Polarity sensitivity of question embedding: experimental evidence

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Introduction Most attitude verbs are easy to classify as either rogative (only embedding interrogatives, e.g., **wonder**), anti-rogative (only embedding declaratives, e.g., **think**) or responsive (embedding both types of complements, e.g., **know**). However, it appears that there are also borderline cases such as **be certain**. Although this verb is often classified as a responsive verb (Karttunen, 1977; Preuss, 2001; Lahiri, 2002; Uegaki, 2015; Theiler et al., 2016), some authors claim that it can only embed interrogative complements under specific circumstances (Egré, 2008; Hölker, 2014; Mayr, 2017). Specifically, Mayr (2017) argues that **be certain whether** can appear whenever negative polarity items (NPIs) can. For instance, on his view, **be certain whether** is degraded in positive sentences, but fine under negation, just like NPI **any**:

(1) a. #John is certain whether Mary smokes.
b. John is not certain whether Mary smokes.

(2) a. #John saw any girl.
b. John didn't see any girl.

This contrasts with verbs like **know** and **think**: the former can always embed interrogatives, while the latter never can.

Polarity sensitivity of be certain+*int* Mayr's account of this striking observation is inspired by theories of NPI licensing (e.g., Krifka, 1995; Chierchia, 2013), and goes roughly as follows: the literal meaning of a sentence φ is strengthened by means of an exhaustivity operator, which negates all formal alternatives of φ which are not entailed by φ. If this strengthening procedure leads to a systematic contradiction, φ is perceived as ungrammatical.

The formal alternatives of a sentence are constructed in a point-wise manner. Mayr assumes that the alternatives of a polar interrogative complement, **whether** p, are **that** p and **that not** p. Thus, (1b) entails both of its alternatives, and its strengthened meaning is the same as its literal meaning. In contrast, (1a) does not entail either of its alternatives. They are therefore negated and this leads to a contradiction, which explains the presumed degradedness of the sentence.

Empirical questions to address Mayr's analysis raises two questions that need to be addressed experimentally. First, if the analysis is right, there should be a correlation between the acceptability of **be certain whether** and NPIs (see Chemla et al., 2011 for similar ideas and tests applied to Chierchia's predicted link between NPIs and scalar implicatures). Apart from the contrast between (1a) and (1b), an analysis based on NPI licensing also predicts that **be certain whether** is fine in antecedents but not consequents of conditionals and restrictors but not scopes of universal quantifiers, to the extent that NPIs are.

Second, Mayr only discusses polar questions. If his analysis of **be certain whether** is right, the question arises how it should be extended to *wh*-complements. A first step in this direction is to test whether **be certain wh** exhibits the same polarity sensitivity as **be certain whether**.

Experiment To address these questions, we carried out an acceptability judgment task, involving judgments on a five point scale from *odd* to *natural*. The context for all sentences was a quiz about alien properties in order to rule out any expectations about their truth or falsity. Target sentences were of the form of (3a–f), where COMP was one of the complements in (4).

(3) a. Bob is certain COMP. (unembedded)
b. Madison is not certain COMP. (negation)
c. If Michael is certain COMP, then he will raise his hand. (antecedent)
d. If Chris raised his hand, then he is certain COMP. (consequent)
e. Everyone who is certain COMP raised their hands. (restrictor)
f. Everyone who raised their hands is certain COMP. (scope)

(4) a. whether the Ikreht aliens are fluffy (polar interrogative complement)
b. which aliens are speckled (*wh*-complement)
c. that the Gryjihq aliens are red (declarative complement)

Control sentences with **know** followed the same scheme, and fillers with **think** and **wonder** were included to balance the ratio of expected odd/natural responses. Sentences (5a–d) contained NPI **any** in the same environments, allowing us to test the correlation between the acceptability of **any** and **be certain**+*int*. Associated control sentences had the indefinite **a** in place of **any**.

(5) a. The teacher asked *any*/*a* question about the Vuekhae aliens.
b. The teacher did not ask *any*/*a* question about the Kloqilmue aliens.
c. If Sarah answers *any*/*a* question correctly, then she will receive *any*/*a* reward.
d. Everyone who answers *any*/*a* question correctly will receive *any*/*a* reward.

100 participants were recruited on Mechanical Turk and paid $1 for their participation (age range: 22–62). The experiment took about 7 minutes.

Results The results are presented in Figure 1. For reasons of space, we leave a detailed analysis of the quantified and conditional sentences out of consideration here. A linear mixed-effects model fitted on plain affirmative and negative sentences with questions embedded under **know** and **be certain** showed a main effect of polarity across verbs and question-type ($t = 10, p < .001$), yet **be certain** was much more affected than **know** ($t = 6.9, p < .001$), and **whether**-questions than **wh**-questions ($t = 10, p < .001$). We also found a triple interaction: **whether**-questions under **be certain** were particularly sensitive to polarity ($t = 4.5, p < .001$). We further tested whether this polarity effect could be predicted by the polarity effect found with **any**, yet we found no correlations between a participant's acceptance of **any** and **be certain whether** ($\chi^2(8) = 9.2, p > .3$) in the various conditions we tested. In particular, the acceptability of **be certain whether** was fully independent from the acceptability of **any** in plain affirmative sentences ($\rho = .03, p = .85$).

Conclusion Our results suggest that **be certain whether** is indeed degraded in positive episodic sentences. Moreover, they confirm that this effect disappears under negation. In these two sentence types, **be certain whether** shows a similar overall pattern as NPIs.

However, when looking at individual participants, judgments for **be certain whether** do not correlate with judgments on NPIs. Furthermore, the similarity found in plain positive and negative sentences does not seem to extend to conditionals and quantified sentences. This suggests that **be certain whether** and NPIs are (anti-)licensed by different mechanisms.

Two more pieces of data are worth highlighting as well: first, **be certain** is much less polarity

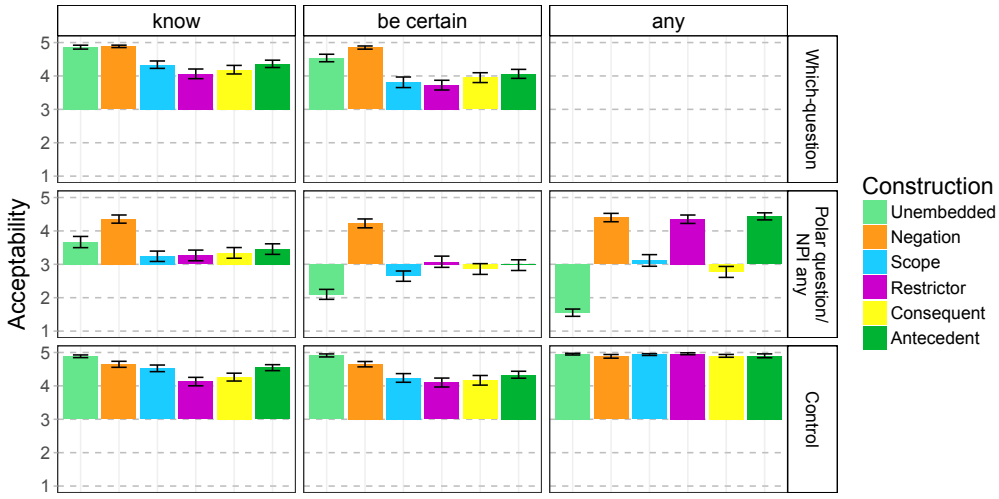

Figure 1: Mean (SE) acceptability for each construction on a 1-5 scale. The results for NPI **any** are presented in the same row as polar questions. Controls for **know** and **be certain** had an embedded declarative. Controls for NPI **any** used the indefinite **a**.

sensitive with **which**-complements than with **whether**-complements; and second, quite unexpectedly, **know whether** appears to be somewhat polarity sensitive, similar to **be certain whether**. These results have been replicated in several versions of the experiment presented here. More work is needed, however, to determine what causes these effects.

To conclude, our results confirm that the acceptability of **be certain whether** is polarity sensitive, but they challenge Mayr's hypothesis that the same mechanism is responsible for both unlicensed NPIs and the degradedness of **be certain whether** in positive sentences. This is an important empirical contribution to the ongoing debate on the polarity sensitivity of question embedding predicates.

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