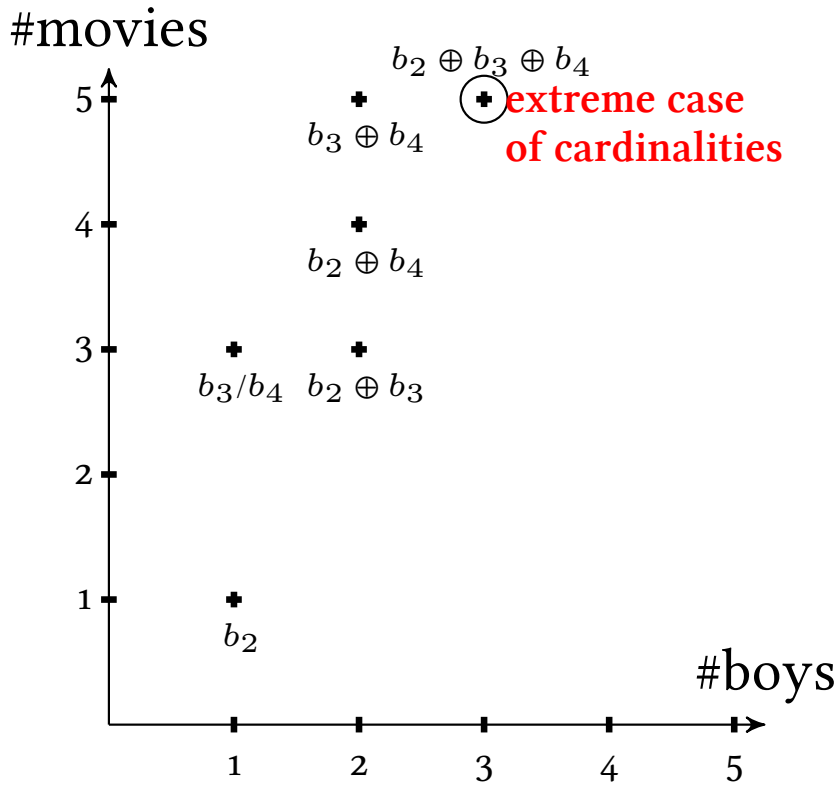
Maximality is based on informativeness and is sensitive to a degree QUD

(9) Exactly three boys saw exactly five movies.

(10) In Guatemala, at most 3% of the population own at least 70% of the land.

- Zhang (2023): In these cumulative-reading sentences, it is rather their underlying degree QUD that determines how numbers are associated with informativeness.
  i.e., degree QUDs determine whether the increase or decrease of numbers leads to higher informativeness.

The case of the movie-seeing scenario

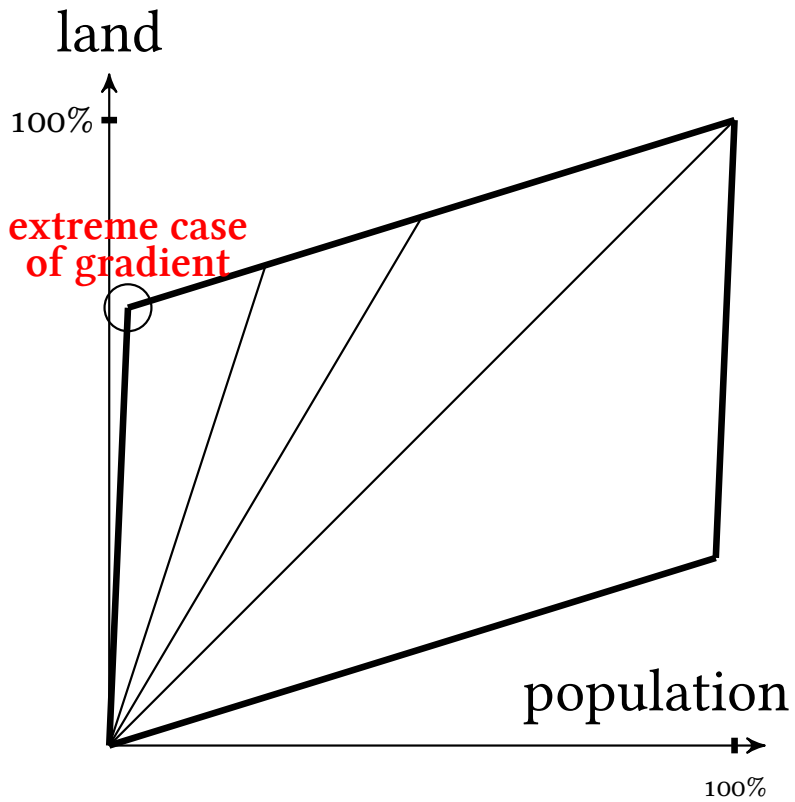


(9) Exactly three boys saw exactly five movies.

QUD: How much is the overall film consumption among boys?

$\rightsquigarrow$ The maximally informative true answer corresponds to the cardinalities of the mereologically maximal drefs.

The case of the land-owning scenario



(10) In Guatemala, at most 3% of the population own at least 70% of the land.

QUD: How skewed is wealth distribution in Guatemala?

$\rightsquigarrow$ The maximally informative true answer corresponds to the case with the maximal ratio between the amount of land and the population of its owner.

Extending to multi-head comparatives

(1) More silly lectures have been given by more silly professors – than I would have expected.

(2) More dogs ate more rats than cats ate mice.

(3) Less land produces more corn than ever before.

(4) No airline saves you more money in more ways than Delta.

(8) Nowadays, more goods are carried faster (than before).

- von Stechow (1984): a good multi-head comparative involves **two comparisons**.
- Hendriks (1994), Hendriks and De Hoop (2001): the two comparisons are mutually independent.
- Zhang (2023): Together the two comparisons address one underlying degree question

What degree QUD is underlying the two comparison

(1) More silly lectures have been given by more silly professors – than I would have expected.

⇝ How many silly lectures have been given by how many silly professors?

⇝ QUD: how education is bad / worse than I would have expected

(2) More dogs ate more rats than cats ate mice.

⇝ QUD: how dogs are more successful predators than cats are

(3) Less land produces more corn than ever before.

⇝ QUD: how corn productivity is better than before

(4) No airline saves you more money in more ways than Delta.

⇝ QUD: how Delta is more economical than other airlines

(8) Nowadays, more goods are carried faster (than before).

⇝ how many goods are carried how fast?

⇝ QUD: how transportation is more efficient than before

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Proposal

(2) More dogs ate more rats than cats ate mice.

- The semantics of multi-head comparatives compares two cumulative-reading sentences
  - comparing ‘how many dogs ate how many rats’ (the matrix clause) with ‘how many cats ate how many mice’ (the *than*-clause)
- The pragmatics of multi-head comparatives addresses one underlying degree QUD
  - QUD: how dogs are more successful predators than cats are
  - comparing ‘how many dogs ate how many rats’ (to what extent dogs are successful predators) with ‘how many cats ate how many mice’ (to what extent cats are successful predators)

The semantics of multi-head comparatives

measurement sentence	$\rightsquigarrow$	**comparative sentence**
Mary is d-tall how tall is Mary		Sue is taller than Mary is ~~d-tall~~ how tall is Mary how tall is Sue
cumulative-reading sentence	$\rightsquigarrow$	**multi-head comparative**
m-many cats ate n-many mice how many cats ate how many mice		More dogs ate more rats than ~~m-many~~ cats ate ~~n-many~~ mice how many cats ate how many mice how many dogs ate how many rats

(See Zhang and Ling 2021, Fleisher 2018, 2020)

An additivity-based view of comparative morphemes

- *-er/more* is similar to *another* and indicates an **increase**.
  - The increase and its base are in different sentences:

    (11) I ate an apple. Then I ate another.

    (12) I ate some chocolate. Then I ate (a bit) more (chocolate).

    (13) Mary is tall. Sue is taller.

  - The increase and its base are in the same sentence:

    (14) A girl, Mary, met another girl, Sue.

    (15) Sue is taller than Mary.

(16) $[\![\text{-er/more}]\!]_d \stackrel{\text{def}}{=} d_0$ such that $d_0 \in (0, +\infty)$
i.e., an unspecified positive degree value that indicates an increase
Requirement of additivity:
there is a salient scalar value serving as the base for this increase.

(See Zhang and Ling 2021)

The semantics of comparatives

measurement sentence	$\rightsquigarrow$	**comparative sentence**
Mary is 6 feet tall		Sue is tall-er than Mary is ~~tall~~
$\textsc{height}(\text{Mary}) \geq 6'$		d_0 $\iota d[\textsc{height}(\text{Mary} \geq d)]$
		$\textsc{height}(\text{Sue}) \geq d_0 + \iota d[\textsc{height}(\text{Mary} \geq d)]$

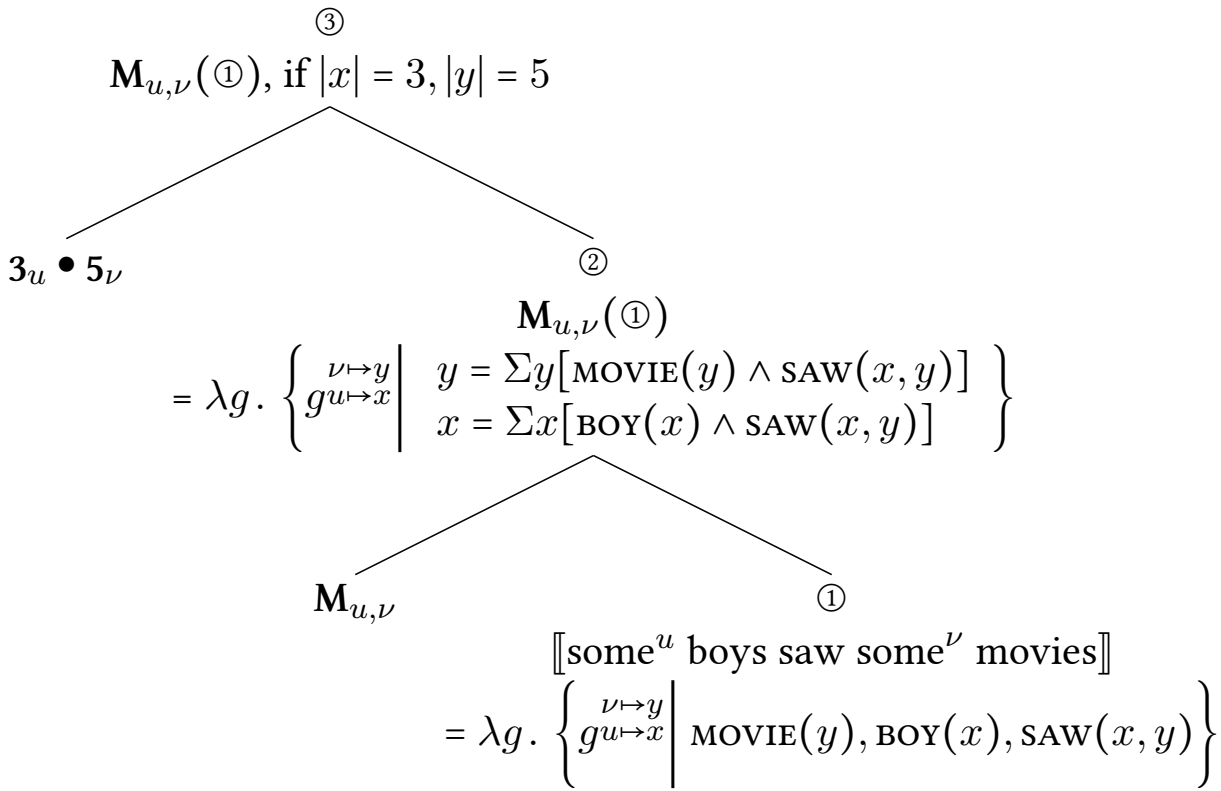
(17) $[\![\text{tall}]\!]_{\langle d,et\rangle} \stackrel{\text{def}}{=} \lambda\delta_d.\lambda x_e.\textsc{height}_{\langle e,d\rangle}(x) \geq \delta$

- The meaning of the *than*-clause is considered the most informative short answer to a corresponding degree question

(See Zhang and Ling 2021)

The semantics of cumulative-reading sentence

(9) Exactly three^{u} boys saw exactly five$^{\nu}$ movies.



- Brasoveanu (2013): the meaning of (9) within a dynamic semantics framework:
  - ①: introducing discourse referents (drefs) and relevant restrictions
  - ②: maximality operator $\mathbf{M}_{u,\nu}$ checks mereology-based maximality
  - ③: cardinality tests $\mathbf{3}_u \bullet \mathbf{5}_\nu$ check the cardinality of maximal drefs

The semantics of multi-head comparatives

(2) More dogs ate more rats
d_1 d_2
than ~~m-many~~ cats ate ~~n-many~~ mice

$$\iota m \iota n[\textsc{cardinality}(\Sigma z[\textsc{cat}(z) \wedge \textsc{eat}(z,w)]) = m \wedge \textsc{cardinality}(\Sigma w[\textsc{mouse}(w) \wedge \textsc{eat}(z,w)]) = n]$$

- The meaning of the *than*-clause denotes the most informative short answer to the degree question 'how many cats ate how many mice'
  - i.e., the cardinality of the maximal cat-sum that ate mice, which is m
  - and the cardinality of the maximal mouse-sum eaten by cats, which is n
- The two instances of *more* denote two unspecified increases along the scale of cardinality, d_1 and d_2
- The matrix clause addresses
  - the totality of dogs Σx who ate rats, and its cardinality is $m + d_1$
  - and the totality of rats Σy eaten by dogs, and its cardinality is $n + d_2$
- Here **maximality** is mereology-based.

Maximality based on informativeness and sensitive to a degree QUD

(18) $\mathbf{M}_{u_1,u_2,\ldots} \stackrel{\text{def}}{=}$

$\lambda m.\lambda g.\,\{h \in m(g) | \neg\exists h' \in m(g)\,.\,G_{\text{QUD}}(h'(u_1,u_2,\ldots)) >_{\text{info}} G_{\text{QUD}}(h(u_1,u_2,\ldots))\}$

(Type of m: $g \to \{g\}$; Type of $\mathbf{M}$: $(g \to \{g\}) \to (g \to \{g\})$)

- The QUD-based maximality operator $\mathbf{M}_{u_1,u_2,\ldots}$ works like a filter on information states.
- With the application of $\mathbf{M}_{u_1,u_2,\ldots}$, the discourse referents (drefs, which are assigned to $u_1, u_2, \ldots$) that lead to the maximal informativeness in resolving a degree QUD will be selected out.
- The definition of $\mathbf{M}_{u_1,u_2,\ldots}$ includes an operator G_{QUD}, which, when applied on drefs, returns a value indicating informativeness.
- This informativeness amounts to a measurement in addressing a contextually salient degree QUD.
- In this sense, G_{QUD} can be considered a measure function.

The pragmatics of multi-head comparatives

(2) More$_{d_1}$ dogs ate more$_{d_2}$ rats than ~~m-many~~ cats ate ~~n-many~~ mice

$$\iota m \iota n[\textsc{cardinality}(\Sigma z[\textsc{cat}(z) \wedge \textsc{eat}(z,w)]) = m \wedge \textsc{cardinality}(\Sigma w[\textsc{mouse}(w) \wedge \textsc{eat}(z,w)]) = n]$$

- Underlying degree QUD:
  how dogs are more successful predators than cats are
- The maximal informativeness amounts to mereology-based maximality,
  i.e., $G_{\text{QUD}} = \lambda x.\lambda y.|x| + |y|$
- $[\![(2)]\!]$ is true iff $|\Sigma z| = m \wedge |\Sigma w| = n \wedge |\Sigma x| = m + d_1 \wedge |\Sigma y| = n + d_2$,
  i.e., $|\Sigma x| = |\Sigma z| + d_1 \wedge |\Sigma y| = |\Sigma w| + d_2$

Less land produces more corn than ever before

(3) Less land produces more corn than ever before.

- There is a proportion reading.
- Underlying degree QUD:
  how corn productivity is better than before (e.g., $\frac{80\% \text{ (of the product)}}{5\% \text{ (of the land)}} > \frac{60\%}{20\%}$)
- More examples of multi-head comparatives with a proportion reading:

(19) The trend is indisputable: Fewer people own more of the overall wealth, and fewer companies own more market share. (https://www.deseret.com/opinion/2020/9/14/21436415/guest-opinion-america-capitalism-strengths-dark-side-too-far-inequality-divisiveness-wealth-gap)

(20) Fewer people own more of the land in Brazil than anywhere else in the world. (https://newint.org/features/2003/01/05/cutting)

Less land produces more corn than ever before

(3) $\underbrace{\text{Less}}_{d_1}$ land produces $\underbrace{\text{more}}_{d_2}$ corn

than before ~~m-much land produced n-much corn~~

$\iota m \iota n[\%(\Sigma z[\textsc{land}(z) \wedge \textsc{prd}(z,w)])=m \wedge \%(\Sigma w[\textsc{corn}(w) \wedge \textsc{prd}(z,w)])=n \wedge \frac{n}{m}$ is maximal$]$

- The maximal informativeness amounts to the maximal ratio between the percentage of corn and the percentage of land, i.e., $G_{\text{QUD}} = \lambda x.\lambda y.\frac{\%(y)}{\%(x)}$
- $[\![(3)]\!]$ is true iff for the highest ratios in the past $\frac{n}{m}$ and nowadays $\frac{n'}{m'}$, $m' = m + d_1$ and $n' = n + d_2$.
- Here d_1 is a decrease (or a negative increase) (see Zhang and Ling 2021).

(16) $[\![\text{-er/more}]\!]_d \stackrel{\text{def}}{=} d_0$ such that $d_0 \in (0, +\infty)$ an unspecified increase

(21) $[\![\text{less}]\!]_d \stackrel{\text{def}}{=} d_0$ such that $d_0 \in (-\infty, 0)$ an unspecified decrease

More goods are carried faster

(8) More goods are carried faster than ~~*m*-many goods were carried~~

d_1 (More) ~~*n*-fast~~

d_2 (-er)

- Underlying degree QUD:
  how transportation is more efficient than before
- The maximal informativeness is achieved when the measurements of amount of goods and speed are both maximal
- $[\![(8)]\!]$ is true iff there is an increase for the amount of goods and there is an increase for the speed

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With regard to von Stechow (1984)'s view

(2) More$_{d_1}$ dogs ate more$_{d_2}$ rats than ~~*m*-many~~ cats ate ~~*n*-many~~ mice

(3) Less$_{d_1}$ land produces more$_{d_2}$ corn than before.

(8) More$_{d_1}$ goods are carried fast er$_{d_2}$

- von Stechow (1984): a good multi-head comparative involves **two comparisons**.
- Under the current analysis, each comparison indicates a (positive or negative) increase.

With regard to Hendriks (1994), Hendriks and De Hoop (2001)'s view

(2) More dogs ate more rats than cats ate mice.

(3) Less land produces more corn than ever before.

(5) *Fewer dogs ate more rats than cats ate mice.

(Hendriks and De Hoop 2001: p.10, (15))

- Hendriks (1994), Hendriks and De Hoop (2001): the two comparisons are mutually independent
- For (2), where both comparative expressions are positive increases (i.e., in the same direction), maximal informativeness is basically achieved with mereological maximality.
- For (3), where the comparative expressions are in opposite directions, maximal informativeness is achieved with ratio maximality.
- For infelicitous multi-head comparative (5), there is no salient underlying degree QUD out of blue. (Maybe accommodations?)

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Take-home messages

- Semantically, multi-head comparatives are based on cumulative-reading sentences.
- Pragmatically, there is an interplay between the two comparative plural/mass nouns in a multi-head comparative, and the entire sentence addresses only one underlying degree QUD.

(1) More silly lectures have been given by more silly professors – (two comparative expressions that are plural nouns)
than I would have expected ~~how many silly lectures have been given by how many silly professors~~. (one *than*-clause)

$\rightsquigarrow$ addressing 'how education is worse than I would have expected'

Thank you!

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