

Comparative and superlative differentials: experimental evidence from Czech

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i) bare numerals

(1) This chocolate contains 25 grams of sugar.

Modified Numerals

ii) modified numerals

1. **comparative modifiers (class A)** (*more than, less than, over, ?no more than, ...*)

(2) This chocolate contains more than 25 grams of sugar.

2. **superlative modifiers (class B)** (*at most, at least, minimally, maximally, ...*)

(3) This chocolate contains at most 25 grams of sugar.

extensive research: Büring 2008; Geurts and Nouwen 2007; Nouwen 2008; Nouwen 2010; Cummins and Katsos 2010; Kennedy 2015; Alexandropoulou et al. 2016

Comparative modifiers can scope under or over existential modals.

(4) This bus can carry fewer than 45 people.

- | | | |
|----|------------------------------------|-----------------------------|
| a. | $\diamond > \text{fewer than } 45$ | true - coach bus: 55 people |
| b. | $\text{fewer than } 45 > \diamond$ | true - city bus: 44 people |

Modified Numerals and Existential Modals

Superlative modifiers have to outscope existential modals.

- the contrast crucial for our experiment

(5) This bus can carry at most 45 people.

- | | | |
|----|----------------------------------|------------------------------|
| a. | $*\Diamond > \text{at most } 45$ | false - coach bus: 55 people |
| b. | $\text{at most } 45 > \Diamond$ | true - city bus: 44 people |

Geurts and Nouwen 2007; Blok 2019

Ignorance Implicatures

- another important contrast
- sometimes related to the Maxim of Quantity: logically weaker sentences can signal speaker's ignorance
- comparative modifiers without ignorance implicature

(6) This chocolate contains more than 25 grams of sugar. no II

- superlative modifiers with ignorance implicature

(7) This chocolate contains at most 25 grams of sugar. II

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Nouwen 2008 claims that *no more than* is a comparative modifier since:

- both scopes in the existential modal env.
- no ignorance implicature (and with scalar bounding reading)

(8) Cody's paper is allowed to have no more than 20 pages.

Both properties are intuitively inappropriate for Czech *no more* (\leftrightarrow motivation behind the experiments)

Differences between Czech and English *no more*

English *no* can act as a determiner:

- (9) a. No man arrived.
b. Every/the man arrived.

Unlike Czech *no* in *ne víc* which seems to be a focus particle

- (10) #*Ne*/✓*žádný muž nepřijel*.
no/any man arrived

Slavic focus particles (FP) have to (Jasinskaja 2012 a.o.):

- c-command their associated F-marked expression
- be adjacent to the F-marked constituent

Czech *no* behaves like all other FPs, as exemplified in (11) and (12) with a prototypical FP *pouze* ‘only’

(11) c-command

*Já se choval [seriózně]_F *ne/pouze.*

I SE behaved seriously no/only.

(12) adjacency

a. I behave only [seriously]_F.

b. I only behave [seriously]_F.

c. *Já *pouze/*ne jsem se choval [seriózně]_F.*

I *only/*no AUX SE behaved seriously

d. *Já jsem se choval pouze/ne [seriózně]_F.*

I AUX SE behaved only/no seriously

But the comparative morphology in Czech *no more* is present: *víc* is a comparative of *mnoho* ‘much’, *než* ‘than’ is used in the comparatives

- (13) a. *Petr měří ne víc než dva metry.*
Petr measures no more than two meters
- b. *Petr je starší než Marie.*
Petr AUX older than Marie

Summary of *no more* vs. *ne víc* diffs:

- both are built on a comparative base
- but *no* is a determiner while *ne* focus particle (constituent negation)
 - being a focus particle, Czech *no more* is close to focus sensitivity of *at most/at least*: Cohen and Krifka 2011; Coppock and Brochhagen 2013

Two Theories, Two Predictions

1. Nouwen 2008; Nouwen 2010: based on the morphology, *no more than* – comparative modifier
2. Kennedy 2015: the difference between comparative and superlative modifiers comes from the ordering (semantics) – strict (comparative) vs. non-strict (superlative)
 - comparative *fewer than 3*: $\max < 3$ strict ord.
 - superlative *at most 3*: $\max \leq 3$ non-strict ord.
 - *no more than*: can be treated as a superlative modifier (non-strict ord.)

Predictions

		$\diamond > \text{no more than}$	$\text{no more than} > \diamond$
Predictions	NMC as CM	✓	✓
	NMC as SM	*	✓

Question Addressed by the Experiment

- (14) If *no more than* is SM, it should sound odd in a context preferring $\diamond > \textit{no more than}$ interpretation.

Question 1

- (15) Does Czech *no more* behave more like a comparative or superlative modifier (in the modal environment)?

Question 2

(16) Does Czech *no more* behave like other differential quantifiers?

Consequences:

- theoretical: support for one type of (modified) numerals theory;
- eventually distinguishing two types of differentials:
 1. regular: *slightly less*, e.g. (tested in the experiment)
 2. morphologically comparative but semantically superlative (Czech *no more than*)

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- two experiments addressing two research questions
- Experiment 1: only three conditions
- Experiment 2: four conditions, joint work with Hana Krajíčková

Further: exp 2 – included all the conditions of exp 1

- Czech native speakers
- Likert scale 1-5
- the appropriateness of one of the conditions in a context
- truth-value judgement task where a context described a situation strongly preferring the wide scope of the existential modal over the degree quantifiers

- 16 items and 16 fillers
- 98 subjects participated in the experiment (implemented on L-Rex), all of them passed fillers (uncontroversial TVJT)
- four conditions

4 conditions:

1. standard comparative modifier (*méně než* 'fewer than'): FEWER
2. standard superlative modifier (*nanejvýš* 'at most'): AT-MOST
3. *no more* modifier (*ne víc než* 'no more than'): NO-MORE
4. standard differential comparative modifier (*trochu méně než* 'slightly less than'): SLIGHTLY-LESS

- FEWER and AT-MOST tested the acceptability of modified numerals without differential
- SLIGHTLY-LESS, NO-MORE tested the presence of a differential (vague and zero degree differential)

The design was 2x2 factorial:

- comparative vs. superlative modifier (CLASSA,CLASSB) x
- absence/presence of a differential (DIFFYES,DIFFNo)
- the main conditions:
 1. FEWER: [+CLASSA,-DIFF]
 2. AT-MOST [-CLASSA,-DIFF]
 3. NO-MORE [-CLASSA,+DIFF]
 4. SLIGHTY-LESS [+CLASSA,+DIFF]

contra Nouwen 2008

Example item

Context: Alex is reading the following sentence on a chocolate bar packaging:

(17) *Toto balení může obsahovat*
this packaging can contain

- a. *méně než* FEWER
fewer than
- b. *nanejvýš* AT-MOST
at-most

Example item

Context: Alex is reading the following sentence on a chocolate bar packaging:

(18) *Toto balení může obsahovat*
this packaging can contain

a.

NO MORE

ne víc než
no more than

b.

SLIGHTY LESS

trochu méně než 60 gramů cukru
slightly less than 60 grams of-sugar

Alex says: 'So, in this chocolate bar there can be sometimes even 65 grams of sugar.'

- the boxplot representing means and SEs below

Boxplot

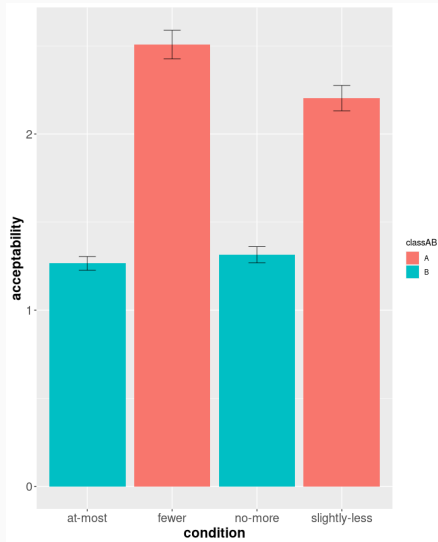


Figure 1: Boxplot of responses

Results

- mixed-effects linear model with subject and item intercept+slope random effects (R package LMERTEST)
- dependent variable was the subject's response
- several models, and the one that describes data the best (the less fitting models included models with main effects only and models where *no more* was treated as a CM):
- the model with independent variable conditions CLASSA/B vs. DIFFYES/No and their interaction

Results

- negative main effect of CLASSB (SM) (t-value: -11.004, $p < 0.001$)
- positive effect of the absence of a differential (t-value: 3.946 $p < 0.001$)
- negative interaction of CLASSB (SM) by DIFFNO (t-value: -3.129, $p = 0.002$)
 - AT-MOST was less acceptable than FEWER considering that both of them are without differentials

- Tukey's pairwise comparison of the conditions: only AT-MOST and NO-MORE were statistically indistinguishable (t-value: -0.478, $p = 0.964$)
- all other pairs: differed significantly

The experiment confirms:

- the scope behavior of Czech *no more* construction follows the pattern of superlative, not comparative modifiers
- \leftrightarrow subjects rejected NO-MORE to the same extent as AT-LEAST
- the significant difference between NO-MORE and SLIGHTLY-LESS
- \leftrightarrow *no more* is a superlative differential quantifier and *slightly less* as a comparative diff quant.

Surprising result:

- low acceptability of all conditions: even the most default comparative modifier without a differential (cond FEWER) had $\mu=2.51$ (SD: 1.61, SE: 0.04)
- possibly priming effect of the most frequent everyday contexts like (19), which strongly prefer the $max_d > \Diamond$ reading, just the opposite against the contexts described in our exp.

(19) *Tato elektrokoloběžka může jet méně než 25 km/h.*
this electric-scooter can run fewer than 25 km/h.

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Answers to the questions

Question 1

- (20) Does Czech *no more* behave more like a comparative or superlative modifier?

According to the scope behaviour in the existential modal env., it is a superlative modifier.

Question 2

- (21) Does Czech *no more* behave like other differential quantifiers?

Czech *no more* differs from the regular (comparative) differential (*slightly less*).

The scope behaviour of Czech NMC is of a superlative modifier profile

- generally: our exp confirms Kennedy 2015
- implementation: there is no positive difference in degree between the arguments of the comparative *more*
 1. following Nouwen 2008: analyze German/Dutch *nicht mehr/niet meer* as a negative differential expressing
 2. $\llbracket \text{nicht mehr } \alpha \rrbracket = \lambda P. \neg \exists d' [\max_d (P(d)) = \alpha + d']$

- the negative differential analysis is equivalent to the superlative at-issue semantics of *at most*
- in Kennedy's style of class A/class B analysis, we can classify Czech *no more* as a superlative modifier

(22) a. $\lambda P. \neg \exists d' [max_d(P(d)) = \alpha + d']$

b. $\approx \lambda P. max_d(P(d)) \leq \alpha$ (after Kennedy 2015)

Another approach

In Zhang and Ling 2021 interval arithmetic compositional approach

- both *no more than 60* and *at most 60* denote upper bounded closed interval:

(23) a. no more/at most than 60 ... $(-\infty, 60]$

b. more than 60 ... $(-\infty, 60)$

Similar to the logic in Kennedy 2015: composition is semantically but not morphologically driven.

The analysis correctly derives:

1. the wide scope of the class A modifiers NO MORE and AT-MOST:

$$(24) \quad \max_d(\Diamond \text{contain}(\text{ChocBar}, d)) \leq 60g$$

2. incompatible with Alex's continuation and predicts low acceptability of NO-MORE and AT-MOST

The weak surface scope

(25) $\Diamond[\max_d(\text{contain}(\text{ChocBar}, d)) \leq 60g]$

allowed only for comparative modifiers

- explains the higher acceptability of FEWER and SLIGHTLY-LESS (whatever the reasons for obligatory wide scope of SM over existential modals are, see Blok 2019)

1. morphology isn't always the right clue: Czech *no more* behaves as a superlative modifier, despite its comparative morphology
2. the experiment brings support for the CM vs. SM theory presented by Kennedy 2015: the distinction between class A/B = the type of ordering relation (strict vs. non-strict) – **semantics**
 - Czech *no more* can be interpreted as \neg (strict) \rightarrow ordering entailments of non-strict ordering
 - regular differential quantifiers (SLIGHTLY-LESS) remain strictly ordered, thus class A

So far: three types of NMC-languages:

1. *no more* as class A, English type of NMC (bounding inferences and both scopes w.r.t. existential modals)
2. *no more* as class B, Czech type of NMC (only $\max_d > \Diamond$, lack of bounding inferences: Dočekal 2017)
3. languages where NMC depends on its realization behaves as CM or as SM (Hungarian according to Balázs Surányi (p.c.))

The variation seems to be related to the morpho-syntactic status:

1. a focus particle/constituent negation in NMC (Czech) behaves as a superlative modifier
2. a negative quantifier (English) in NMC leads to the comparative modifier behaviour

Thank You for Your Attention!

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