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# Testing a PPI analysis of superlative modified numerals

**Introduction.** Comparative modified numerals (CMs) and superlative modified numerals (SMs) have equivalent truth conditions: *John saw* ***less than 4*** *stars* = *John saw* ***at most 3*** *stars* = John saw 0/1/2/3 stars (Cohen & Krifka 2011). However, they're known to differ in other ways: SMs require ignorance (Geurts & Nouwen 2007; Nouwen 2010; Coppock & Brochhagen 2013; Mayr 2013; Kennedy 2015; Mendia 2015), and SMs appear to be worse than CMs under negation: *John didn't see less than 4/??at most 3 stars* (Nilsen 2007, Cohen & Krifka 2011, 2014 and Spector 2014, 2015). To account for this difference, Spector (2015) treats SMs as underlyingly disjunctive positive polarity items (PPIs). We present 3 experiments in which we test **whether SMs pattern with other PPI items**: (a) PPIs are anti-licensed/not acceptable under a negation operator; (b) PPIs are acceptable in restrictors even when those define a DE-environment; and (c) PPIs can again become acceptable if the anti-licenser is itself in the scope of a DE-operator / in a DE-environment (Szabolcsi 2004, Nicolae 2012, Spector 2014). For each prediction we test whether the ways that SMs diverge from CMs would have been expected on a PPI account, and show that to the extent that a PPI account remains tenable, there still remains much data to be accounted for.

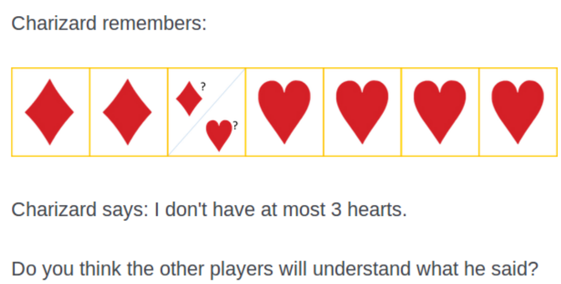
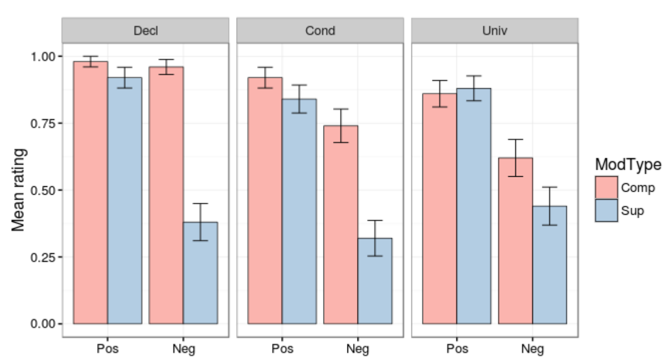



Fig. 1: Example trial: superlative modifier in negative declarative (Answers: Yes/No)

**Experiment 1 (n = 25).** Because SMs *require* ignorance and CMs *permit* it, our stimuli present (partial) ignorance via a card game, inspired by Cremers & Chemla (2016) (Fig. 1). Twenty-four accepability judgments were presented which crossed modifiers (CMs: *less than*, *more than*, SMs: *at least*, *at most*), sentence type (declarative, conditional, universal) and polarity (positive, negative). Data were analyzed using mixed effects logistic regression.

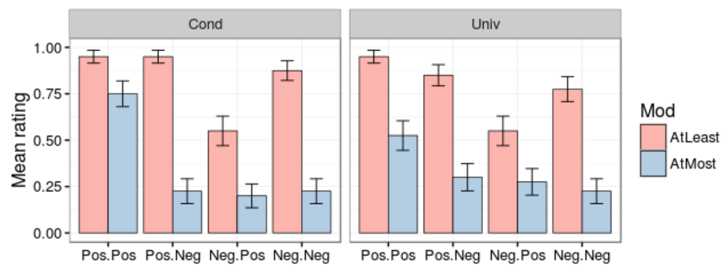



(Decl) I have/don't have [modifier] 3 [card suit].
(Cond) If you have/don't have [modifier] 3 [card suit], then we have something in common.
(Univ) Everyone who has/doesn't have [modifier] 3 [card suit] has something in common with me.

Fig. 2: Exp. 1 results grouped by sentence type, polarity, and modifier type

Our results confirmed prediction (a): we found a significant difference between CMs and SMs under negation in simple declaratives ($\beta = 4.28, z = 5.24, p < .0001$). Second, supporting prediction (b), the effect of negation on SMs does not generalize to other downward-entailing environments: there was no difference between CMs and SMs in positive conditionals and universals. However, we did not find the same support for prediction (c): the contrast between CMs and SMs under negation remained when the combination occured under conditionals ($\beta = 2.25, z = 4.48, p < .0001$), and universals ($\beta = 0.92, z = 2.01, p = 0.044$) (Fig. 2). However, it has also been suggested that judgments of SMs under negation that are further embedded in a conditional/universal are subject to a pragmatic polarity match between the antecedent/restrictor and the consequent/scope (Cohen & Krifka 2014), which could account for the failure of Exp. 1 to support prediction (c). We therefore designed a follow-up study (Exp. 2) to vary the negative or positive valence of the continuation.

**Experiment 2 (n = 40).** Design was similar to Exp. 1 except with positive/negative continuations of conditionals and universals (see Fig. 3). Partially supporting the alternative hypothesis, *at least* in a negative antecedent/restriction improved with polarity match in the consequent/scope (in conditionals: $\beta = 1.92, z = 3.21, p = 0.003$; in universals: $\beta = 1.15, z = 0.026, p = 0.027$), but *at most* did not. Further support for the heterogeny of SMs comes from another Exp. 2 finding that *at most* is judged unacceptable in conditionals and universals even when the only negative meaning is in the verb *lose* in the second argument (conditionals: $\beta = 2.62, z = 4.71, p < .0001$; universals: $\beta = 1.07, z = 2.15, p = 0.031$), a surprise under any account that treats the interaction of SMs with negation as only due to PPI anti-licensing. Given the improvement of *at least* under negation in Exp. 2 when further embedded in conditionals/universals, Exp. 3 tests whether this improvement generalizes to another combination of two DE operators: matrix and embedded negation.




(Cond) If you have/don't have [modifier] 3 [card suit], you win/lose.
(Univ) Everyone who has/doesn't have [modifier] 3 [card suit] wins/loses.

Fig. 3: Exp. 2 results grouped by sentence type, polarity, and modifier

**Experiment 3 (n = 45).** Design was similar to Exp. 1-2 except for the introduction of clausal embedding (and its supporting experimental context) in order to directly compare the behavior of local negation in two DE contexts: one under matrix negation versus the other in the antecedent of a conditional. Sentences varied by crossing four modifiers (as above) with sentence type (negative declarative (*Scyther doesn't know that he ...*), conditional (*If Scyther knew that he ...*)) and polarity (positive, negative for embedded clause/scopes). Results did not uniformly support prediction (c) for *at least*: *at least* under two negations is significantly worse than in a negated antecedent ($\beta = -1.9, z = -2.5, p = 0.025$) and differences between SMs persisted such that *at least* was judged worse than *at most* in every condition.

**Conclusions.** Overall, our data found some support for the predictions of the PPI account of SMs, but also raised multiple unresolved issues. First, why are SMs not always "rescued" when the anti-licensor is in the scope of another DE operator (*contra* prediction (c))? Second, why does the positive/negative valence of the predicate in the consequent play a role in the acceptability of SMs? Finally, what accounts for the difference between *at least* and *at most*? The empirical pattern is predicted neither under a strict PPI account nor under a simple account of processing complexity (given that SMs are acceptable in conditionals and universals but not under negation). We conclude that a full account of how SMs differ from CMs is still an open question and needs to be sensitive to semantic, pragmatic, and processing factors.

**Selected references:** Cohen, A., & Krifka, M. (2014). Superlative quantifiers and meta-speech acts. Linguistics and philosophy. Cremers, A., & Chemla, E. (2016). Experiments on the acceptability and possible readings of questions embedded under emotive-factives. Spector, B. (2014). Global positive polarity items and obligatory exhaustivity. Semantics and Pragmatics. Spector, B. (2015). Why are Class B modifiers global PPIs? Hurford disjunctions as a model for Class B modifiers. Handout at Workshop on Negation and Polarity in Jerusalem.