

## The Grammar of Relative Measurement

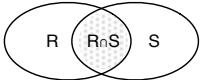
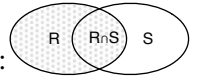
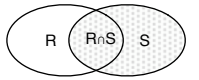
Previous work on measurement has exclusively considered absolute, intersective measures. ‘Gram’ is a typical example: ‘30 grams of gold’ are both 30 grams heavy *and* entirely golden. Intersectivity is implicitly assumed as a universal property of the grammar of measurement by Krifka (1989), Schwarzschild (2006), Champollion (2010), Scontras (2014), and others.

- (1) 30 grams of (the) gold / 3 ounces of gold
- a.  $\lambda x . \text{grams}(x) \wedge \text{gram}'(x) = 30 \wedge \dots$  [quantization requirement] (after Krifka 1989)
  - b.  $\exists x \exists \text{Dim: gold}(x) \ \& \ 3\text{-ounces}(\text{Dim}(x)) \ \& \ \text{MON}(\text{Dim}, \text{gold})$  (after Schwarzschild 2006)

However, there are also relative, *non-intersective* measures – namely proportion nouns and fractions:

- (2) 40 percent / two fifths of (the) Llamas

**Two Readings** Relative measures require a new, non-intersective take on the semantics of measurement. But furthermore, the phrase structure must also be reconsidered because, in many languages, relative measures give rise to ambiguities not observable with intersective measures. Consider the sets relevant to different measures *M* in the phrase ‘thirty *M* (of) *R* are *S*’ in (3). Intersective measures like ‘thirty grams (of) *R* are *S*’ only measure the intersection of  $R \cap S$  so the order of the arguments is irrelevant to interpretation. Relative measures like ‘thirty percent (of) *R* are *S*’ could measure either the ratio of  $R \cap S$  to *R* or to *S*. In terms of generalized quantifier theory, either *R* or *S* could be the restrictor.

- (3) intersective:  relative conservative:  relative reversed: 

We call the reading targeting the  $R \cap S$  to *R* ratio the *Conservative Reading*, and the one targeting the  $R \cap S$  to *S* ratio the *Reversed Reading*. Languages differ as to whether and how they distinguish between the two readings. In Mandarin, relative measures are ambiguous. The reversed reading requires focus on *běndì-rén* ‘local person’.

- (4) *c/r*: Tāmen lùyòng le 30% de běndì-rén (MANDARIN)  
 3PL hire perf. 5% DE local-person  
 ‘They hired 30% of the locals.’ / ‘30% of the people they hired are locals.’

In English the reversed reading is much more restricted, but when it is available as in (5b), it is distinguished from the conservative reading by case (i.e. ‘of’) and definiteness:

- (5) *con*: The company hired 30% of the locals last year.  
*rev*: The company hired 30% locals<sub>F</sub> last year.

In French, disambiguation is made by definiteness (6), while case is decisive in German (7):

- (6) *con*: Ce film a été vu par deux tiers des journalistes (FRENCH)  
 this movie has been seen by two thirds-of-the journalists  
*con/\*rev*: ‘Two thirds of the journalists have seen this movie.’  
*rev*: Ce film a été vu par deux tiers de journalistes<sub>F</sub>  
 this movie has been seen by two thirds of journalists  
*rev/\*con*: ‘Two thirds of the people who have seen this movie are journalists.’

- (7) *con*: Zwei Drittel westfälischen Bieres werden in Berlin getrunken. (GERMAN)  
 two thirds.NOM Westphalian-GEN beer-GEN are in Berlin drunk  
*con/\*rev*: ‘Two thirds of the Westphalian beer is drunk in Berlin.’  
*rev*: Zwei Drittel westfälisches Bier<sub>F</sub> wurde in Berlin getrunken.  
 two thirds.NOM Westphalian-NOM beer.NOM was in Berlin drunk  
*rev/\*con*: ‘Two thirds of what was drunk in Berlin was Westphalian beer.’

Finally in Korean, the position of the case marker determines the available readings.

- (8) *con*: [Kyosu isip-phulo]-ka wassta. (KOREAN)  
 professor twenty-percent-NOM come-PAST-DECL  
*con/\*rev*: ‘Twenty percent of the professors came.’

c/r: Kyosu<sub>F</sub>-ka isip-phulo wassta.  
 professor-NOM twenty-percent come-PAST-DECL  
 rev/?con: ‘Twenty percent of those who came were professors.’

While proportional *many/few* allow two readings as well (Herburger 1998 et al.), no language distinguishes between the two readings of *many/few* morphologically.

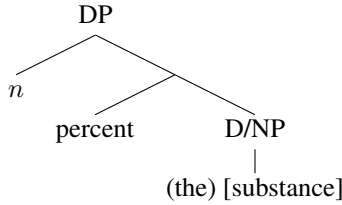
**Focus Sensitivity** In all languages, the reversed reading requires focus on the substance noun. With complex substance NPs, more narrow focus is possible as in (9). The unfocused parts of the substance noun in this case also restrict the reference set.

(9) Zwei Drittel DEUTsche Frauen haben das Konzert besucht. (GERMAN)  
 two thirds German women have the concert visited

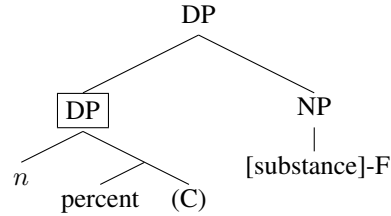
‘Two thirds of the women who attended the concert were from Germany.’

**Proposal** We propose that measures are ambiguous between two distinct structures. In the (pseudo-)partitive structure (10), the measure noun and the substance noun form a constituent, and this structure receives the conservative interpretation. Reverse interpretations are derived from (11), where the degree argument and the measure noun form a constituent, the boxed DP in (11). We assume the meaning of ‘percent’ in (12) based on a mereological approach.

(10) **Conservative (partitive)**



(11) **Reversed (appositive)**



$$(12) \quad \llbracket \text{percent} \rrbracket = \lambda x \in D_e \lambda n \in D_d \lambda y \in D_{et} \cdot \frac{\mu(x \sqcap \oplus y)}{\mu(x)} = \frac{n}{100}$$

With (12), (10) can be interpreted directly, but (11) cannot. We propose that the measure noun and its degree argument must raise as illustrated in (13), applying trace conversion (Fox 2002) to its result. The restrictor argument of *percent* is then provided by maximizing closure of the focus value of its scope within Rooth’s (1992) focus semantics. Specifically we assume the maximalization operator in (13a).

(13)  $\downarrow$  30%  $\lambda x$  the company hired [the<sub>x</sub> locals<sub>F</sub>]  
 [thirty percent max(C)]  $\sim_C$   $\lambda x$  the company hired [the<sub>x</sub> locals<sub>F</sub>]

- a.  $\max(C) = \bigoplus_{c \in C} \bigoplus_{c(x)=1} x$
- b.  $C = \{ \lambda x. \text{the company hired the}_x \text{ locals}, \lambda x. \text{the company hired the}_x \text{ non-locals} \}$
- c.  $\max(C) = \bigoplus \{ x \mid \text{the company hired } x \}$

For example, in (13), the focus alternative set is (13b), and maximization in (13c) results in the plurality of all people the company hired. This correctly predicts the reversed reading that 30% of all the people hired by the company were locals. This LF adjustment is covert in English, German, and Chinese, but overt in Korean. We propose that ‘20%’ in (8)c/r must move in Korean overtly to an adverbial position before the subject DP moves to the nominative case position as shown schematically in (14). Subject movement must reconstruct to bind the variable *x*.

(14) [professor<sub>F</sub> the<sub>x</sub>] -NOM  $\downarrow$  20%  $\lambda x$  [professor<sub>F</sub> the<sub>x</sub>] came

**Conclusion** We show that 1) relative measures require a new semantics of measurement, and 2) that relative measures also reveal novel structural ambiguities of measure in many languages.

**Selected References**

Champollion, Lucas: 2010, *Parts of a whole: Distributivity as a bridge between aspect and measurement*, Doctoral Dissertation, University of Pennsylvania, Philadelphia, Penn.

Scontras, Gregory: 2014, *The semantics of measurement*, Doctoral Dissertation, Harvard University, Cambridge, Mass.