The semantics and pragmatics of directional numeral modifiers

Introduction On the basis of data from fifteen different languages (table 1, other side) I argue that directional numeral modifiers (DNMs), exemplified here by *up to*, differ from other numeral modifiers with regards to the bounds they set. Studying the bounds of numeral modifiers adds a novel element to the recent semantic and pragmatic discussion on modified numerals. My study extends Schwarz, Buccola, and Hamilton's (2012) observations on English *up to* to other languages and provides an account to explain their and new observations.

The bottom-of-the-scale effect (BOTSE) Schwarz et al. note that *up to*, unlike other upper-bounded class B numeral modifiers such as *at most* (Nouwen, 2010), cannot be combined with the numeral at the bottom of the scale it quantifies over, as shown in (1). The authors claim that this is due to the fact that *up to* must always quantify over a range of numbers, not a single element. I found that DNMs display BOTSE in all fifteen languages I studied.

(1) a. {Up to / At most} ten people died in the crash.
b. {#Up to / At most} one person died in the crash.

Monotonicity Schwarz et al. mention that while other upper-bounded numeral modifiers are downward monotone, *up to* is not ((2-a)-(2-b)). It for instance does not license NPIs, as (2-c) demonstrates. The authors claim that there is no entailment in (2-b) and propose a non-monotone semantics for *up to.* In contrast with Schwarz et al., I found that speakers of different languages did not outright reject the entailment pattern in (2-b). Furthermore, they did not reject the opposite entailment pattern, either. Finally, speakers were unable to determine the direction of entailment in cases like (2-b).

(2) a. At most three students smoke. $\models$ At most three students smoke cigars.
b. Up to three students smoke. $?\models$ Up to three students smoke cigars.
c. {#Up to / at most} three people had ever been in this cave. (Krifka, 2007)

Weak upper bound A hitherto undiscovered property of DNMs is that their upper bound is weak. Across languages, the upper bound set by DNMs but not the one set by other upper-bounded numeral modifiers can be cancelled, as in (3-a), and reinforced, as in (3-b).

(3) a. Peter is allowed to choose {up to / #at most} ten presents, perhaps even more.
b. You're allowed to choose {up to / #at most} ten presents, but no more than that.

Analysis I claim that DNMs assert a lower bound and only implicate an upper bound. I formalise this idea using inquisitive semantics (e.g. Ciardelli, Groenendijk, and Roelofsen, 2012) in the framework of Coppock and Brochhagen (2013), as shown in (4).

(4) $[\![\text{up to}]\!] = \{\lambda n \lambda P.f\{P(m) | s \leq m \leq n\} | f \text{ is a choice function}\}$
where $s > 0$ and $s \neq n$

Up to n takes a cardinality predicate P and says that P is true of all numbers in a range from a starting point s (the BOTS element) to n. Assuming a monotone semantics of numerals, this does not exclude any numbers except 0. *Up to 2*, for instance, selects the possibilities $\{p_1, p_2\}$, where $p_n = \{w_n, w_{\text{n+1}}, w_{\text{n+2}}, \text{etc.}\}$ and w_n is the world in which P holds for exactly n elements (figure 1a). Exhaustification (as defined in Coppock and Brochhagen) removes all worlds above w_2, giving rise to the upper-bound implicature (figure 1b).

As in Schwarz et al., a range requirement ($s \neq n$) is presupposed. Schwarz et al. use this range requirement to explain the ignorance effects and BOTSE of *up to.* I argue instead that since all class B numeral modifiers display ignorance effects, the range requirement holds for all of them. In the present framework, this ensures that their meaning is *interactive* (i.e. the proposition contains multiple possibilities) (Coppock and Brochhagen).

My theory presents quite a different view on BOTSE than Schwarz et al.'s, for according to the present proposal, *all* upper-bounded class B numeral modifiers display BOTSE, since they all require a range. It is just that DNMs differ from other modifiers in where the bottom of the scale is. Since the range of DNMs starts above 0 while the range of other numeral modifiers starts at 0, BOTSE manifests itself in *#up to 1* as well as in *#at most 0*.

The account predicts that DNMs are upward monotone and thus that they do not license NPIs. As DNMs have an asserted lower bound and an implicated upper bound, the lack of clarity in judgments on entailment patterns is predicted.

This analysis introduces the new element of numeral modifiers differing in the bounds they set to the discussion on modified numerals. In doing so, it provides a more general account for BOTSE that holds for all class B numeral modifiers, sheds new light on the monotonicity properties of DNMs, and explains why DNMs have a weak upper bound. Data from fifteen languages provide crosslinguistic support for these claims.

Danish	German	Polish
Dutch	Greek	Romanian
English	Hebrew	Russian
Farsi	Hungarian	Spanish
French	Italian	Turkish

Table 1: Languages studied

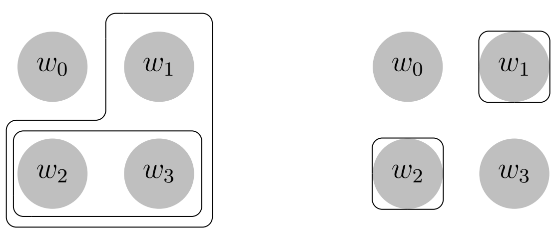

Figure 1a Figure 1b

Figure 1: Visual representation of a) the semantics of *up to 2*, and b) the exhaustified meaning of *up to 2*, where w_3 stands for $w_3, w_4, w_5, ..., \infty$.

References Ciardelli, I., Groenendijk, J., & Roelofsen, F. (2012). Inquisitive semantics. NASSLLI 2012 lecture notes. ∗ Coppock, E., & Brochhagen, T. (2013). Raising and resolving issues with scalar modifiers. *Semantics & Pragmatics*, *6*(3), 1-57. ∗ Krifka, M. (2007). *More on the difference between more than two and at least three.* Retrieved from `http://amor.cms.hu-berlin.de/~h2816i3x/Talks/MoreThanTwo.pdf` ∗ Nouwen, R. (2010). Two kinds of modified numerals. *Semantics & Pragmatics*, *3*(3), 1-41. ∗ Schwarz, B., Buccola, B., & Hamilton, M. (2012). Two types of class B numeral modifiers: A reply to Nouwen 2010. *Semantics & Pragmatics*, *5*(1), 1-25.