

Facilitation effects of QUD and event type on negative sentences

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Background While early investigations suggest that negative sentences are more difficult to comprehend [1,2,3], recent work suggests that supportive contexts can mitigate the processing costs of negation, suggesting a pragmatic factor that was previously underappreciated [4,5,6,7]. We investigate how certain types of explicit QUDs can provide such supportive contexts.

Scope of Neg When negation appears with a comparative numeral (Num), a negative sentence like (1) exhibits a scope ambiguity: there is a *surface scope reading* where negation scopes above Num, but also an *inverse scope reading* where Num is interpreted above negation:

(1) Mary hasn't read more than two of Tolstoy's 12 novels.

a. Surface scope: Mary has read *no* more than 2 T-novels. (Neg>Num)

b. Inverse scope: More than 2 T-novels are s.t. Mary has *not* read them. (Num >Neg)

Although both scope construals involve integrating negation into the meaning, previous work on scope ambiguity resolution suggests that they are not equally accessible: the inverse scope is less preferred or harder to access than the surface scope [8,9,10]. However, it has been also shown that QUDs play an important role in facilitating access to the inverse scope [11,12].

Neg QUDs We argue that the two scope construals in (1a-b) are natural answers to different *how-many* questions, with the inverse scope being directly **congruent** with a negative QUD:

(2) a. QUD for (1a): I wonder how many T-novels Mary has read.

b. QUD for (1b): I wonder how many T-novels Mary hasn't read.

The question nucleus of the negative QUD in (2b) contains negation. Correspondingly, directly congruent answers will have the answer term *more than two T-novels* combining with a negated degree predicate. Thus, (2b) is expected to **facilitate** inverse scope. Given a general preference for surface scope, we ask whether facilitation via negative *how-many* QUDs actually exists. If it does, we further speculate that facilitation effects will depend on the event type described by the verb: because *how-many* questions seek the maximal degree d such that the question nucleus is true of d , they license a default **existence inference** as typical answers specify some degree greater than 0. These hypotheses are tested by probing the effect of a (negative) *how-many* QUD in conjunction with event types that do or do not support the existence inference.

Experiment As in *Table 1*, we constructed contexts which introduce an expectation for certain events to take place but not for others, e.g. a judge at a baking competition is expected to *taste* (possibly all of) the cupcakes (EXPECTALL) but there is no expectation for them to *eat* (possibly any of) the cupcakes (NOTEXPECT). This is followed by an explicit QUD: we manipulated Event Type (EXPECTALL vs. NOTEXPECT) and QUD Type (POSITIVE vs. NEGATIVE) in a 2 × 2 design. Finally, the scopally ambiguous target sentence varies across Event Type but is consistent across QUD Type. Participants (N=32) were asked to judge the naturalness of the target sentence as an answer to the preceding QUD in the given context on a 7-point Likert scale.

Results & Discussion We take the naturalness ratings to be indicative of the intended scope assignment. As shown in *Fig. 1*, in the POSITIVE QUD condition, the generally preferred surface scope construal, which is equivalent to *no more than n*, provides a felicitous answer for both Event Types. However, in the NEGATIVE QUD condition, the general dispreference for inverse scope is **ameliorated** in the EXPECTALL condition. An analysis of the responses in a linear mixed effect model revealed a significant interaction between Event Type and QUD Type (*Fig. 2*; $t = -1.999$, $p < 0.05$). This is predicted: the inverse scope construal *more than 2 ... not* licenses the existence inference, which meets the expectation introduced by the context and echoed by the verb in the ExpectAll condition, but not in the NotExpect condition. Our findings on the effects of QUD and event type suggest that speakers are sensitive to the inference introduced by *how-many* QUDs and the way it interacts with contextual information, ameliorating the comprehension difficulty of negation in the inverse scope construal.

Table 1: Sample stimuli

Context	John is a cupcake lover who is invited to be a judge at a baking competition. There are some cupcakes and some tarts on the table.			
QUD	ExpectAll_Positive: I wonder how many cupcakes John has tasted .	ExpectAll_Negative: I wonder how many cupcakes John hasn't tasted .	NotExpect_Positive: I wonder how many cupcakes John has eaten .	NotExpect_Negative: I wonder how many cupcakes John hasn't eaten .
Target (Ambiguous)	ExpectAll: John hasn't tasted more than two cupcakes.		NotExpect: John hasn't eaten more than two cupcakes.	
Intended reading	Surface scope (Neg>Num)	Inverse scope (Num>Neg)	Surface scope (Neg>Num)	Inverse scope (Num>Neg)

Fig 1: Raw ratings for the Target sentence

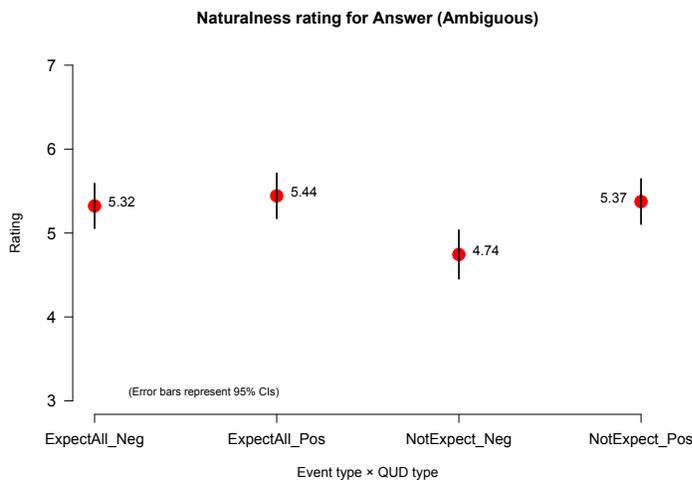
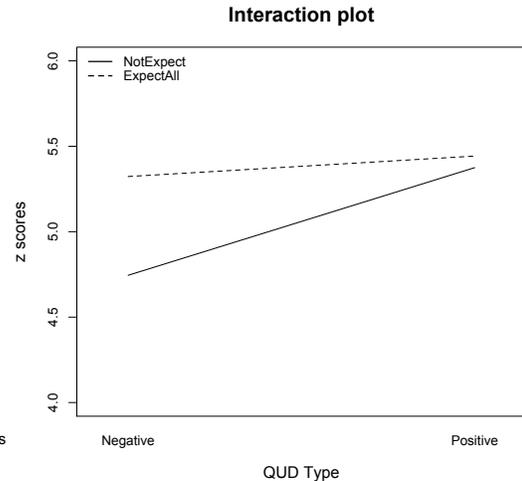


Fig.2: Interaction plot (z scores)



Selected References

[1] Clark & Chase, 1972. On the process of comparing sentences against pictures. [2] Kaup, B., Lüdtkke, J., & Zwaan, R. (2006). Processing negated sentences with contradictory predicates: Is a door that is not open mentally closed? [3] Lüdtkke, J., Friedrich, C., De Filippis, M., & Kaup, B. (2008). Event-related potential correlates of negation in a sentence-picture verification paradigm. [4] Lüdtkke, J., & Kaup, B. (2006). Context effects when reading negative and affirmative sentences. [5] Nieuwland, M., & Kuperberg, G. (2008). When the truth is not too hard to handle. [6] Xiang, M., Grove, J., & Giannakidou, A. (2016). Semantic and pragmatic processes in the comprehension of negation. [7] Nordmeyer, A. E., & Frank, M. C. (2015). Negation is only hard to process when it is pragmatically infelicitous. [8] Kurtzman, H. S., & MacDonald, M. C. (1993). Resolution of quantifier scope ambiguities. [9] Anderson, C. (2004). *The structure and real-time comprehension of quantifier scope ambiguity*. [10] Chemla, E., & Bott, L. (2015). Using structural priming to study scopal representations and operations. [11] Gualmini, A., Hulse, S., Hacquard, V., & Fox, D. (2008). The question–answer requirement for scope assignment. [12] Savinelli, K. J., Scontras, G., & Pearl, L. (2018). Exactly two things to learn from modeling scope ambiguity resolution: Developmental continuity and numeral semantics. [13] Rullmann, H. (1995). Maximality in the semantics of wh-constructions [14] A flexible approach to exhaustivity in questions. [15] Kroch, A. (1989). Amount quantification, referentiality, and long wh-movement.