The interpretation of prenuclear accents in English (biased) questions

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Abstract

English positive and negative questions (PQ / NQ) with a prenuclear accent on the initial auxiliary can be perceived as biased. Particularly in NQ, previous research has associated the rising pitch accents L+H* and L*+H with double-checking a prior speaker belief or current evidence. We report two perception experiments investigating six prosodic profiles of clause-initial auxiliaries that were previously observed in semi-spontaneous corpus data, with nuclear contours held constant. In Experiment 1, US English speakers rated the illocutionary function of PQ and NQ (seeking / giving information). In Experiment 2, they rated the perceived target of double-checking (prior belief / current evidence). In both experiments, participants also rated the extent to which the speaker had strong feelings, testing for the conveyance of expressive meaning. Our findings suggest that negation is the strongest indicator of bias. Prosodically, a step-like, fast and steep rise from L* on the auxiliary to H on the subsequent pronominal subject increased ratings of double-checking current evidence for PQ. This accent also affected perception of strong feelings across question types, aligning with the interpretation of evidence-checking, which plausibly is based on surprise.

Index Terms: polar questions, biased interpretation, prenuclear accenting, perception studies.

1. Introduction

Polar questions aim to deduce whether a proposition is true (p) or false ($\neg p$), and in some contexts, these questions can indicate a bias towards one propositional alternative or the other. Bias typically means that the speaker is leaning toward a previous belief or toward contextual evidence, which can be marked by lexical means, prosody and/or syntax. Negative questions (NQ) usually carry implications of bias, and their negative polarity is traditionally linked to this effect [1]. Positive questions (PQ), particularly those involving contrastive focus, may also invoke bias [2]. English speakers have been found to mark their bias in both PQ and NQ prosodically, one of the intonation strategies being a rising prenuclear accent on the initial auxiliary [1, 3, 4].

The meaning of biased questions has been described in different dimensions (see [5] for an overview): In comparison to information-seeking questions, they can be described as generally more information-giving. Another dimension is the origin of bias, that is whether the speaker is leaning toward a belief originating in previous assumptions or a belief forming on the basis of contextual evidence. The combination of these domains makes up a question's bias profile [6]. Beyond this profile, however, bias can also reflect that a speaker may not be willing to accept the evidence presented for subjective reasons. All these layers of bias contribute to the *question concern* [7], the intended outcome, which captures the multi-faceted meanings and objectives that accompany a polar question.

Previous research has thoroughly explored the meaning of utterance-final rising intonation in English, with strong evidence that declaratives and interrogatives with a steeply rising nuclear contour create a confirmation- or information-seeking interpretation, resp. [8, 9, 10, 11]. Further studies have added more nuance to this debate by showing that a declarative or interrogative may be interpreted as less information-seeking, or questioning, if that contour is less steep or varies in shape [9, 12, 13, 14]. The interpretation of rising intonation in combination with clause type differs widely based on context and interlocutor expectations. Regarding speaker-specific expectations, parameters like pitch excursion and duration also seem to influence the pragmatic interpretations of statements and questions [15, 16, 17]. An important consideration there may be the compounding effects of changes in duration and excursion in perception [18, 19, 20]. It is presently unknown in how far compounding effects also play a role in the interpretation of prenuclear accents.

The meaning of accenting the sentence-initial auxiliary in questions is comparatively understudied. For North American English, the variety investigated in this work, a corpus study [3] reports that most NQ had a L+H* auxiliary accent (in MAE-ToBI), while PQ were mostly unaccented. Meanwhile, [4] found that half of their elicited NQ used L+H* auxiliary accents and 35% were unaccented. L+H* accents also were more commonly linked to checking the speaker's (previous) belief. Conversely, in PQ, accenting the auxiliary has been linked to the addressee's belief [1]. There is some debate on whether auxiliary accenting in PQ is interpreted as the conversational epistemic operator VERUM [5] or polarity focus [2, 21]. VERUM has been linked to strengthening the illocutionary force [22, 23, 24, 25]; polarity focus aims at resolving propositional choices [2]. Regardless of this potential ambiguity of auxiliary accenting, however, its presence in both (biased) PQ and NQ makes a systematic, empirical investigation necessary.

The work reported in this paper builds upon work reported in [27], who carried out a corpus study of US English PQ and NQ extracted from a TV soap opera. These semi-spontaneous productions were annotated prosodically and served as stimuli in a perception study. The prosodic analysis showed that both PQ and NQ contained a wider auxiliary accent inventory than what was observed previously [3, 4]. In addition to the L+H* and L*+H accents, the inventory included H* and (L+H)*. The latter, a faster rising variant of L+H* has been associated with rhetorical *wh*-questions, and with surprise and disbelief in German [26], but had not been reported for English before. Furthermore, there was a "step accent", annotated as L*| H, which is characterised by a large, abrupt pitch change between the first and second syllables in the clause. In the perception

study in [27], illocutionary components of the question concern of the corpus-extracted questions were rated: giving information, seeking information, or suggesting an action (suggestions being often expressed by interrogatives). PQ were rated as more information-seeking and less -giving when the auxiliary was accented independently of accent type. NQ mainly showed effects of nuclear contour (not reviewed here). The finding that the accent type on the auxiliary did not influence the association with question concern may be due to a lack of power. On the other hand, and maybe more crucially, with the stimuli being corpus data, auxiliary and nuclear accents could not be systematically controlled or balanced. Lexical differences also limited comparability. The current study overcomes these limitations and systematically explores the choice of accent type for encoding question concern.

2. Study

In this study, we explore several components of question concern, distributed over two perception experiments. In Experiment 1, we tested the two components that were shown to be sensitive to auxiliary accentuation by [27]: seeking and giving information. In Experiment 2, we tested in how far a question was perceived as double-checking a previous belief or current evidence, building on the findings reported in [4]. In both experiments, we included a rating for an expressive meaning component, because conveying emotions often is a part of question concern [7]. Indeed, in questions expressing incredulity, disbelief or rejection, this part is very prominent and has been shown to have prosodic reflexes [28, 29]. As a first approximation to exploring expressive meaning in polarity questions, we focused on a high arousal level: *strong feelings*.

The experimental design in this study is inspired by the method used in [13], who investigate the role of prosody in the assertive vs. inquisitive interpretation of declarative sentences using a step-wise manipulation of the nuclear contour and asking participants if a stimulus was asking or telling. Here, nuclear contour was the primary influence on the choice of interpretation. The method was also used by [30] who study the influence of nuclear pitch accent type (L* vs. H*) and nuclear contour on the perception of speaker surprise in American English declaratives. Both parameters played a role with larger pitch excursion and mean F0 being additional cues. In the present study, we designed an audio questionnaire featuring PQ and NQ with differing prenuclear accents on the auxiliary. Building on [27], we tested H*, L+H*, L*+H, (L+H)*, and L*|H, and a condition with an unaccented auxiliary.

2.1. Stimulus creation

The stimuli were created from audio recordings from a female speaker of standard US English, in accordance with [27], which investigated Soap corpus data from the same dialect. The current recordings targeted the prenuclear pitch accents H* and L+H*, the recordings for the latter serving as the basis for manipulations using a Praat [31] script (available at https://osf.io/9njgs) that harnessed the program's pitch point manipulation function to create the L*+H, (L+H)*, and L*|H rising pitch accents, while allowing for some manual adjustments. The precise syllabic alignment for these pitch accents was adopted from [26]. Meanwhile, the high tone for L*|H was sustained across two-thirds of the second syllable to emphasise the abrupt jump in pitch between the first and second syllables, which was in accordance with the corpus data. Following the normalisation parameters for rises and falls in [32], the script resynthesised the recordings such that the fall from H* was 3 semitones, the rise for L*|H was 9 semitones, and the rise for the other three rising pitch accents was 5 semitones. To create the non-accented condition, the resynthesised and normalised contour for H* was flattened, such that the entire prenuclear contour was leveled. To keep the contour of the rest of the sentence consistent, the contour from one of the recordings was extracted and concatenated onto the other stimuli after the prenuclear accent. We chose a prototypical question rise (L* H-H%), which avoided the high excursion found in some of the NQ elsewhere [4] as a neutral option for PQ and NQ, and which occurred frequently in the corpus data reported in [27]. The pitch descriptives for the auxiliary accents are listed in Table 1.

In addition to these pitch manipulations, the duration of the first syllable of the H*, non-accented and L*|H accents was shortened to about 70% of the original duration to meet the characteristics of these accents observed in the corpus data, and to fully match native speaker intuitions. Finally, the duration for all the stimuli was decreased by 15% to create an overall more natural speech rate in the audio. In addition, 200ms of silence was added to the beginning of each file to allow listeners to adjust to a new stimulus during the rating task.

Table 1: *Pitch descriptives for each prenuclear auxiliary accent, measured from onset to offset.*

Pitch accent	**Pitch span (*in Hz*)**	**Excursion (*in ST*)**	**Duration (*in ms*)**
H*	267.5-225	3	370-400
L+H*	225-300	5	390-430
L*+H	225-300	5	390-430
(L+H)*	225-300	5	390-430
L* H	225-378.4	9	350-380
None	225	0	350-400

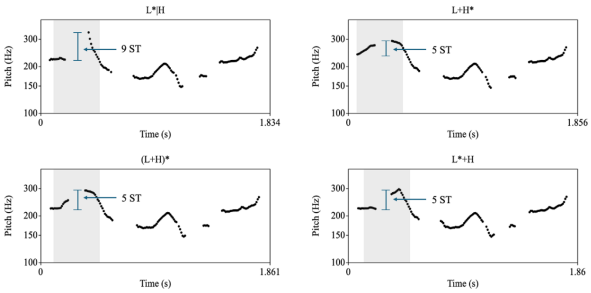


Figure 1: *Pitch contours for the four bi-tonal rises.*

The stimuli consisted of 10 lexicalisations with nine syllables, an initial auxiliary followed by a pronoun, a present participle (gerund), a definite article, and a compound, all items having the same stress pattern (e.g., *Are they controlling the answer key?*). Each item appeared as either a PQ (*Are they…?*) or NQ (*Aren't they...*), paired with one of the six prenuclear accent types. This yielded 10 × 2 × 6 = 120 stimuli in total. For each of the 10 lexicalisations, we created two attention checks, such as *You just heard something about …,* where we repeated the content of the previous sentence or replaced the verb or the object, so that the statement would be true or false.

2.2. Participants

128 English native speakers born and resident in the US completed the audio questionnaire (recruited via *prolific.com*). They reported not to have hearing impediments, speech disorders, dyslexia, or an autism spectrum disorder. Twenty participants were excluded because English self-reportedly was in fact not their first language (3), they completed the questionnaire extremely fast (5), or their error rate for the attention checks exceeded 25% (12). The remaining 108 participants (Experiment 1: 56; Experiment 2: 52) included 56 females and 52 males between the ages of 19 and 78 years.

2.3. Procedure

The experiments were carried out using the SoSci Survey platform [33]. Prior to the experiment, participants gave their informed consent and then answered some demographic questions. In each experiment, the stimuli were distributed across two lists, such that each item-condition pairing (question polarity and accent type for each lexicalisation) appeared 5 times in a list. Each list consisted of 6 blocks of 10 items in pseudo-randomised order. Each item was presented along with an avatar with a friendly but neutral expression. Participants listened to an item and then rated three statements on a seven-point scale from *strongly disagree* (1) to *strongly agree* (7). Experiment 1 included the following scales. A: *The speaker is giving out information;* B: *The speaker is seeking information;* C: *The speaker has strong feelings in this situation.* In Experiment 2, the scales were: A: *The speaker is double-checking a previous assumption;* B: *The speaker is double-checking something she just noticed;* C: *The speaker has strong feelings in this situation*. After participants had rated an utterance on all three scales, a three-tone gong sound was played before the next item in order to diminish pitch-related memory effects. A third of the questions were followed by the above-mentioned attention check. Participants were instructed to wear headphones throughout the experiment.

3. Results

The results from cumulative link mixed models (CLMM) with POLARITY as fixed effect (across accent types) showed an effect of POLARITY for all scales. NQ were perceived as more information-giving and less information-seeking than PQ. NQ were also perceived as more likely to be checking a previous belief and less as checking current evidence than PQ. In both experiments, NQ were more strongly associated with strong feelings than PQ. In the following, we focus on the mediating role of prenuclear accents. For a full description of the results, the reader is referred to https://osf.io/9njgs.

For the statistical analyses (CLMM) of the auxiliary accents, we grouped the accents by the height of the pitch excursion (ST GROUPS) because visual inspection suggested the absence of fine-grained results. This resulted in a factor with four levels (*none* = reference-level, 3ST, 5ST, 9ST). For the first two scales in each experiment, separate models were run for PQ and for NQ. For the last scale, *strong feelings*, we pooled the data for both question types. Figure 1 shows the proportion of responses (levels 1–7) per ST GROUP for the scales in Exp. 1, Fig. 2 does for Exp. 2. Fig. 1 indicates a numerical trend towards less agreement for the scale *give info* the higher the ST difference in NQ and, conversely, towards more agreement for the scale *seek info* the higher the ST difference, but there are no significant differences for these scales. In Exp. 2, there is a significant difference between *none* and the 9ST accent (L*| H) for *check evidence* in PQ (b = 0.52, SE = 0.17, z = 3.12, p = 0.002). The preference to interpret a PQ as checking evidence seems to be enhanced when the auxiliary carries L*| H.

Figure 2: *Proportion of ratings levels per semitone group for each of the three scales in Exp. 1.*

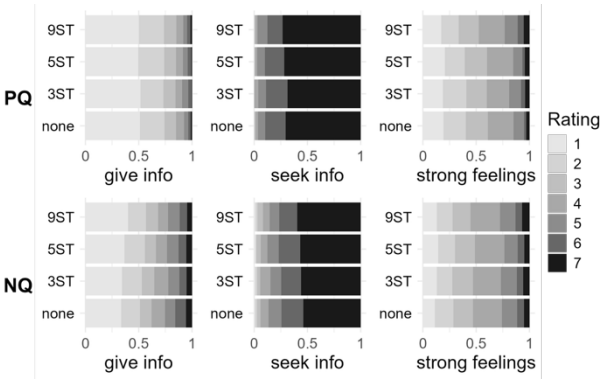
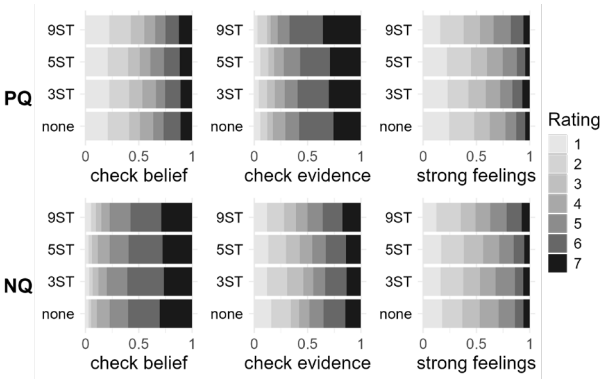


Figure 3: *Proportion of rating levels per semitone group for each of the three scales in Exp. 2.*



Turning to the third scale in both experiments, *strong feelings,* Fig. 1 and Fig. 2 indicate that the 9ST L*| H accent stands out in both PQ and NQ. CLMMs across question types confirm a significant difference between *none* and 9ST for Exp. 1 (b = 0.4, SE = 0.11, z = 3.6, p < 0.001) and Exp. 2 (b = 0.74, SE = 0.12, z = 6.19, p < 0.001). In Exp. 2 there also is a significant difference between *none* and 3ST (H*) (b = 0.23, SE = 0.12, z = 1.96, p = 0.05). When collapsing experiments and adding EXPERIMENT and its interaction with ST GROUP into a CLMM, the output shows an effect of 9ST L*| H (b = 0.41, SE = 0.11, z = 3.68, p < 0.001) and a marginally significant interaction, indicating a difference between experiments for 9ST L*| H (b = 0.31, SE = 0.16, z = 1.89, p = 0.06).

4. Discussion

The aim of our research was to identify the effects of varying the prenuclear accent on the auxiliary in PQ and NQ in American English. Both PQ and NQ have been associated with bias if the auxiliary is accented [5], with bias having been characterised along the dimensions of information-seeking/giving, bias origin, as well as emotional meaning, all contributing to the question concern. These dimensions

correspond to the scales we had rated in our two perception experiments. Overall, the effects of polarity were strong, showing that PQ and NQ clearly differ from each other. We assume that this great influence of polarity is the reason why prosodic variation of the prenuclear accent only had small effects, if any. But these small effects revealed that acoustic prominence affects ratings of bias origin in PQ and feelings across interrogatives when we compare the steeply rising step accent L*| H with an unaccented auxiliary. In the following, we spell out the implications of our findings for discussions on biased questions and the effects of prosody.

3.1. Positive vs. negative interrogatives

Bias in polarity questions has long been linked with negation [5], and our results suggest that polarity is indeed the strongest indicator of bias. NQ are perceived as more information-giving and less information-seeking than PQ in our study, thus replicating the findings from corpus data in [27]. NQ are also more associated with checking a previous belief than PQ, thus clearly showing a bias. NQ are less associated with checking the current evidence than PQ are. This makes sense because PQ are primarily associated with seeking information in a 'neutral' way: they are used if a speaker does not have a prior belief or favor one propositional alternative [34]. However, our results suggest that PQ might be preferred over NQ when inquiring about what is contextually salient: In the context, PQ verbalise what is expected to be confirmed. This is a characteristic PQ share with declarative questions [35]. NQ can also have this use, but our results suggest that highlighting (a conflict with) a prior belief might be a function that is more readily available, at least for NQ presented out of context.

3.2. Auxiliary accenting

Auxiliary accenting has been noted as a common feature of biased interpretations for both PQ and NQ. This accenting is particularly relevant for PQ because they lack the negation most clearly associated with bias. In PQ, accenting the auxiliary is associated with VERUM [1] or polarity focus [2]. If focus is at play, the current context (i.e., what the speaker may have just noticed) can supply its antecedent [21]. Similarly, VERUM is employed when various alternatives are at issue, and when the choice between these alternatives needs resolving. This link between auxiliary accenting and context-sensitivity seems supported by the present finding that increasing the pitch height to 9ST receives higher ratings of checking contextual evidence. In line with much previous literature on the perception of English intonation, we assume that the larger pitch difference, together with the shorter duration, which results in a very steep rise, leads to increased prominence [18, 19, 20], and thus a clear signal of accentuation in the clause-initial region. The fact that auxiliary accenting needed to be particularly prominent may also explain why such accenting according to [2] is possible but not necessary for biased interpretations of PQ. Still, unlike in the current study, [27] found that accenting the auxiliary in PQ also increased ratings of seeking information and decreased ratings of giving information; what gave auxiliary accenting more of an impact in [27] requires further investigation.

In NQ, the previous literature has shown rising accents to potentially discriminate the source of bias in English: L+H* occurs more often in NQ when the speaker is checking contextual evidence rather than their own (previous) belief [4]. It is therefore astonishing that auxiliary accenting, including the often-cited L+H* accent [3], did not make a difference for NQ except regarding expressivity (see below). It is possible that the previous findings on the effects of auxiliary accenting were influenced by an interaction of nuclear contour and auxiliary accenting [4], which we cannot account for here, because we held the nuclear contour constant (L* H-H%).

3.3. Expressivity and bias

The strongest effect of auxiliary accenting that we found was the increase in ratings of strong feelings with the step-like L*| H accent. As discussed in the Introduction, personal convictions can contribute to the question concern beyond the classic bias profile as evidenced in incredulity and rejection questions [28, 29]. It is well-known that a larger pitch range may contribute to the perception of a larger level of emotional arousal [36, 37, 38]. Also recall that [30] found higher surprise ratings with larger nuclear pitch excursions. Production data for English and German echo *wh*-questions further support this assumption: in contexts with increased emotional arousal, speakers produce larger pitch excursion on nuclear accents [39, 40].

Interestingly, the effects on perceived emotional arousal differed between our experiments. Combining the expressivity ratings with ratings at the illocutionary level exhibited slightly stronger effects than combining them with ratings targeting the source of bias. We propose that this difference is grounded in a closer conceptual proximity of expressivity and current perception compared to giving or seeking information. It seems plausible to assume that expressing feelings is interpreted as being surprised in a context negotiating previous assumptions and contextual evidence that has just come about, and it seems that participants were influenced by the type of scales that they rated. While a possible inter-dependency of these ratings must await confirmation from future research, the notable increase in ratings of expressivity for the fast, step-like L*| H accent, and the additional effect of the H* accent, strongly suggests that the avenue of expressivity is worth exploring further in the context of (the bias of) NQ and PQ.

5. Conclusion

In this paper, we reported a systematic investigation of prosodic variation in prenuclear accents on sentence-initial auxiliaries in English polar questions. Among the auxiliary accents mentioned in the previous literature, only a step-like, fast and steep rise from L* on the auxiliary to H on the subsequent pronominal subject had significant effects on their interpretation in PQ (apart from the obvious differences between PQ and NQ grounding in their polarity difference). These prosodic effects related to the perception of checking contextual evidence ("something [the speaker] just noticed") and expressing strong feelings, that is emotional arousal. In combination, these effects may be capturing a sentiment of surprise, which is encoded by a highly prominent auxiliary that adds an important layer of meaning to an otherwise hardly biased interpretation of PQ. Future work will need to extend the current systematic investigation of prenuclear accents to the nuclear contour (individually and combined) and should also find a way for embedding the present perception paradigm in some pragmatic context to shed more light on the role of accenting in distinguishing origins of bias, that is, what exactly is being double-checked. As a key takeaway from our study, however, we highlight the need to expand classic dimensions of characterising bias through the addition of expressivity.

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