Processing polar questions in contexts with varying epistemic biases in English

Background: In English, there are two possible ways to form a polar question with negation (NPQ): the negation marker can be "low" (LNPQ) (1) or "high" (HNPQ) (2).

　　1) Is there **not** a vegetarian restaurant around here?

　　2) Is**n't** there a vegetarian restaurant around here?

While (1) can be said to straightforwardly question the negative proposition, (2) is more complex. In an early theoretical characterization of NPQs, Ladd (1981) claimed that there is an "ambiguity" whereby (2) *can* question the negative proposition, but it can also be used to indicate that the questioner has a prior belief that the *positive* proposition is true. This proposed ambiguity has been at the heart of numerous theoretical studies of NPQs, which have been concerned with the different meanings of the negation marker (e.g. Krifka, 2015; Repp, 2009; Romero & Han, 2004) as well as the conditions that license these questions (Gärtner & Gyuris, 2017; Sudo, 2013).

While there has been rich theoretical work on these constructions, little experimental work has investigated the potential semantic ambiguity of HNPQs, with the limited available experimental evidence speaking against any ambiguity. Early preliminary results from a small acceptability judgment task by Sailor (2013) first suggested that the ambiguity might not hold in English. More recently, results from a larger scale experimental investigation by Domaneschi et al. (2017) show that English natives have preferences as to which question to produce, depending on their epistemic state and the evidential context surrounding the discourse. Indeed, while participants prefer to produce LNPQs in contexts in which there is negative evidence for a proposition and no belief regarding that proposition, in contexts in which negative evidence is contrasted with a prior belief participants prefer to produce HNPQs, suggesting no ambiguity in the meaning of the question form. In the present study, we report results from a self-paced reading experiment investigating whether Ladd's hypothesized ambiguity holds in online processing.

Design and procedure: We carried out a word-by-word self-paced reading experiment, with 120 self-reported English natives recruited through the crowdsourcing platform Prolific. Participants read LNPQs and HNPQs against short background discourses designed to target the effects of prior belief given negative evidence (e.g. 3-4). All vignettes were normed by an independent sample of participants for the presence or absence of a prior belief.

　　3) *Prior belief*: Someone told you I won the marathon at the weekend. However, I start
　telling you I am disappointed with my performance. You say:

　　　　HNPQ: Hold | on | a | minute. | Didn't | you | win | the | marathon?
　　　　LNPQ: Hold | on | a | minute. | Did | you | not | win | the | marathon?

　　4) *No belief*: We are talking about baths. I say I haven't had one in 3 years. You say:

　　　　LNPQ: I | love | a | bath. | Have | you | not | got | one | at | home?
　　　　HNPQ: I | love | a | bath. | Haven't | you | got | one | at | home?

Given the empirical results by Domaneschi et al. (2017), and contra Ladd (1981), we hypothesize that HNPQs will be facilitated in contexts where there is a prior belief about the proposition, whereas LNPQs will be facilitated in contexts where there is no prior belief about the proposition.

Results: As per pre-registered protocol, we focus our analysis on the sentence regions containing the question forms, as well as on the relevant spillover regions. We compare the reading times (RTs) at each region up to the main verb (Figure 1), which serves as the spillover for the negation marker in the LNPQs. We model our RT data using Bayesian hierarchical regression models, regressing the log-transformed RTs as a function of the belief and negation type for each region of interest.

In HNPQs, we find no evidence for an effect at the critical region nor at its immediate spillover[1]. However, we do find strong evidence for an effect at the VERB region[2], such that HNPQs are read faster against contexts with a prior belief compared to contexts without a prior belief. This is in line with our original hypothesis. In the case of LNPQs, we find no evidence for an effect at the regions up to the VERB[3], which contradicts our hypothesis. However, the descriptive results at the region immediately following the VERB suggest that LNPQs are read more slowly against contexts with a prior belief compared to contexts without a prior belief. While we did not have predictions about regions following the verb, this result suggests difficulty in integrating the question form with information from the verb when there is a prior belief in the discourse context.

Discussion: Our results show that, at least in the case of HNPQs, comprehenders process NPQs in English differently depending on whether or not the prior discourse context sets them up with a belief about the truth of a proposition. This partially supports Domaneschi et al.'s (2017) results and challenges the idea of Ladd's (1981) ambiguity in HNPQs. We discuss our results in light of possible theoretical implications as well as in terms of relevant constraints on belief-tracking in incremental language processing. Importantly, we discuss the limitations of our materials and present preliminary results from a replication experiment where we revise our items to re-assess the case of LNPQs and to more directly inspect the integration (or lack thereof) of the question form with other semantic cues downstream in the sentence.
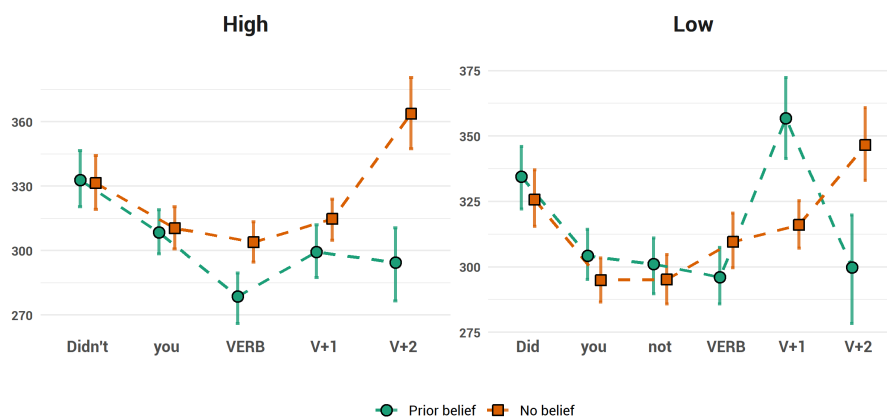

Figure 1: Reading times at the different sentence regions as a function of the negation type (*low* vs. *high*) and belief (*prior belief* vs. *no belief*).

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[1]CRITICAL: $\beta_{\text{belief}} = 0.01$, 95% CrI [-0.03, 0.06], $P(\beta_{\text{belief}} < 0) = .28$; CRITICAL +1: $\beta_{\text{belief}} = -0.01$, 95% CrI [-0.05, 0.03], $P(\beta_{\text{belief}} < 0) = .62$

[2]VERB: $\beta_{\text{belief}} = -0.18$, 95% CrI [-0.31, -0.05], $P(\beta_{\text{belief}} < 0) > .99$

[3]CRITICAL: $\beta_{\text{no-belief}} = -0.01$, 95% CrI [-0.05, 0.03], $P(\beta_{\text{no-belief}} < 0) = .70$; CRITICAL +1: $\beta_{\text{no-belief}} = -0.02$, 95% CrI [-0.06, 0.01], $P(\beta_{\text{no-belief}} < 0) = .91$; CRITICAL +2: $\beta_{\text{no-belief}} = -0.01$, 95% CrI [-0.14, 0.11], $P(\beta_{\text{no-belief}} < 0) = .58$; VERB: $\beta_{\text{no-belief}} = 0.06$, 95% CrI [-0.09, 0.22], $P(\beta_{\text{no-belief}} < 0) = .20$

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