

Cardinality and the *many/much* Distinction

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1. INTRODUCTION

- ◆ **Starting point:** the distribution of the ‘adjectives of quantity’ *many* and *much* (also *few* and *little*):

(1)	<u>Many/few</u> trees fell	<i>quantity</i>
(2)	a. <u>Much/little</u> wine was consumed	<i>amount</i>
	b. The company grew too <u>much/little</u>	<i>adverbial modifier</i>
	c. Fred is <u>much/little</u> taller than John	<i>degree modifier</i>
	d. Fred is <u>much</u> too tall	<i>degree modifier</i>

- ◆ **A unified analysis:** *many/much/few/little* are predicates of scalar intervals, i.e. type $\langle dt, t \rangle$ (Schwarzschild 2006; Rett 2006; Solt 2007a, 2007b).

- Each of examples in (1)-(2) provides interval (set of degrees) to serve as argument, with degrees introduced by gradable expression (2b), degree morpheme (2c,d), or null measure function (1, 2a):

(3)	a.	$\text{many}(\lambda d. \exists x[\text{tree}(x) \ \& \ \text{fell}(x) \ \& \ \text{MEAS}(x) \geq d])$	(1)
	b.	$\text{much}(\lambda d. \exists x[\text{wine}(x) \ \& \ \text{consumed}(x) \ \& \ \text{MEAS}(x) \geq d])$	(2a)
	c.	$\text{too-much}(\lambda d. \text{growth}(\text{the company}) \geq d)$	(2b)
	d.	$\text{much}(\lambda d. \text{height}(\text{john}) < d \leq \text{height}(\text{fred}))$	(2c)
	e.	$\text{much}(\lambda d. \text{max}_{\text{height}} < d \leq \text{height}(\text{fred}))$	(2d)

⇒ ‘Large’ for *many/much*; ‘small’ for *few/little*

- ◆ Adjectives of quantity belong to same class as degree expressions such as *-er than 10*; *too*; *very* (Heim 2000, 2006; Hackl 2000; Bhatt & Pancheva 2004; a.o):

- Not quantifying determiners

(4)	a.	John’s good qualities are <u>many</u>
	b.	The <u>little</u> wine that was consumed

- Not predicates over individuals

(5)	a.	<u>Many</u> fewer than 100 runners finished the race
	b.	We drank <u>much</u> less than a gallon of wine

(6)	a.	Five is too <u>many</u>
	b.	A gallon is too <u>little</u>

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Today’s topics:

- ❖ How to characterize the distribution of *many/few* vs. *much/little*
- ❖ Implications of their distribution for theories of quantity and measurement

2. POSSIBLE ACCOUNTS

- ◆ *Much/little* typically taken to be mass counterparts of *many/few* (e.g. Higginbotham 1995)
- ◆ But...
 - Occurrence outside of nominal domain (e.g. (2b-d))
 - Analysis as predicates of scalar intervals → any semantic explanation must be found in structure of domain of scales and degrees vs. domain of individuals
- ◆ I will contrast three positions that could be taken:
 - i) Dimension: *many* is associated with dimension of cardinality (number); *much* is associated with other dimensions (Schwarzschild 2006)
 - ii) Dense/discrete scale structure: as a formalization of (i), *many* is predicated of intervals on a discrete scale (the natural numbers); *much* is predicated of intervals on dense scales (cf. Rett 2006; contra Fox & Hackl 2006)
 - iii) Agreement: *many*, as the plural form of *much*, agrees with the plural noun (Chierchia 2005)
- ◆ The data in (1)-(2) yield little insight into this question, as the three properties in question coincide. It is thus instructive to examine cases where they do not.

3. THE ANALYSIS

3.1 *Many* and discrete vs. dense scales

- ◆ Intuitively, scale involved in measurement of cardinality (as in (1)) appears to differ from other measurement scales in being discrete vs. dense:

(7) A scale $S = \{D, >, DIM\}$ is **dense** iff for all $d, d' \in D$ s.t. $d > d'$, $\exists d''[d > d'' > d']$

- Volume: For any two portions of (say) water having distinct volumes d and d' , there can be a third portion of water whose volume d'' falls between d and d'
- Cardinality (number): For two groups of individuals numbering n and $n+1$, there can be no third group whose number falls between n and $n+1$

- ◆ Fox & Hackl (2006): Universal Density of Measurement (UDM): all scales involved in natural language measurement – including cardinality – are formally dense
 - (8) a. *How much doesn't John weigh?
b. *How many children doesn't John have?
 - Ungrammaticality of (8a): asks for the maximally informative degree *d* (i.e. the minimum degree *d*) such that John doesn't weigh *d*. On the assumption that the scale of weight is dense, there is no such minimum degree.
 - Explanation can only be extended to (8b) if it is assumed that the scale of cardinality is likewise dense
- ◆ Further evidence that cardinalities may be mapped to a dense scale:
 - Average values
(9) The average American household has 2.3 televisions
 - Nouns of measure
(10) The rod is 3.791 feet long
 - Counting divisible entities
(11) a. We ate 2½ pies / 2¼ pies / 2⅙ pies / etc.
b. Our firm built 3½ houses this year
- ◆ Importantly, in each of these cases the corresponding question is formed with *many*, not *much*:
 - (12) a. How many/*much televisions does the average American household own? 2.3
b. How many/*much feet long is the rod? 3.791
c. How many/*much pies did you eat? 2½
- ◆ Dense vs. discrete scale structure is not the determining factor in the *many/much* distinction (contra position (ii) above): *many* is not restricted to operating on discrete scales
 - Evidence points to dimension of cardinality requiring a dense scale

3.2 Agreement

- ◆ Does the *many/much* distinction reflect number agreement?
 - On this view, *many/much* a single item (similarly for *few/little*); *many* is the plural form, *much* its (suppletive) singular (Chierchia 2005)
 - (13) a. this_{SG} rice/these_{PL} books
b. much_{SG} rice/many_{PL} books
 - (14) Spanish: *mucho* ('much') vs. *muchos* ('many')

- Solves the puzzle of why *much* and *little* are the only apparent mass-only quantifiers in English: they are just morphological variants of the mass/plural quantifiers *many/much* and *few/little*, differing only from other mass/plural quantifiers (e.g. *all*) in having separate singular and plural forms.

Claim: The primary factor distinguishing *many* and *much* is not morphological number but rather dimension of measurement

3.3 Dimension vs. Agreement

Evidence from mismatches between number and dimension of measurement:

- ◆ Note that pluralities can be quantified on dimensions other than cardinality:
 - (15) a. I bought ten potatoes **cardinality**
b. I bought three pounds of potatoes **weight**
c. I bought two bushels of potatoes **dry volume**
d. The floor was covered by two feet of potatoes **depth**
- ◆ But now consider the following scenario:
 - (16) John has 9 (large) potatoes weighing 3.5 pounds in total
Fred has 12 (small) potatoes weighting 2.5 pounds in total
⇒ Two salient dimensions: cardinality & weight
 - The only felicitous answer to (17a) is (17b) – a *how many* question asks for a number.
 - (17) a. How many potatoes does John have?
b. 9
c. #3.5 pounds
 - (18) is false, despite the fact that on the dimension of weight, Fred has a lesser quantity of potatoes John does – comparisons expressed by *many* are comparisons of cardinality
 - (18) Fred doesn't have as many potatoes as John **false**
 - However, replacing *many* with *much* is at best marginal (though considerable speaker variation here):
 - (19) a. *?How much potatoes does John have?
 - (20) a. *?Fred doesn't have as much potatoes as John
 - There is no completely acceptable way to describe/inquire about the weight relationship in (16)

- ◆ What do these data tell us?
 - Only reading available to *many* is a cardinality reading
 - ◆ *Many* itself encodes cardinality?
 - ◆ Cardinality is default dimension on which pluralities are quantified?
 - Infelicity of *much*
 - ◆ Number mismatch?
 - ◆ Incompatibility with cardinality as default dimension?
- ◆ Evidence that number is not the determining factor from idiosyncratic plurals that denote substances of matter, e.g. *mashed potatoes, scrambled eggs, refried beans*.¹
 - Take plural agreement:
 - (21) a. These mashed potatoes/*this mashed potatoes
 - b. The mashed potatoes are/*is cold
 - *Much* preferable to *many* (though varies by speaker and construction):
 - (22) a. How much mashed potatoes do you want?
 - b. Don't give me that much mashed potatoes
 - c. I made too much mashed potatoes
 - (23) a. ??How many mashed potatoes do you want?
 - b. ??Don't give me that many mashed potatoes
 - c. ?I made too many mashed potatoes

⇒ Presence of *much* vs. *many* not determined by same factor as presence of *this* vs. *these* (agreement)

⇒ Possibility of *many* suggests agreement still plays some role?
- ◆ Possibility also with some other count nouns:
 - (24) a. Whether you are newlyweds or a couple now finding themselves with an "empty nest", knowing how much vegetables to buy for two servings can be tricky.
(http://www.practicalkitchen.com/cooking_for_two/buying_vegetables_for_two.shtml)
 - b. If you carry just too much clothes you will end up with dirty laundry on your back all the time... (www.oldcontinent.com/tips/how_to_pack.shtml)
- ◆ Subtle difference in meaning when both *many* and *much* allowed:
 - (25) a. How much scrambled eggs do you want?
 - b. Two scoops/a plate-full/about half the amount you gave him...
 - (26) a. How many scrambled eggs do you want?
 - b. Two

¹ I thank Greg Carlson for directing my attention to these.

- (27) a. I bought too many clothes
- b. I have too many clothes to fit in my closet
- (28) a. I packed too much clothes
- b. If you put too much clothes in the washer, the detergent won't dissolve
- c. You're wearing too little clothes

⇒ *Many* and *much* themselves convey dimension (position (i))

- A further test is provided by the comparative. Note that the *many/much* distinction is neutralized in the comparative, but the *few/little* distinction is not:
 - (29) a. many...more than
 - b. much...more than
 - c. few...fewer than
 - d. little...less than
- Consider again scenario (16). In this situation, (30a) arguably has a reading on which it is true, and (30b) is certainly true; by contrast (30c) is false, and (30d) is ungrammatical
 - (30) a. John has more potatoes than Fred **true on one reading (?)**
 - b. John has 1 pound more potatoes than Fred **true**
 - c. Fred has fewer potatoes than John **false**
 - d. *Fred has 1 pound fewer potatoes than John **ungrammatical**

⇒ Pluralities can be compared on dimensions other than number; it is the presence of *many/few/fewer* (which encode cardinality) that disallows this

3.4 Conclusion

- ◆ Dimension of measurement (+/- cardinality) is primary factor in selection of *many* vs. *much*
- ◆ Some sort of agreement as well?

4. CONSEQUENCES OF THE ANALYSIS

- ❖ English has degree expressions that make a distinction between the dimension of cardinality and other dimensions
- ❖ I will discuss consequences for three issues in the semantics of quantity and measurement

4.1 The Dimension of Cardinality

- ◆ *Many/few* predicated of intervals on the scale of cardinality:
 - The distinction between cardinality and other dimensions cannot be reduced to discrete vs. dense scale structure
 - There nonetheless must be some fundamental distinction between cardinality and other dimensions of measurement
- ◆ Fox & Hackl (2006): Granularity
 - Contextual parameter G that specifies a level of granularity (formalized as equivalence relation)
 - In the measurement of collections of indivisible objects, granularity assumed to be 1:

(31) $x \text{ Gy iff there is a natural number } n \text{ s.t. } x \in (n, n+1] \text{ and } y \in (n, n+1]$ (p. 569)
 ⇒ Presupposes existence of natural numbers
 ⇒ Only contextual?

- ◆ An alternate possibility: cardinality is distinguished from other dimensions in having a unique scale associated with it:

(32) A scale *S* is a set of points *D* ordered by an ordering relationship $>$ relative to some dimension *DIM*

<u>Dimension</u>	<u>Scale</u>
Cardinality:	...1...2...3...4...5...
Weight:	...1 pound...2 pounds...3 pounds...4 pounds... ...1 kilogram...2 kilograms...3 kilograms... ...1 stone...2 stones...3 stones... ...1 grain...2 grains...3 grains...
Distance	...1 foot...2 feet...3 feet... ...1 meter...2 meters...3 meters... ...1 light year...2 light years...3 light years...

- Put differently: points (major divisions) on scale of cardinality are non-arbitrary; dimension of cardinality has built-in granularity
- Evidence of granularity
 - ◆ Scenario 1: Fred has 3.3 pounds of rice; John has 3.8 pounds of rice
 - ◆ Scenario 2: Fred has 2.8 pounds of rice; John has 3.3 pounds of rice

(33) John has more rice than Fred True or false in both scenarios
 (depending on relevant level of granularity)

- ◆ Scenario 1: Fred ate $3\frac{3}{8}$ pies; John ate $3\frac{7}{8}$ pies
- ◆ Scenario 2: Fred ate $3\frac{3}{4}$ pies; John ate $4\frac{1}{2}$ pies

(34) John ate more pies than Fred False in Scenario 1; potentially true in Scenario 2

(35) John ate more pie than Fred True or false in both scenarios
 (depending on relevant level of granularity)

⇒ Cardinality has natural units; volume does not

- ◆ Scenario 1: Fred's age: 15 years 2 months; John's age: 15 years 10 months
- ◆ Scenario 2: Fred's age: 15 years, 6 months; John's age: 16 years, 2 months

(36) John is older than Fred Could be judged false in Scenario 1, true in Scenario 2

⇒ Age has conventionally defined units (cf. *John is 15*)

- ◆ Consequence: cardinality is distinguished from other dimensions in having a non-arbitrary scale associated with it. The *many/much* distinction is sensitive to this aspect of scale structure.

4.2 Fake Mass Nouns

- ◆ Current account holds that *much/little* are predicated of intervals on a scale other than cardinality
- ◆ Prediction: Use of *much/little* entails that entities are not being counted
- ◆ Test case: 'fake mass nouns' (Chierchia 1998): *furniture, jewelry, mail, silverware*

(37) a. How much furniture does John have?
 b. John doesn't have as much furniture as Fred
 c. John has too much furniture

- ◆ On what dimension are entities such as furniture, jewelry, mail, etc. measured?

- Barner & Snedeker (2005): fake mass nouns are cognitively count

(38) Who has more furniture?



- On the surface, problematic for current theory. But:
 - (39) Who has more furniture?
 - John: a king-sized bed, a dining table, and a couch
 - Fred: an end table, two folding chairs, and a filing cabinet
 - (40) Who is wearing more jewelry?
 - Sue: a large necklace, a chunky bracelet and a large diamond ring
 - Jane: a thin gold chain, two slim gold rings and a thin bracelet
- Hypothesis: We don't count furniture, jewelry, mail, etc., because they don't have homogeneous atoms (cf. rice, water; Chierchia 1998, 2005)
 - ⇒ Would imply count/mass distinction not purely formal
 - ⇒ Opportunity for further experimental investigation

4.3 Structure of comparatives

- ◆ Recent analyses of cardinal numbers (Krifka 1999; Ionin & Matushansky 2006; Geurts & Nouwen 2007) hold that modified numbers such as (41a) is not parsed as in (41b), but rather as in (41c):

- (41) a. More than three beers
- b. [[more than three][beers]]
- c. [more than [three beers]]

- Geurts & Nouwen (2007):

- *More than* operates on scales of alternatives
- Allows unified analysis of *more than three beers*, *more than happy*, etc.

$$(42) \quad \llbracket \text{more than } \alpha \rrbracket = \lambda x. \exists \beta [\beta \triangleright \alpha \ \& \ \beta(x)] \quad (\alpha \text{ and } \beta \text{ of type } \langle \text{et} \rangle)$$

- Ionin & Matushansky (2006):

- Cardinal numbers are modifiers (type $\langle \text{et}, \text{et} \rangle$)
- Compositional analysis of complex cardinals

$$(43) \quad \llbracket \text{three hundred thousand books} \rrbracket = \llbracket 3 \rrbracket (\llbracket 100 \rrbracket (\llbracket 1000 \rrbracket (\llbracket \text{books} \rrbracket)))$$

- Entails complex cardinals not constituents

- ◆ Consider now the following

- (44) a. Fred drank many more than three beers.
 [He drank eight!]
- b. Fred drank much more than three beers.
 [He drank a glass of wine and three martinis too!]

- How to accommodate under the analysis (41c)?

Possibility 1: Different scales (Geurts & Nouwen 2007)

- ◆ *many more than* operates on scales whose points differ only in cardinality

{...1 beer...2 beers...**3 beers**...4 beers...5 beers...}

- ◆ *much more than* operates on non-cardinality scales

{...1 beer...1 martini...**3 beers**...3 beers+1 martini....3 beers + 3 martinis...}

Possibility 2: Two distinct structures

- (45) a. [much more than [3 beers]] b. [[many more than [3]][beers]]

⇒ Entails that cardinals (including complex cardinals) are constituents

5. OVERALL CONCLUSIONS

- ❖ Fundamental separation of cardinality from other dimensions of measurement (reflected in availability of degree expressions that encode cardinality)
- ❖ Further evidence of relevance of scale structure to distribution and interpretation of lexical items (cf. Kennedy & McNally 2005)

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